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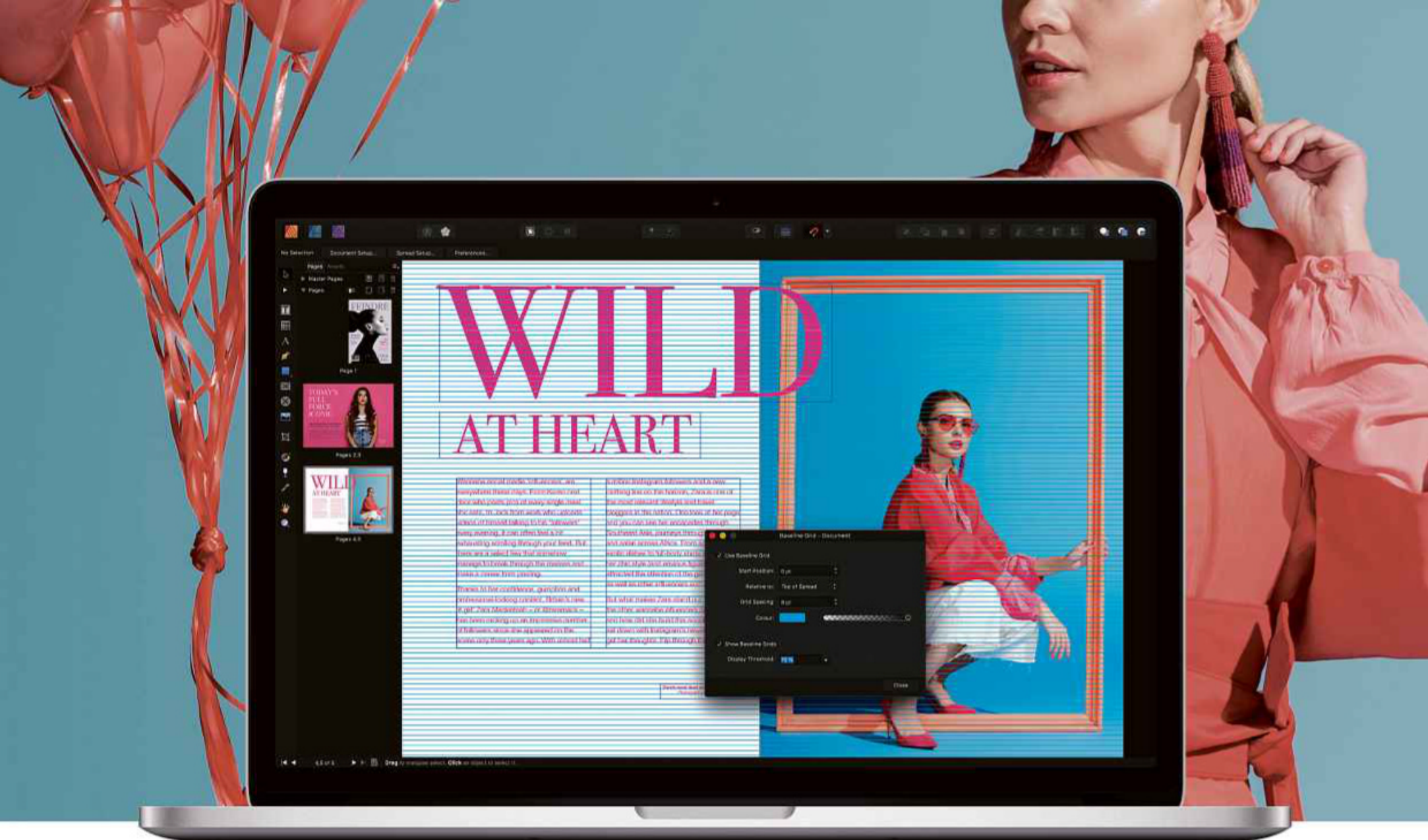
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A DENNIS PUBLICATION

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A year ago, I set up a code club at my children's school, after seeing first hand how limited the students' access to actual computing is during the course of a normal school day.

The club is still running, and more than half the school has since had the opportunity to get to grips with programs such as Scratch and start understanding the back end of a website.

But they're now moving away from software, and on to the insides of a computer. At our latest session, the children were amazed at seeing a tiny micro:bit and starting to understand that a computer is not just the beige box on their desk (this is a school ICT suite, after all – no flashy all-in-one PCs around here), but all the various components that go into making it.

They're all incredibly excited about the next few lessons, when they'll be taking apart some old computers and electronic items to see what's inside, before getting to make a electronic gadget of their own, perhaps a robot or mini arcade console. Although one boy was left disappointed on learning that he couldn't make an iPhone X, both for fear of the school getting sued, and also due to our slightly limited handset-manufacturing resources.

It's a given that most, if not all, of you reading this magazine will be well aware of the inner workings of computers. But that doesn't necessarily mean you've also designed and created your own PC from scratch. Turn to page 88 for our step-by-step guide to building your own dream machine, and you'll soon be reaping the rewards of a custom-built computer.

Hopefully, this guide will inspire you to your first PC build, or come in handy for an upgrade. Better still, if you've got a child, grandchild, niece, nephew or family friend who doesn't know much about computers, get them involved in the build and inspire the next generation of technologists at the same time.

Madeline

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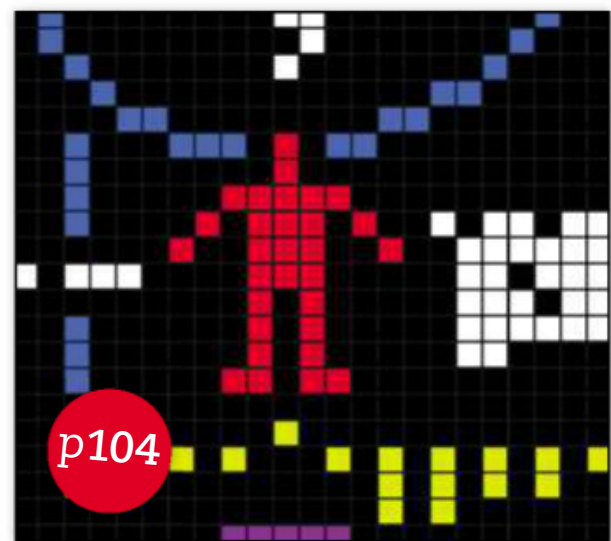
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Letters

Alexa is great for turning on your lights and music, but could it also be used to give vulnerable people peace of mind?

 letters@computershopper.co.uk

Windows update fix

@ I have a lovely little Intel NUC PC running Windows 10.

There was a persistent problem whereby Windows Update was not working. In advanced settings, 'Automatically download updates' was off and refuses to be set to on.

On numerous occasions, I manually updated Windows using the Microsoft Update Catalog, hoping it would fix the problem. It didn't. I tried switching Kaspersky internet protection off, but this didn't enable updates. I searched on the web for the problem and error codes, but although it seemed to be a common fault I didn't come across a straightforward fix. I downloaded and tried WUMT, but still no benefit.

And then, as if by magic, the latest issue arrived through my letterbox (*Shopper 381*). I studied your 'Keep Windows 10 updated at all times' section carefully and worked my way through your suggestions. Every step failed to resolve the update failure until the last: 'You can try to force the May 2019 update.'



I am pleased to report that this has fixed the problem completely. Many thanks for this solution.

R G Willis, Axminster

Share and share alike

@ In response to Bill Edwards' question regarding his

sharing issues with Windows 10 (*Helpfile, Shopper 380*), if the suggested options fail to work, I had a similar issue. In Windows 10 version 1803, Microsoft removed the home group functionality and in doing so managed to break some of the network functionality.

Bill needs to check that the function discovery resource publication service is running. It should start automatically, but doesn't turn on properly after the 1803 upgrade, and this continued into version 1809. Hope this helps.

Chris Hesketh

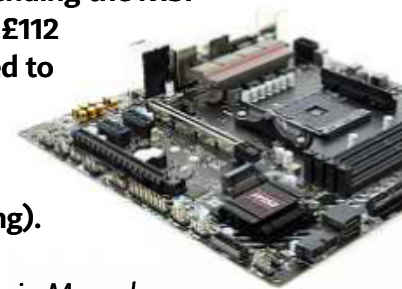
Better buys?


@ I have been monitoring any changes made to the buyer's guides for many months now. There are some discrepancies I have found that I cannot ignore any more.

In Best Buys, you continue to recommend the Nvidia GTX 1050 Ti as the budget GPU. I know it does not require any additional power connectors and draws its power from the PCI-E slot. However, in this day and age I would think most people have a decent enough power supply, and the AMD Radeon RX 570 is a considerably better buy overall in terms of actual performance compared to the GTX 1050 Ti.

You are also recommending the MSI B350M Mortar priced at £112 from Amazon, as opposed to the newer MSI B450M Mortar that can be had for considerably less (£89 at the time of writing). Why is this?

Darrin Maunders



● The B350M is still the best AMD motherboard we've tested at that price. We haven't had the chance to test the MSI B450M Mortar so it's not a candidate for Best Buys yet, and we'll consider the RX 570 as a future addition. 

★ Star letter

Alexa emergency

@ The recent guide on Amazon Alexa (*Shopper 378*) prompted me to write this in respect of the Make calls and Send message application.

I purchased two Echo devices, a Plus to use in the lounge and also a Dot for the bedroom. I expect that very many households have a requirement for through-house entertainment, but I would like to see more mention from publishers and manufacturers of the potential benefits of buying these from the point of view of calling for aid if people, in particular the elderly, find themselves in a situation where they are unable to reach the phone in an emergency situation.

Friends, neighbours and family could encourage and indeed help those at risk to install these devices and encourage single or people at home alone to call them if

they find themselves taken ill, have an accident or if they take a fall by agreeing to act as their watch over. The recipient of a call could then quickly call emergency services.

Clearly the emphasis would have to be on an emergency situation only, particularly with friends and neighbours, and it would



have to be made clear that the 'Drop-in' could not be a means of regular companionship support as determined by the user.

This could in any event be controlled by the minders if this turned out to be the case.

Keith Pearce

» Write in and win

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As a thank you for helping us find the winners, we're offering every reader the chance to win a prize (see the awards website for full details).

Voting is open now and closes on Thursday 7th November, so please make sure you've filled in the online voting form by then to ensure your favourite products get the awards, and you get the chance to win the prize.

COMPUTER SHOPPER AWARDS 2019

WE'LL BE ANNOUNCING ALL THE WINNERS OF THE COMPUTER SHOPPER AWARDS 2019 IN SHOPPER 384, ON SALE FROM 5th DECEMBER

In the next issue



«Bye bye, Windows 7

We explore the options if you want to keep running an unsupported operating system, and whether the features in Windows 10 mean it's no longer worth running an old OS



«Graphic design

We go in search of the best budget, mid-range and premium graphics cards, with full tests of AMD's and Nvidia's latest GPUs

»Christmas sorted

Our round-up of the best technology gifts for everyone from kids to commuters, and foodies to technophobes



»Telling the future

We explore the world of computer simulation, from its vital role in developing life-saving drugs to why it's not always so successful in weather forecasting and economic modelling



COMPUTER SHOPPER ISSUE 383 ON SALE IN NEWSAGENTS FROM 7th NOVEMBER

Appy hour

A new app means you don't even have to leave your seat to order drinks from the bar. **Mel Croucher** braves the sticky carpets and cheap despair in Wetherspoons to test it out



MEL CROUCHER

Tech pioneer and all-round good egg
letters@computershopper.co.uk

I AM SITTING in a branch of the Wetherspoons pub chain and I am unhappy. This matches the condition of everyone else in here. I am in an unfamiliar city and I need a place to sit down, charge up my laptop and drink a coffee, before meeting a lady and two gentlemen in a nearby office with whom to do business. By the look of it, this Wetherspoons may once have been a dancehall, or an abattoir, which in my day served much the same purpose. It is one of 900 similar establishments under the control of Tim Martin.

I have never met Tim Martin, but I don't like the cut of his jib. I don't like the cut of his hair. I don't like the cut of his Wetherspoons rug, soaked in the sticky dregs of ill-informed hostility and cheap despair. But I do like the fact that there's no need for me to go to the bar and risk losing my seat, my laptop or my temper, because

"You have to serve yourself over there, mate."

I explain that the only reason I am using the app is that I don't want to leave my temporary office seat and abandon my electronic appendages.

"Over there, at the machine."

DUMB WAITER

I try to cancel my order. It turns out this is impossible, because the app is satisfied I have paid and received a cup of coffee, as opposed to paid and received a cup for coffee. Sod this. I gather up my gear and approach the bar to complain. There is nobody to complain to, because app orders are dealt with by special people with special powers that render queuing customers invisible. I wait. And I wait.

I am often rendered invisible in unfamiliar pubs, where preference is given to regulars, loudmouths, note flashers, sociopaths and drunks. But

provoke more arguments than it solves, and it's obvious to me that queuing wrangles can be solved not by yet more facial recognition intrusion, but by employing good bar staff. Preferably named Betty.

'SPOONS FED

It has now been 25 minutes since I entered this distinctive circle of hell. If it wasn't for the fact that I can arrive for breakfast, drink for £1.99 a pint and be on dialysis by lunchtime, then I would never frequent a Wetherspoons again. As it is, all I want is Tim Martin's phone number so I can tell him where to stick his antisocial app.

I have an empty coffee cup, whereas his cup runneth over with my data. And the data he slurps from me is not insignificant. According to the embedded terms and conditions, the Wetherspoons app logs my name, my payment alias, my payment account number, my domestic address, my email address and my phone number. It also stores a record of my current location, browsing history, and everything I've eaten, drunk or evacuated in the toilet, and all this private information is stored in its database.

And just for good measure, the small print declares, "Our sites may contain links to and from the websites of our partner networks, advertisers and affiliates" and "we may disclose your personal data". Oh, for crying out loud! Or, in the case of the habitual drinkers hereabouts, for crying out softly into their glasses of cut-price oblivion. The phrase "partner networks, advertisers and affiliates" can be translated as "your private data is up for grabs and your personal habits will be exploited any way we like, sucker".

As I leave the premises, I spot a sign that has been attached to the self-service coffee machine. Wake up and smell the coffee? No. It reads, "Out of order". ☹

I am often rendered invisible in unfamiliar pubs, where preference is given to regulars, loudmouths, note flashers, sociopaths and drunks

Wetherspoons offers an automated table service option, and I have just downloaded the app to make use of it.

The Wetherspoons app already knows who I am and where I am, which is more than I do. I have fed it my payment details, my table number and my order for a regular Americano, and now I wait for table delivery as I go through my notes and files. I wait a little while. I wait a long while. After eight minutes, I hail a harassed member of staff and ask where my coffee is. I wait a while more. According to my screen display, it is now 12 minutes since I placed my electronic order.

The harassed member of staff returns. He hands me a spoon and an empty coffee cup.

there's an app for this, too. It's called AI Bar and it's offered by a company called Data-Spar-Q.

It uses facial recognition to scan crowds of thirsty boozers and assign them democratic service on a first-come, first-served basis. As soon as you hit the bar, AI Bar's superintelligence allocates you with a queue number, and your mugshot appears on a shiny screen to show bar staff when it's your rightful turn to be served.

All it needs is a webcam, an iPad for each member of staff, a monitor, a decent broadband connection, and a £200-a-month ransom payment by the landlord.

The system also alerts staff to anyone who it reckons is under age, banned or too pissed to be served. This, of course, will

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A cure for procrastination?

She lives by the maxim, 'Never do today what you can put off until tomorrow'. But **Kay Ewbank** has discovered a tool that may help her tackle her to-do list



KAY EWBANK
Software guru and Shopper legend
letters@computershopper.co.uk

THE OTHER DAY, I caught sight of my to-do list in Outlook, and realised that most of the items had been languishing on there for months, if not years. In my defence, this is my personal to-do list rather than my work-related one, but it did make me think I really ought to do something about my procrastination problem. Fortunately, by the time I'd watered the greenhouse, hung out the washing, had a cup of tea and played a couple of games of Spider Solitaire, the feeling had dissipated.

LOTUS POSITION

For 'real' work, I use the calendar in Outlook, but that doesn't really work for the sorts of tasks that don't have a due date. Personally, I still mourn the loss of Lotus Organizer (there's a blast from the past). For those of you who don't remember Organizer, it looked like a Filofax, and you could easily set up separate 'pages' for subsets of tasks such as

There are modern snazzy organisers such as ToDolst, which many people swear by, but none of the ones I've tried has motivated me like Organizer used to. This month, however, someone sent me details of a new to-do organiser called Gone. This uses a really scary technique – every item only shows up for 24 hours, then it's gone.

MAKING PROGRESS

What happens is that when you create a task, it appears on your to-do list, but over the next 24 hours a progress bar appears and fills up. Once the bar is completely full, the task disappears – gone. It acted as a strong motivator to begin with, but I found after a while that rather than rushing to finish a task in time, I was adding it again to get another 24 hours. Gone's a good idea, however, so long as you live by its rules.

One slight problem with Gone is that it's web-based, so you only see the tasks if you open Gone as a tab in your web

apparent is to use a New Tab Redirect add-on for your web browser and set it to show your Gone page every time you open a new tab, and this is a useful thing to know about whether or not you're using Gone.

New Tab Redirect is something that's useful for more than this particular situation. As the name suggests, it lets you specify a page to appear when you open a new tab. I know some people who choose to show their recent browser history, for example, making it easier to find a page you've recently used.

Depending on which browser you're using, you can also set the tab to open a local file. This might provide a useful alternative to Gone; you could create an HTML page where you have your current to-do list, and see the contents whenever you open a new tab – without the items disappearing in a day!

REDIRECT ACTION

There are New Tab Redirect or Override add-ons for Chrome and Firefox, and if you choose to install the appropriate add-on you'll get the chance to specify the URL of your Gone page. If you're using Microsoft Edge as your browser, you can set an alternative start page from the Settings, More, Settings, Launch option, where you can choose a specific page to be used.

So am I using Gone, and has it stopped me putting things off? I'm still giving it a go, and it has made me get on and finish one or two things that would probably still be languishing on my list without its nagging. However, in addition to adding jobs back on to Gone once they're about to expire, I've found myself adding tasks to Gone... and then to my 'usual' to-do list manager in Outlook, just so I can't forget them. Once a procrastinator, always a procrastinator. 📧

I thought I ought to do something about my procrastination problem. By the time I'd watered the greenhouse, hung out the washing, had a cup of tea and played a couple of games of Spider Solitaire, the feeling had dissipated

'garden' or 'kids homework'. What I liked about it was the way you could enter tasks then cross them out, and still see what you'd achieved.

I worked with one colleague who used to write things like 'make a cup of tea' just so she could get the reward of the noise it made when you finished a task. The closest I get to Organizer these days is the back of an old envelope and a handwritten list, and that's a sad state of affairs for someone who spends so many hours on a computer.

browser or if you click on the tab while you've got other tabs open. However, if you open the tab and see that a task has only a short time to live, it gives a feeling of urgency that is a good incentive to actually get on and finish that item.

The fact you have to remember to look at the tab on your web browser is a drawback. If you're busy enough to forget to finish a task, chances are you'll forget to check what tasks you're forgetting.

One suggestion for how to make the urgency more



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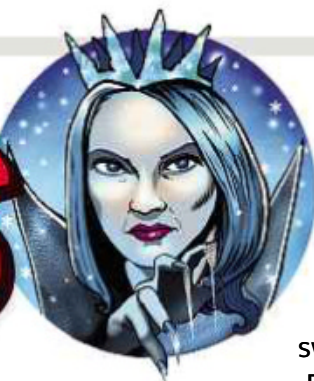
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RANTS & RAVES

Whether it's old-fashioned tills in high-street shops or venerable mobile phones, sometimes the old ways are still the best

Madeline Bennett

RANTS



THE LAST WEEK of September was another sad week for the UK high street. Travel operator Thomas Cook went out of business after 178 years, leaving holidaymakers stranded and thousands of people out of a job. This was followed by Sainsbury's announcing it was closing 70 Argos stores, leading to hundreds of job losses.

The blame was placed partly on the internet. Retailers are often accused of failing to shift their business over to the world of online fast enough, and so digital competitors are left to cash in.

But even when high-street companies try to capitalise on the latest technologies, it doesn't always go their way. Earlier this year, Sainsbury's refurbished its Holborn store to remove the checkout area. Rather than queuing at a till, customers had to download an app to their phone, scan items as they went round the store and then pay for them through their handset.

No doubt the supermarket's digital experts were thrilled with the whole concept, excited at the notion of setting shop assistants free from behind their tills to instead help customers on the shop floor (although I'm sure the prospect of job cuts may have also crossed their minds) and tech-savvy millennials swanning around the store waving their iPhones.

But it didn't turn out that way. Instead, customers were stuck in long queues at the helpdesk as people attempted to pay for their groceries using cash or a card. So Sainsbury's has ended up paying to have some tills put back into the store, and will probably not be running any other till-free experiments any time soon.

What Sainsbury's learnt the hard way is that even in the face of internet shopping, there's still a real need for a high street with grocers, banks and other services for those who want to pay cash or go in and talk to an actual human. Perhaps the bricks and mortar companies would do well talking to firms such as Amazon to get tips on technology systems to invest in, or even teaming up with their online competitors – my local Co-op is an Amazon Locker point, meaning there's an extra reason to pop into the store even for avid internet shoppers. It's certainly a much more sensible use of space and investment than mobile tills nobody wants to use.

James Archer

RAVES



IT BEGAN, AS it often does, with an argument. Smartphones are status symbols, argued my fellow enthusiast; owning the latest and most powerful model, or at least being seen using it, would raise your station in the eyes of tech cred arbiters and grant you opportunities otherwise closed off.

This stance is silly for a variety of reasons, but the joke's on him: not only has he now been paraphrased in a mildly uncomplimentary manner, but he's also rekindled my love for several ageing and underpowered devices from my past. None of these would have enhanced my schmoozing capability with far cooler or more influential people, but they remain testaments to how seemingly soulless gadgets can become treasured mementos.

Case in point: my Samsung NC10. Bought for about £300 – a relative pittance even in 2008 – and smaller than my hand span, the NC10 nonetheless proved to be a trusty companion that managed to

see me through university even after an ill-advised installation of Windows Vista. It's telling that, after retiring it for some Acer ultraportable I ended up hating, I couldn't bear to part with the NC10, and kept it in various cupboards like a family photo album.

Similarly, it took about seven years before I could bear to dispose of an old HTC Wildfire – my first proper Android smartphone – and that certainly never impressed anyone worth impressing. What it did do, much like the NC10, was provide a reliable constant through several eventful years: the moves, the late nights in libraries, the friendships and the breakups, it was always there, and ready to do its job. Everything starts as a mere product – a tool – but don't underestimate the power of formed attachments over fashion and forced obsolescence.

Even my current handset, a Google Pixel 2, feels as if it's getting long in the tooth, but as both a work aid and a social sidekick it's already served faithfully enough to have pre-emptively earned a spot in the storage drawer of fame. I won't be upgrading before it starts to falter, and that's not out of monetary concerns or a deliberate aversion to the 'prestige' of having something newer and shinier.

Never be ashamed to stick with something just because you like it, as whether it's a phone, laptop, tablet, camera or anything else, there will be many like it – but that one is yours.

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NEED TO KNOW

The biggest stories from the tech world, and what they mean for you

Acer reveals world's 'slimmest ever laptop'

SAY WHAT?

CUTTING MILLIMETRES OFF the thickness of laptops has been a target for ultraportable laptops for some years. The crown for world's slimmest laptop has passed between the major computer makers and spawned subcategories of other slim laptop types, such as the world's slimmest gaming laptop.

At the recent IFA 2019 consumer electronics show in Berlin (see page 100 for our full report), *Computer Shopper* witnessed Acer reveal what it claims is the "world's slimmest 14in laptop" in the form of the redesigned Swift 5.

While the Swift 5 from 2018 was far from a chunky machine, 2019's model measures a mere 14.95mm thick, and it's light as well at 990g. Yet despite this svelte frame, it still manages to fit in a USB-C port with Thunderbolt 3 compatibility, a brace of USB Type-A ports, an HDMI connection, Kensington lock and a 3.5mm headphone jack. It also has a 14in display, running an acceptable if not razor-sharp 1,920x1,080 resolution, and slim bezels help the display look larger than it really is.

Under the chassis, you'll find a fairly standard 8GB or 16GB of RAM, and storage that tops out at 512GB of PCI-E SSD space.

However, there are two interesting factors. The first is that the Swift 5 can be specced with Nvidia's GeForce MX250, a dedicated graphics card that, while far from a gaming-grade GPU, should handle some more graphically demanding tasks with better aplomb than laptops stuck with



regular integrated GPUs in the form of Intel UHD graphics accelerators.

The second is the Intel Core i7-1065G7 processor. That's the second most powerful CPU in Intel's new 10-nanometre (nm) 10th-generation laptop processor line-up.

Not only does it bring a quad-core processor to a slim machine, it also offers the performance gains and power efficiencies Intel has extracted from its new 10nm process node. We've yet to properly see such chips in action, but the Core

i7-1065G7 can apparently hit 3.5GHz across all four of its cores, which is no mean feat for a laptop chip with a base thermal design power of 15W.

The CPU comes with Intel's new Iris Plus integrated graphics accelerator, which promises a significant hike in graphical performance over Intel UHD, although in the Swift 5 the GeForce MX250 was on graphics duty.

Battery life is set at 12.5 hours, which is pretty good for a laptop that doesn't feel as though it has much of a battery pack inside it. A full test will reveal if the Swift 5 lives up to Acer's claims of electrical endurance, but the Ice Lake chips touted improved power efficiency over the older eighth-generation Core laptop CPUs, so over 10 hours of battery life in regular use isn't beyond the realms of practical possibility.

Acer is not only keeping the laptop slim, but also giving it a wallet-friendly price that starts at €899 (£812); not bad for a svelte 14in laptop, although we'll reserve judgment until we've given it a full review.

Qualcomm aims to bring 5G to the masses

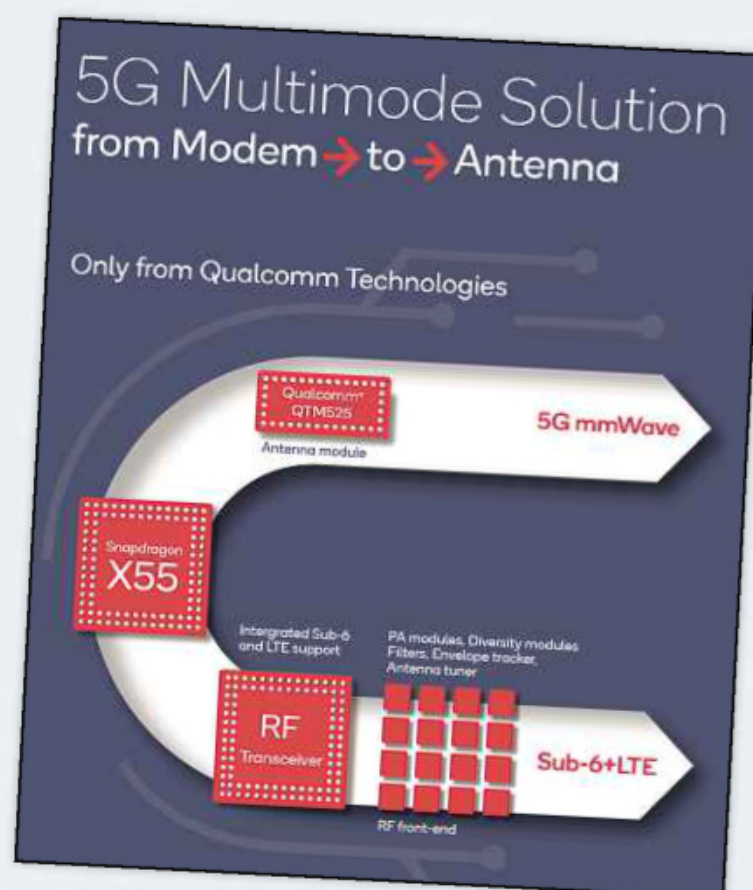
SAY WHAT?

5G IS HERE, but it's only really available in a limited number of smartphones. And those phones, such as the OnePlus 7 Pro 5G and Samsung Galaxy S10 5G, are flagship devices with expectantly high prices.

As such, while 5G networks are being rolled out and expected to cover more cities and areas as 2020 comes around, there isn't a vast number of smartphones accessible to all that can tap into the speeds and bandwidth the next-generation network promises and seems to be delivering so far.

But Qualcomm hopes to be the firm that helps turn that around. At IFA 2019, the chip maker noted that it will be bringing its 5G modem chips to its 6- and 7-series Snapdragon system-on-a-chip ranges.

If you currently want a Qualcomm chipset that supports 5G, you need to have an SoC from the high-end 8-series, notably the Snapdragon 855. Unsurprisingly, you'll find such a chip in phones that cost over £1,000 in the case of the



Galaxy S10 5G and come at a monthly cost of £79 on an EE contract for the OnePlus 7 Pro 5G.

However, Qualcomm's plan to bring 5G modem chips to its mid-range chipsets, found in the likes of Nokia smartphones, is set to change that.

Qualcomm didn't say when we can expect to see 5G modems pop up in 6- and 7-series Snapdragon chips. But we wouldn't be surprised to see a suite of affordable phones with 5G compatibility early next year.

There still remains the issue that 5G contracts could still be pretty pricey even if cheaper 5G phones arrive. However, as more 5G networks roll out and 5G coverage expands, we can expect competition between the telecoms providers to heat up and thus result in better-priced deals for people after a 5G phone and contract.

SO WHAT?

YOU MAY SIGH at yet another laptop that's ever so slightly slimmer than previous models. But what's interesting here is that computer makers haven't called it a day when it comes to shaving off depth from their laptops.

Packing in a processor that promises solid performance and adding a dedicated graphics card into the mix takes a bit of engineering nous, as the heat such components generate needs to be siphoned away while ensuring hot air isn't vented uncomfortably onto the user's lap or hands.

So improvements in cooling such specs in a slim chassis are likely to benefit future models in the rest of Acer's laptop line-up, and potentially laptops from other brands that are looking to steal the thin crown from the Swift 5. And having a super-slim laptop is always appreciated if you do a lot of travelling or working on the go.

Another thing the Swift 5 showcases is the role of Intel's new Ice Lake processors in the laptop world. With the potential for Ice Lake



chips to offer not only a boost in processor performance but a hike in graphics power, an incoming wave of new ultraportables looks to offer machines that can not only handle plenty of day-to-day computing work but could even manage a bit of gaming and graphics-rendering tasks.

With the Swift 5, there could even be an argument for opting for a model without the GeForce MX250 graphics card in order to tap into the performance of the Iris Pro, providing it lives up to Intel's claims, although Nvidia's dedicated graphics card probably still has a role in some tasks that work well with its drivers and architecture.

The Swift 5, alongside a few other ultraportables shown off at IFA, is the tip of the iceberg for Intel's Ice Lake thrust. And we can expect to see more laptops popping up using the chip maker's 10nm processors, which could yield machines with some impressive performance in laptops that can be easily held between two fingers.

SO WHAT?

QUALCOMM'S 5G AMBITIONS are nothing new. The chip maker revealed its Snapdragon X50 modem last year, and earlier this year showcased the Snapdragon X55 modem chip with access to a new antenna package to improve the way 5G signals are received and reduce the power consumption of 5G connectivity.

But 5G is in a bit of a Catch-22 situation; while a 5G network is needed for tech to connect to it, there's no point having a network if there aren't any devices that can access it.

With a few phones now available that can support 5G and more on the way, and with the networks being rolled out, there's now a base for the next-generation connectivity. But the challenge is scaling it up.

"That is our next industry challenge. We launched this technology, but now we're committed to drive the proliferation of 5G

“We want all users to have the benefit of this technology”

Qualcomm president Cristiano Amon

across all device tiers,” said Qualcomm's president Cristiano Amon at IFA 2019.

“We want all users to have the benefit of this technology.”

That's where Qualcomm's pushing down of its 5G modems to other Snapdragon chipsets will come into play. Such chips will help pave the way for more affordable 5G phones, which in turn should get more people moving from 4G to the faster network. In theory, that could propel further 5G rollouts.

This means all the things that technology companies and luminaries have been claiming 5G will bring could then become a reality for large numbers of people. That could mean watching 4K movies on the go rather than needing to download hefty files, or streaming graphically impressive games over 5G through upcoming services such as Google Stadia and Microsoft xCloud.

BOOTING UP

Ultrabook oomph

Razer's Blade Stealth ultraportable now comes with Intel's 10th-generation Ice Lake processors and an optional Nvidia GeForce GTX 1650, making it a genuine gaming ultraportable

Apple's aces

Apple has launched the iPhone 11, iPhone 11 Pro and 11 Pro Max. The former is a decent upgrade over the iPhone Xs, while the latter models pack in a triple camera array and a slick Super Retina RDX display



Helping hertz

OnePlus has taken the covers off the OnePlus 7T, which now comes with a 90Hz display, triple camera array and Snapdragon 855 Plus chip

Robo rumba

A strip club in Nantes, France, has added two new dancers to its line-up: robots with a camera for a head to make punters think about the nature of voyeurism

Whistleblowing

Edward Snowden faces a civil lawsuit in the US alleging material in his memoirs breach non-disclosure agreements he had with government agencies

NAS-ty security risks

Cyber security researchers found a mix of 13 routers and NAS devices, including those from Lenovo, Netgear and Zyxel, contained flaws that could expose them to remote hacking

Blundering broadband



Zen Internet has found that a fifth of internet users in Southampton and Glasgow are fed up with their broadband service because it's slow and unreliable, leaving local residents feeling stressed

Pricing out of this world

Samsung's folding phone, the Galaxy Fold, is now on sale, but EE is the sole seller in the UK and the handset will cost a hefty £119 a month, or £2,856 over the course of a two-year contract

CRASHING

FROM THE LAB

Wi-Fi 6 launches, promising a new era of wireless connectivity

SLOW WI-FI SPEEDS can be one of the most frustrating things in modern life, but that could change soon with the launch of Wi-Fi 6.

Wi-Fi 6, or 802.11ax, will not only make browsing and downloading faster, it also promises to boost the battery life of phones, tablets and other devices, and save energy and money.

If you think of a traditional Wi-Fi network as being like a motorway, the data is the vehicles: they can only travel in one direction, and even though they may be able to change lanes, their ultimate direction of travel and destination are the same. The first versions of Wi-Fi were narrow, so few cars/data packets could travel on them. As standards improved, the 'road' – the bandwidth – was widened to increase the number of cars, and lanes were put in to help handle this flow of cars/data. However, as more cars joined, the lanes became congested.

Wi-Fi 6 solves this congestion problem by using access points that can send data to multiple devices all at once. It works out how much bandwidth is needed for a single task and reserves that amount of bandwidth for that single device, while simultaneously doing the same for every other device it's connected to. For example, a 4-K video requires much more bandwidth than sending a tweet, so the larger amount of data is reserved and sent to the streaming device, and a smaller packet is sent to Twitter, without one slowing down the other.



Wi-Fi 6 technology also has a feature called Target Wake Time, in which Wi-Fi radios built into devices only need to be on when they're sending or receiving data, significantly boosting battery life in everything from phones to smart light bulbs.

Wi-Fi 6 is capable of reaching speeds of 9.6Gbit/s, compared to 3.5Gbit/s on Wi-Fi 5 (or 802.11ac).

However, these speeds are theoretical maximums and are rarely, if ever, achieved in real-world tests. Wi-Fi 6 is quoted as being around 30% faster than Wi-Fi 5's average of around 1.2Gbit/s.

Currently, devices such as the Samsung Galaxy Note 10 and the latest iPhone 11 models are Wi-Fi 6 certified. Netgear was one of the first to sell a range of Wi-Fi 6 routers under its Nightgear AX brand, and other manufacturers, including Asus and TP-Link, have also joined the roster.

But before you panic about accidentally buying a Wi-Fi 6 device you're lacking a supporting router for, you needn't worry. All Wi-Fi 6 devices and routers are backwards-compatible, meaning they will work with older Wi-Fi standards.

However, only certified devices will benefit from the faster Wi-Fi 6 speeds. The plus side to this is that freeing up bandwidth and more efficiently sending data to Wi-Fi 6 devices will have a knock-on effect on the rest of the network. It will clear the air, so to speak, of those devices, making more bandwidth available to older devices on your network, helping to ease congestion and boost speeds.

Self-driving cars could reduce crashes by 22%

NEW RESEARCH FROM the Transport Research Laboratory (TRL) estimates that almost a quarter (22%) of collisions may be avoided by introducing highly automated vehicles.

TRL anticipates that level 4/5 automated vehicles will hit the streets at a level of 4% by 2025, increasing to 25% by 2030. These self-driving cars require no human intervention during defined use cases, such as motorway driving, with the driver handing over full control.

The TRL study used in-depth case analysis from Road Accident In-Depth Studies (RAIDS) and vehicle fleet data, and found that by replacing one traditional vehicle in a collision with an autonomous car, an estimated one in five serious and fatal incidents could be prevented.



The study further projected a reduction in crashes involving vulnerable road users, junctions and single-vehicle incidents. This could potentially prevent up to 650 collisions resulting in serious and fatal injuries annually by 2040 if between 8% and 19% of cars were automated.

The study was limited to one- and two-vehicle collisions that resulted in serious injury or fatality.

"Our analysis suggests the introduction of automated vehicles to our roads is likely to bring the biggest change in road safety since the introduction of the seatbelt," TRL Academy director Richard Cuerden said.

"However, more data is needed to build a more in-depth and robust view of future collisions and opportunities for improving occupant protection."

SOUND BYTES

“It's clear that we fell short of our high standards in making it easy for you to understand how your data is used, and we apologise”

Google promises it will no longer listen in to audio from its Assistant users, unless they have agreed to human review

“Very few people are talking about this, but if we are not careful one or more of these weapons, these killer robots, could accidentally start a flash war, destroy a nuclear power station and cause mass atrocities”

Ex-Googler Laura Nolan worries about AI starting a war

“We had to walk away from some low-end mobile share as well as some channel desktop share”

Jason Grebe, Intel's Cloud Platforms and Technology Group general manager, basically notes the chip-maker has lost market share to AMD

“Human speech to a computer will sound like very slow tonal wheezing, kind of like whale sounds”

Elon Musk musing on what humans will sound like to future AIs

THE LOWDOWN

Samsung SmartThings

A closer look at the comprehensive smart home platform

HASN'T SMARTTHINGS BEEN AROUND FOR A WHILE?

You're right: SmartThings started life as a platform for so-called Internet of Things (IoT) gadgets back in 2012. It was then snapped up by Samsung in 2014, and over the years the South Korean electronics giant has been building the platform to support all manner of gadgets, not just those it makes.

But the smart home device market and ecosystem is a confusing one, with plenty of brands having their own control systems, and startups offering software platforms to tie disparate gadgets together.

Suffice to say, SmartThings hasn't really marketed itself in the best way. Sure, plenty of smart home gadgets with SmartThings certification have been sold, but Samsung hasn't really come up with a compelling way to present the platform.



SO WHY SHOULD I CARE?

Because Samsung has finally got its act together and is now presenting SmartThings in a fashion that really showcases what the platform can do. We recently visited a swanky apartment overlooking London's Wembley Stadium to see a flat that was fully kitted out to be a real-world SmartThings demonstration.

When we've seen such smart home demonstrations before, we've been aware that a lot of the tech is in the works or undergoing further development. But Samsung's showcase was assembled from smart gadgets and systems that can be bought today.

There was a whole suite of smart devices all shown working together to produce a comprehensive smart home that can be controlled from one multi-platform app, rather than showing how you can bark a command at a smart speaker to turn on some lights.

Instead, smart devices from Samsung and other brands all fed into a SmartThings hub and the cloud-based SmartThings platform, where the heavy lifting of pulling all these devices together is taken care of by Samsung servers. That meant we got to see certain SmartThings scenarios in action, such as the 'laundry experience'.

EXCUSE ME?

While it's a term that smacks of lifestyle marketing-speak, in action this showcases how a laundry load can be set up with a slick Samsung washing machine, which uses its smarts to figure out how best to clean the load.

All this can be controlled with Samsung's SmartThings app, which works on Android and iOS, allowing washing to be scheduled and monitored.

It might seem a bit like overkill, but Samsung claims that for families with a busy lifestyle these small time-saving techniques add up to making a solid difference to managing the chaos of modern family life.

And this is Samsung's big push with SmartThings. The company is showcasing how it can influence lifestyles rather than present it as an impressive open IoT platform for only the tech-savvy.

WHAT OTHER PRODUCTS WERE ON SHOW?

Naturally, Samsung had a connected fridge, which has become a bit of a joke in discussions around IoT devices. But the company presented it in a scenario where it's actually useful.

Rather than have a fridge ordering milk, it contains a camera so someone can look at what's inside through the SmartThings app to see if they're missing an ingredient for the evening meal while

they're on the commute home, and thus find out if they need to pop into the local corner shop on the way back.

At the same time, other connected devices such as lights and speakers can be configured to effectively set the mood when dinner is being served.

Essentially, SmartThings is about streamlining life, with connected cookers or vacuum cleaners given routines to ensure a family can return home to a clean house, with food ready to eat and an ambience for a relaxed evening.

ISN'T THIS ALL A BIT FADDISH?

SmartThings also provides a platform for home security. Not only can feeds from smart home cameras and doorbells pipe live footage to Samsung TVs from 2018 and later, SmartThings plugs can detect when something like a pair of hair straighteners has been left on and allow for them to be turned off remotely.

One thing that impressed us is a small cheap sensor that can detect when a tap or sink is leaking and feed that data back to a hub. This tells the SmartThings platform that there's water where there shouldn't be, which will then trigger another connected unit to switch off the mains water supply to the house or flat. This could stop a leak escalating into a major house flood and an expensive insurance claim; a setup costing around £100 could prevent damage to the tune of thousands of pounds.

THIS ALL SOUNDS EXPENSIVE

Samsung didn't say how much the setup its showcase would cost, but the mix of high-end TV, fridge and washing machine isn't likely to be cheap.

However, a few smart sensors connected to a SmartThings hub is all that's needed to begin with, and over time the platform can be expanded with new TVs, speaker systems and sensors added to the setup.

SmartThings is designed to help Samsung sell more of its smorgasbord of electronics, especially as whole swathes of its tech is now coming with the connectivity. And while the firm has its own Bixby virtual assistant, Samsung happily showed us how SmartThings works with Google Assistant, Amazon Alexa and Microsoft Cortana.

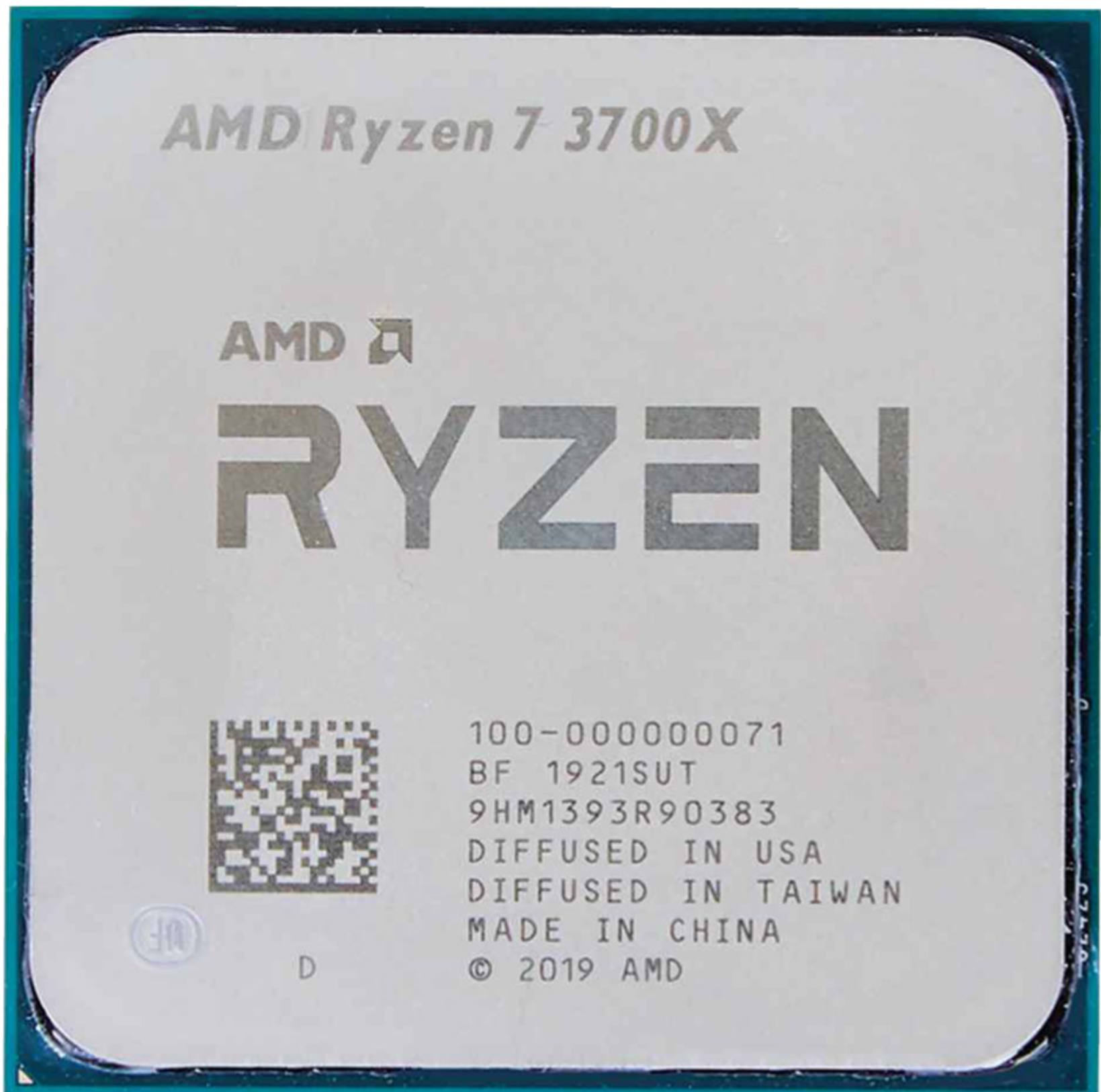
For people with older Samsung devices, such as its smart TVs, the company told us it has plans to effectively retrofit SmartThings to its pre-2018 devices.

While smart home tech might seem like a mess of gadgets with different apps and control systems, SmartThings is pushing ahead to be the one platform that binds them all together. 📺

A family can return home to a clean house, with food ready to eat and an ambience for a relaxed evening

REVIEWS

YOUR TRUSTED GUIDE TO WHAT'S NEW



AM4 PROCESSOR

AMD Ryzen 7 3700X



£313 • From www.ebuyer.com

VERDICT

Big power, small price and unbeatable efficiency, the Ryzen 7 3700X is a triumph of CPU design

EVEN IF IT'S not the most powerful CPU in AMD's newest, third-generation Ryzen series, the Ryzen 7 3700X makes the best poster child for what this processor family is all about. The Ryzen 9 3900X (*Shopper 381*) has more cores and threads, while the Ryzen 5 3600 is cheaper, but it's the Ryzen 7 3700X that most fully encapsulates the AMD way: loads of cores, high performance and a low price, at least compared to Intel equivalents.

SWEET 16

First, let's look at the cores. You get eight of them here, with a total of 16 usable threads via Simultaneous Multi-Threading (SMT). The 12-core, 24-thread Ryzen 9 3900X has it beat, but that's more for bridging the gap between mainstream and enthusiast CPUs; the Ryzen 7 3700X is a fully mainstream chip, and in this arena it's unbeatable. Even its closest Intel rival, the Core i7-9700K, has eight cores but only eight threads.

Next, performance. Following on from the Ryzen 7 2700X (*Shopper 366*), AMD has taken the unusual step of clocking the Ryzen 7 3700X with a lower base clock speed but a higher boost clock speed, rather than raising both, as you'd expect. It consequently runs at a minimum of 3.6GHz, compared to 3.7GHz on its predecessor, while its maximum boost clock has gone 100MHz in the other direction, up to 4.4GHz.

AMD's usual dynamic auto-overclocking features, Extended Frequency Range (XFR) and Precision Boost, are both present, but as with second-generation Ryzens, their potential gains are included in the stated maximum boost speed. You'll therefore need a good cooler to ensure there's sufficient cooling headroom for both systems to kick in.

Lowering the base speed also seems counterproductive, but based on what we've seen from the Ryzen 9 3900X and Ryzen 5 3600X, there are reasons to be confident. Like these chips, the Ryzen 7 3700X is built

exchange. It's also a hefty £233 cheaper than the Ryzen 9 3900X, which is an effective consolation to missing out on four extra cores and eight extra threads.

CORE STRENGTH

There's no integrated graphics, which is fine as the Ryzen 7 3700X is intended specifically for desktop systems with dedicated graphics cards. What you do get is an RGB-lit Wraith Spire cooler bundled in the box. It's not a bad start if you spent the last of your PC build

beat the Ryzen 9 3900X, which hit 168. Amazingly, it even edges past the 173 scored by Core i9-9900K, which is supposed to be Intel's best single-core performer – even more so than the Core i7-9700K.

Moving on to the video-encoding test, the Ryzen 9 3900K's additional threads helped it take a healthy lead, but the Ryzen 7 3700X is still king of its price range with 315. That's practically enough for professional-grade media editing, contained within a relatively affordable consumer CPU.

ON THE RISE

The multitasking test produced its single best performance, with a score of 389. Again, this isn't close enough to bother the Ryzen 9 3900X, which smashed the record with 523, but it's better than you'd get from even an overclocked Core i7-9700K. It's also a single point behind the Core i9-9900K's multitasking test result: an incredible achievement, considering Intel's top-end chip has far higher clock speeds and a price on a par with the 3900X.

Overall, the Ryzen 7 3700X scored an excellent 330, improving on the Ryzen 7 2700X by 99 points and outperforming the Core i7-9700K. 330 also happens to be the exact same overall score as that of the Core i9-9900K, so not only does the Ryzen 9 3900X outshine Intel's premier CPU on

with an updated 7nm FinFET process, making it more efficient than previous 12nm and 14nm Ryzens. This efficiency doesn't just reduce energy consumption; it also allows, in theory, for more instructions per clock cycle, potentially allowing the CPU to blast through more processes at 3.6GHz than the Ryzen 7 2700X could at 3.7GHz.

Lastly, there's the price. We've found the Ryzen 7 3700X for £313, which is higher than what the Ryzen 7 2700X cost at launch but still easily undercuts the £375 Core i7-9700K – which, don't forget, offers fewer threads in

budget on the chip itself, although for the best XFR and Precision Boost performance, it's better to pair this CPU with either a larger air cooler or a watercooler system. For consistency with previous Ryzen testing, we used the Noctua NH-U12S.

With both components installed in our test PC, with a GTX 1060 on video output duties, the Ryzen 7 3700X put in a commanding performance in our benchmark tests. Its image test score of 182, for example, isn't just a major improvement on the Ryzen 7 2700X's score of 149 – it even

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The Ryzen 7 3700X isn't just a quintessential Ryzen chip, but it's very nearly the complete CPU package in general

performance, but the lower-tier Ryzen 7 3700X beats it on value.

Of course, the 422-scoring Ryzen 9 3900X also remains the better choice for heavy-duty multitasking, but this is a fantastic effort for the money. The slightly lower base clock speed doesn't turn out to be an issue at all, and single-core performance reaches highs hitherto unseen from the Ryzen range.

Speaking of which, gaming performance looks good, too. Together with the GTX 1060, our test rig produced 52fps in Metro: Last Light Redux, running at 1080p with Very High settings. That's 3fps faster than with the Ryzen 9 3900X, and 2fps faster than the Core i9-9900K. Dirt Showdown, which is generally more sensitive to CPU power, also ran best on the 3700X: with the same 1080p resolution and Ultra quality engaged, it averaged 134fps, which is 2fps faster than with the Ryzen 9 3900X and 7fps faster than the Core i9-9900K.

HOT OR NOT

This chip also runs a lot cooler than the Ryzen 9 3900X, although it's warmer than the Ryzen 7 2700X. It idles at a particularly high 39°C at stock speeds, up from the 28°C of last year's CPU. The load temperature of 72°C represents a similar jump, and it peaked – albeit very briefly – at a toasty 76°C. Fortunately, this is nowhere near the 91°C peak of the 3900X, nor the 3700X's official maximum temperature of 95°C, so it's not worth worrying about much.

Experienced overclockers might think otherwise, but unlike the 3900X, AMD has left at least a little overclocking potential for



the Ryzen 7 3700X. It's not much, granted – we ended up settling for 4.2GHz with a raised 1.4v VCORE, which you may note is 200MHz lower than the maximum boost speed.

Nonetheless, this did slightly improve multithreaded performance: its video and multitasking test scores jumped to 336 and 413 respectively, resulting in a higher overall score of 348. Compare and contrast that to the Ryzen 9 3900X, which already comes clocked about as quickly as it can handle.

Then again, even this modest overclock raises temperatures even further. Idle temperature crept up to 41°C, while load temperature rose to 80°C with an 89°C peak. This is getting awfully close to the 95°C maximum, so while it is technically possible to overclock with an air cooler like our NH-U12S, we'd strongly recommend a decent watercooler instead.

This heat also appears to adversely affect single-core performance, so there is a trade-off for enhanced multitasking power. The image score result dropped three points to 179, and while Metro didn't show any difference, Dirt Showdown also ran a tiny bit slower, averaging 131fps. You wouldn't notice a 3fps drop in practice, but it's

still the opposite of what usually happens when manually raising clock speeds.

ELECTRIC TASTES

On the bright side, the Ryzen 7 3700X's TDP – which denotes maximum power usage – is a mere 65W. That's less than the hexa-core Ryzen 5 3600X, and by far the lowest we've seen on any octa-core desktop CPU. You wouldn't guess it from the performance and temperatures, but this thing sips power.

The Ryzen 7 3700X isn't just a quintessential Ryzen chip, then, but it's very nearly the complete CPU package in general. We would have liked a bit more overclocking potential to play with, but you can still wring a tad of additional firepower from it. And even if you have no interest in tweaking clock speeds, the 3700X is brilliantly fast and efficient straight out of the box, all while costing less than the competition.

James Archer



SPECIFICATIONS

SOCKET AM4 • CORES 8 • FREQUENCY (BOOST) 3.6GHz (4.4GHz) • INTEGRATED GRAPHICS None • WARRANTY Two years RTB • DETAILS www.amd.com • PART CODE 100-100000071BOX

Windows overall

Multitasking

Dirt Showdown

330

389

134fps

0%

-50

Reference

+50

+100

See page 84 for performance details

20

DECEMBER 2019 | COMPUTER SHOPPER | ISSUE 382

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SCAN

PALICOMP AMD Navigator

COMPUTER SHOPPER

BEST BUY

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£1,250 • From www.palicompc.co.uk

VERDICT

Both the CPU and GPU shine in this versatile and eye-catching PC, which is pretty good value, too

AMD FINDING SUCH great success with its third-generation Ryzen CPU chips also seems to be bringing out the best in pre-built systems: Palicompc's AMD Navigator is the third Best Buy-winning, Ryzen-powered desktop to grace these pages in as many months.

Specifically, it uses the same mid-range Ryzen 6 3600X as the PC Specialist Inferno R1 (Shopper 380), but overclocked from 3.8GHz to 4.3GHz. It also shares a GPU with the CCL Paladin (Shopper 381), the 8GB Radeon RX 5700 XT, along with an up-to-date X570 motherboard, 512GB SSD and 240mm all-in-one CPU watercooler. That's a lot of PC for £1,250, and it's all wrapped up in a refreshingly unusual case, too.

WHITE ON CUE

The snowy chassis, a Corsair iCUE 220T RGB White, isn't perfect; it only has an unambitious total of two 2.5in drive bays and two 3.5in bays, for instance. However, its metal frame is solid and sturdy, with a distinct look that plays into practicality as well. The front panel, chiefly, is covered in striking V-shaped vents, which allow for plenty of cooling air to be sucked in by the three intake fans.

There's also just the right amount of illumination. The front fans are all RGB-lit, as are the two 8GB sticks of RAM, but other than a dash of solid colour lighting on the graphics card and AIO pump, that's it. They jazz up the AMD Navigator enough to avoid looking dull, but without veering into unsightly tackiness.

Performance is the bigger star. In setting the Ryzen 5 3600X to 4.3GHz, Palicompc is in essence sacrificing 100MHz of the maximum



boost clock speed in order to stay faster in heavily multithreaded tasks, and it's a tactic that pays off: in our benchmark suite's video-encoding and multitasking tests, the AMD Navigator scored 268 and 335, both higher than the stock clocked Inferno R1.

The two PCs were also even in the image-editing test, with 186, so targeting 4.3GHz instead of 4.4GHz doesn't change single-core power as much as you'd think. Overall, the AMD Navigator scored 288 to the Inferno R1's 267, a modest but worthwhile improvement.

Crucially, the overclock is stable, and the watercooler does a fine job of keeping CPU temperature in check: at maximum load, the processor was staying around 74°C, which isn't even close to overheating.

Judging by how close the AMD Navigator's gaming performance is to the CCL Paladin, this CPU tweak has had only the tiniest of impacts on how it enables the GPU, but we suspect the RX 5700 XT would do well either way. In Dirt Showdown, running at Ultra quality, Palicompc's PC cruised to 188fps at 1,920x1,080, only dropping to 185fps at 2,560x1,440 and even averaging 110fps at 3,840x2,160.

It comfortably dealt with Metro: Last Light Redux as well. Using the Very High preset with SSAA enabled, it averaged 95fps at 1,920x1,080, 57fps at 2,560x1,440 and 26fps at 3,840x2,160, so only 4K proves a problem. Simply disabling SSAA bumps this up to a playable 51fps, although for extra slickness you may also want to drop down to High quality, for 72fps.

THINKING AHEAD

With a perfect SteamVR Performance Test score of 11, the AMD Navigator is well prepared for demanding games of all varieties. It's notably better at running high-intensity titles such as Metro than the Inferno R1, as that has a less powerful GPU in its GeForce RTX 2060 Super. The AMD Navigator is also a lot cheaper than the Paladin, although that has a brawnier Ryzen 7 3700X processor and a gigantic 1TB SSD to make up for it.

Not that the 512GB SSD here will make you feel short-changed. It's twice the size of the Inferno R1's, and is accompanied by a 2TB hard disk for even more capacity. It's not breathtakingly fast – AS SSD recorded a sequential read speed of 1,696MB/s and a sequential write speed of 920MB/s – but it's speedy enough to avoid long load times.

If PCI-E 4.0 SSDs ever become more affordable, you could potentially add one in, as the X570 motherboard and Ryzen 3000



CPU combination enables such an upgrade. There's also a spare PCI-E x16 slot, three PCI-E x1 slots, one empty M.2 slot and two RAM slots for you to fill, should you feel the need.

SOUND STERLING

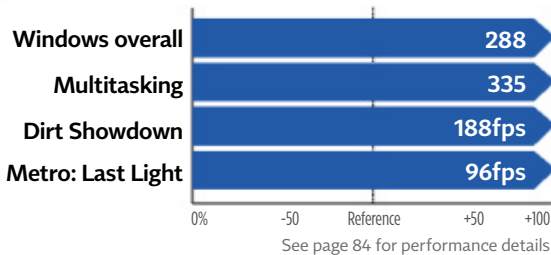
Connectivity is good, too, as while there are only two USB3 ports on the front panel, the rear panel offers plenty more: two USB3.1 ports, four USB3 ports and a USB Type-C port, to be exact. There's no Wi-Fi, unfortunately, but there is a trusty Gigabit Ethernet port, and hi-fi enthusiasts will appreciate the inclusion of optical S/PDIF, rear speaker and side speaker outputs. The same panel also tosses in a PS/2 socket for older peripherals, while video outputs come in the form of one HDMI and three DisplayPort connectors.

Powerful for the money and devoid of serious faults, the AMD Navigator is yet another top-notch Ryzen desktop. It's £50 more than the Inferno R1, but for this you get a reliable CPU overclock, a better GPU, more SSD space and a newer motherboard chipset, so the choice should be obvious.

James Archer

SPECIFICATIONS

PROCESSOR Hexa-core 4.3GHz AMD Ryzen 5 2600X • **RAM** 16GB DDR4 • **FRONT USB PORTS** 2x USB3 • **REAR USB PORTS** 4x USB3, 2x USB3.1, 1x USB Type-C • **GRAPHICS CARD** 8GB AMD Radeon RX 5700 XT • **STORAGE** 512GB SSD, 2TB hard disk • **DISPLAY** None • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three years RTB • **DETAILS** www.palicompc.co.uk • **PART CODE** RYZ8



WINDOWS 10 PRO LAPTOP

DELL Latitude 5500



£1,209 • From www.dell.com

VERDICT

There's much to appreciate about this professional laptop, but a dull screen and awkward keyboard get in the way

IT'S USUALLY WORTH paying attention when Dell launches a laptop; the premium XPS range contains some of the best clamshells and convertibles ever made. The Latitude 5500 is a lot more businesslike, but its focus on security could still make it shine.

At 359mm wide and 20mm deep when closed, this is a chunky notebook by modern standards. That means there's room for a numberpad next to the keyboard, but considering both the dimensions and the 1.8kg weight, it's far from ultraportable territory.

LOCKDOWN PROCEDURES

Even so, it's been put together well enough. With the exception of the plastic underside, there's aluminium bodywork throughout, minimal flex to the screen and a firm hinge. Best of all are the multiple biometric features, namely the webcam's facial recognition and the fingerprint sensor integrated with the power button. Both work quickly and flawlessly: we didn't suffer a single failed reading from either.

The display is a 15.6in IPS panel, running at 1,920x1,080. Our review unit is a touchscreen model, although annoyingly this isn't an option for the closest UK-sold spec.

However, there are bigger issues. Colour performance is downright awful for a £1,000-plus laptop, with the Latitude 5500 covering only 55% of the sRGB colour gamut and averaging a high delta-E of 4.03. That means colours don't just lack vibrancy, but accuracy as well.

Meanwhile, peak brightness is a so-so 236cd/m², and the Full HD resolution is enough to keep everything readable, but not particularly sharp when spread over near 16in of space. The Latitude 5500's only real strong suit, therefore, is contrast, which hits a rather

high 1:246. Viewing angles are wide as well, thanks to the IPS panel, although this seems more like a consolation prize.

In fairness, the Latitude series isn't built for the kind of media-editing work that needs a high-performance display, but such dull, inaccurate colours are still a disappointment on a laptop as expensive as this one.

TYPE GRIPE

There's also something even worse about the Latitude 5500: its keyboard. There's backlighting, which is nice, but the chiclet keys feel uncomfortably small. There's enough space between each keycap – too much, almost – that they could have been expanded slightly without ruining the spacing, and the smallness of certain specific keys, mainly Backspace and Enter, is especially offputting.

The touchpad is better. At first we weren't convinced by the matt surface, but after a while we began to appreciate its tactility, and there's no problem with excess friction.

There's also a pointing stick between the G, H and B keys. The concave shape makes it feel a little slower to get off the mark than, say, Lenovo's famous red pointer, but it works well enough: it's responsive, without being too oversensitive.

Another saving grace is performance. The octa-core Intel Core i7-8665U processor helped the Latitude 5500 score an excellent 151 in our 4K image test, as well as 97 in the video test, 95 in the multitasking test and 105 overall. That set of results puts it slightly beyond the HP EliteBook x360 1040 G5, Vaio SX14 (Shopper 379) and Dell's own Latitude 7400 2-in-1, but these are more expensive.

Storage is fast, too: using AS SSD we recorded a sequential write speed of 1,381MB/s and a particularly nippy sequential read speed of 2,449MB/s. The only weakness is graphics: the Intel UHD Graphics 630 won't do much for hardware acceleration in visual applications, and it's not ideal for gaming either. Running Dirt Showdown on Ultra quality and native resolution, it could average only 16fps.

At least this means there's no dedicated GPU sapping battery life. In our video test, the Latitude 5500 lasted for 9h 31m before running dry, which is more than adequate.

EVERYONE'S HERE

As is often the case with chunkier laptops, the Latitude 5500's girth has the upside of making more room for ports. Here, the haul includes three USB3 ports, one USB Type-C port with Thunderbolt 3, one HDMI output, one microSD slot, one smart card reader (yet another boost to security), one collapsible Ethernet port, a 3.5mm mic and headphone jack and a Kensington lock slot. There also appears to be an optional SIM card tray for always-on connectivity, although this wasn't included on our model.

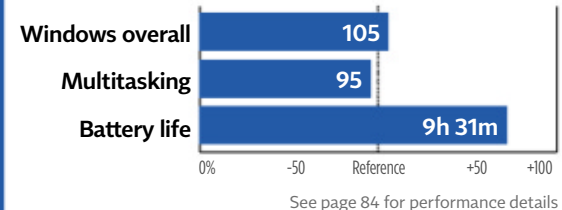
Having multiple video outputs is always useful, as is the option of a more stable wired Ethernet connection, although you still get 802.11ac Wi-Fi and Bluetooth 5.0 as well. There's even an NFC tag to the right of the touchpad, rounding out an impressively comprehensive set of connections.

This, then, is a clearly well-featured and demonstrably high-performing professional laptop. Unfortunately, that only compounds the frustration of the keyboard and display: they're holding back what would otherwise be a very compelling notebook.

James Archer

SPECIFICATIONS

PROCESSOR Quad-core 1.9GHz Intel Core i7-8665U • **RAM** 32GB • **DIMENSIONS** 236x359x20mm • **WEIGHT** 1.8kg • **SCREEN SIZE** 15.6in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Intel UHD Graphics 620 • **TOTAL STORAGE** 1TB SSD • **OPERATING SYSTEM** Windows 10 Pro • **PARTS AND LABOUR WARRANTY** One year onsite • **DETAILS** www.dell.com • **PART CODE** n030I550015emea



WINDOWS 10 LAPTOP

AVITA Liber 14



£485 • From www.ebuyer.com

VERDICT

Avita's UK debut brings an affordable and surprisingly decent ultraportable to the market

AVITA ISN'T LIKELY to be a laptop brand you'll have heard of, as the Hong Kong-based company has only just launched in the UK, with its Liber 14 laptop leading the charge.

This is a lower-end Windows 10 ultraportable, powered by an eighth-generation Intel Core i3 laptop-grade processor, 8GB of RAM, 128GB of SSD storage and a Full HD display; hardly a spec to get the heart racing. Still, it is truly affordable, something that can't often be said of recent ultraportables.

LIVERY LAUGH LOVE

Where the Liber 14 really stands out, however, is its design, with the aluminium chassis coming in a choice of striking finishes: Pearl White, Angel Blue, Ornament on Gold, and Paisley on Lilac. The first colour is a fairly standard white, but the light blue is certainly vivid, while the other two finishes add a textured design to the laptop's lid that sits somewhere between a rug pattern and an intricate tattoo.

Our Ornament on Gold model certainly drew the gaze of colleagues, but the reaction was mixed. While the design is applied to a high standard, whether you find the ornamental pseudo-flower pattern attractive or ostentatious will be a matter of taste. Our personal favourite is the Angel Blue option, which is cleaner and more minimalist.

What won't divide opinion is the build quality of the Libra 14, its metal bodywork feeling pleasant to the touch and solidly formed. There's no real flex in the lid or other surfaces, with the exception of the underside panel near where it meets the hinge, although that's nothing to worry about in practice.

Aside from the lid design and colour scheme, the Liber 14 is a fairly standard sub-£500 laptop; there's no slick bezel-slimming display design or pop up webcam; the rather meagre 720p webcam sits in the traditional spot above the display.

At 222x333x15mm, it isn't the thinnest 14in laptop around either, and its 1.5kg weight is nothing special. Still, it presents



a neat package that's no strain to carry around.

A pair of USB3 ports – one on the left and one on the right – offer connectivity to most popular peripherals, while a USB Type-C connector offers fast charging of the PD 2.0 standard. Thunderbolt 3 is missing, but that's par for the course on budget laptops. There's also a standard barrel DC connection for charging and a 3.5mm headphone jack.

The Liber 14's backlit island-style keyboard delivers a pretty vanilla typing experience, with keys that have just enough travel to allow for speedy touch-typing but feel a tad spongy for a truly tactile experience. We're also not keen on the keys' markings being orientated off centre, or their slightly textured finish; both feel cheap and pointless. Also, on our review unit, the backlighting under the 'C' key was bleeding out from the keycap, thanks

Where the Liber 14 really stands out is its design, with the aluminium chassis coming in a choice of striking finishes

The ports then get a little odd, with the addition of a Micro HDMI and microSD card slot, neither of which are as widely used as their full-size counterparts. Given that laptops of a similar dimension can fit these ports, it's a little disappointing the Liber only has the smaller versions.

It manages to include a fingerprint reader, oddly located to the left of the keyboard, which is unusual given how such scanners normally favour right-handers.

Finally, there's a pair of stereo speakers on the underside, which are on a par with most ultraportables in that they deliver clear sound that lacks real punch; fine for the occasional YouTube video, less so for serious film-watching.

to it being placed a little askew in the keyboard deck. It's a decent enough keyboard, but it certainly doesn't punch above its class.

The trackpad puts on a better performance, offering a large horizontal footprint that's some half the length of the keyboard, with plenty of height as well. While a bit more sensitivity wouldn't go amiss, thanks to the use of Windows Precision drivers the trackpad is reasonably accurate, especially compared to laptops that use Synaptics drivers, such as the HP Spectre Folio (Shopper 380). The diveboard mechanism delivers a solid, precise click as well.

GET THE PICTURE

The 14in, 1,920x1,080 IPS display is pretty much the bare minimum an ultraportable can get away with these days. The bezels around that display haven't been subjected to the diets of those on more expensive ultraportables, but they aren't horribly thick like the frames on some Chromebooks.

As for the IPS panel's performance, it's reasonable rather than stellar. We measured





a peak brightness of 373cd/m², which is good if not retina-searing, and the contrast ratio of 1,095:1 is also perfectly acceptable, at least for web browsing; video content lacks a little something, especially in dark scenes.

Things take a turn for the worse when it comes to colour performance, with the display covering 81.8% of the sRGB gamut, though its gamut volume hits 98.2%. This means photo editing on the Liber is off the cards, and greens in particular lack punch and depth.

With all that mind, it's again worth going back to the Liber 14's price: for less than £500, the display is fine at the very least. There are much more expensive laptops with inferior displays – look no further than one page back for the Dell Latitude 5500 – and for most everyday uses, it presents no problems.

TWO CORES MEAL

Besides, the CPU isn't particularly suited to intensive media editing anyway. The dual-core Intel Core i3-8130U processor is teamed up with a very conservative 4GB of RAM, leading to a lacklustre overall benchmark score of 47, and that includes a multitasking test result of just 29.

Like many U-Series Core chips, the graphics accelerator is integrated in the form of the Intel UHD Graphics 620. It's a pretty common ultrabook GPU, but given it's paired with a slower CPU and smaller amount of RAM, the Liber 14 isn't powerful enough to run AAA games.

However, benchmarks are only half the story here. It's easy to forget that many programs and apps still rely on single-core performance, and the Core i3-8130U can Turbo Boost up to 3.4GHz, which is plenty of power for such software. Indeed, its score of 84 in our single-threaded image test was its best individual showing by far.

Sure, web pages are a little slower to load, especially those with embedded videos, and 4GB of RAM will fill up if you open too many Chrome tabs. But we didn't encounter any major hiccups with the Liber 14's performance; just don't expect to do any hefty work beyond word processing and the occasional spreadsheet.

Storage comes in the form of a 128GB M.2 SATA SSD, which delivered a sequential read speed of 454MB/s and a sequential write speed of 121MB/s. The former is fine, but the latter is slow for an SSD, even a SATA drive; we suspect Avita is simply using a cheaper, slower model.

Not that the Libra loads things up particularly slowly; it's just not going to be fast at transferring large files in a pinch. That said, it's best to avoid popping too many large files on the SSD as 128GB can fill up pretty sharpish, especially when 20GB or so is already taken up by Windows 10.

Our looping video rundown test saw the Liber 14 eke out 7h 14m from its battery, which is just about enough to squeak through a full day before it's gasping for power.

DRESSED UP

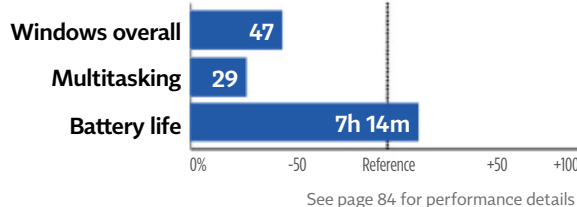
Other than the flowery design of certain models, we can't say there's a lot about the Liber 14 that excites. At the same time, however, for £485 it doesn't really need to.

The Core i3 processor is more than enough for web browsing, emailing and idling away with some YouTube videos, and even if aspects such as the screen, connectivity and storage aren't top-tier, they're all good enough for the price. Add in that touch of visual flair, and you've got a flawed but likeable budget contender.

Roland Moore-Colyer

SPECIFICATIONS

PROCESSOR Dual-core 2.2GHz Intel Core i3-8130U • **RAM** 4GB
DIMENSIONS 222x333x15mm • **WEIGHT** 1.5kg •
SCREEN SIZE 14in • **SCREEN RESOLUTION** 1,920x1,080 •
GRAPHICS ADAPTOR Intel UHD Graphics 620 • **TOTAL STORAGE** 128GB SSD • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** One year RTB • **DETAILS** www.avita.global
PART CODE NS14A2UK002P



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GAMING GRAPHICS CARD

ZOTAC GeForce RTX 2060 Super Mini



£390 • From www.ebuyer.com

VERDICT

The RX 5700 is cheaper and the RX 5700 XT is faster, but this is still a powerful and well-designed graphics card

NVIDIA AND AMD'S endless GPU tango continues with the GeForce RTX Super series. These upgraded refreshes of the RTX 2060, 2070 and 2080 are Nvidia's response to AMD's excellent Radeon RX 5700 and 5700 XT (*Shopper 380*), with the RTX 2060 Super targeting mid-range system builders that might otherwise be tempted by the RX 5700.

This Zotac model we've been testing is a beauty. It's short enough to fit in most microATX and Mini-ITX cases, but still crams in two good-sized open air fans for better cooling. Most of the casing is plastic, but has a convincing matt metal effect, and there's a strong aluminium backplate covering the circuit board. Besides contributing to a cleaner look, this backplate protects the PCB and makes it easier to wipe away dust.

All of this puts it in good stead next to the RX 5700, which is still mainly available in AMD's reference design – one that's a lot longer than the RTX 2060 Super Mini, and has a less appealing blower-style cooler as well. However, if you can make room for it, the Radeon GPU has a gigantic price advantage: you can buy it directly from AMD for just £290, whereas Zotac's customised card is a full £100 more expensive.

NEW TRICKS

At least hardware-wise, the RTX 2060 Super is significantly souped up over the standard RTX 2060. It has 8GB of GDDR6 memory instead of 6GB, bringing it in line with the RX 5700, and has 256 additional CUDA processor cores, bringing the total up to 2,176. Base clock speeds have been raised from 1,365MHz to 1,470MHz, and the RTX 2060 Super also has more RT cores – 34 instead of 30 – for improved performance when enabling ray-traced graphical effects.

The end result is that the RTX 2060 Super Mini has a performance advantage over the RX 5700, but the extent will depend on the game. *Dirt: Showdown*, for instance, runs so quickly on both cards that our test rig's CPU became the bottleneck before either of the GPUs did; as such, the RTX 2060 Super Mini produced completely identical scores of 111fps at 1,920x1,080, 111fps (again) at 2,560x1,440 and 97fps at 3,840x2,160.

Metro: Last Light Redux, which is more GPU-dependent, allows Nvidia's GPU to open up a lead, producing 95fps at 1080p, 57fps at 1440p and 26fps at 4K. This last result might make it look as if 4K is beyond the RTX 2060 Super Mini's capabilities, but disabling SSAA boosts it to 51fps, which is enough to enjoy. The RX 5700 sits between 3fps and 7fps behind, which isn't a huge amount but can make for a visible difference below 60fps.

In *Tomb Raider*, there's also only a small gap at 4K: the RTX 2060 Super Mini averaged 62fps, the RX 5700 58fps. At lower resolutions, the

strength. That said, it's still a lot of cash for what can sometimes be a single-digit advantage, as there's also the matter of the RX 5700's big brother, the RX 5700 XT.

At £329 for the reference model, this is still cheaper than Zotac's GeForce GPU, and while it lacks ray-tracing or DLSS support it does overtake it in core performance. *Tomb Raider* provides the best example for this: the RX 5700 XT produced 199fps at 1080p, 166fps at 1440p and 67fps at 4K, beating the RTX 2060 Super Mini on all three counts.

SUPER POWERS

Consequently, it's stuck between the superior value of the RX 5700 and the superior performance of the RX 5700 XT. In terms of a strictly logical purchasing decision, then, either AMD GPU could be the better option.

The RTX 2060 Super Mini has a performance advantage over the RX 5700, but the extent will depend on the game

RTX 2060 Super Mini is the clear winner, with 187fps at 1080p and 129fps at 1440p. The RX 5700 was quick, too, with 168fps and 113fps respectively – we're not convinced you could even tell the difference at 1080p – but for smooth 1440p, the Nvidia card has it beat.

BIGGER FISH

Both GPUs tied in the SteamVR Performance Test, scoring 11, but the RTX 2060 Super Mini is inarguably the more powerful of the two. Now that a few more games have begun supporting ray-tracing and DLSS, its Nvidia-exclusive feature set is also more attractive than it once was, although don't expect ray-traced performance to be anywhere near as high as that of the RTX 2070 Super, RTX 2080 Super or RTX 2080 Ti.

These advantages make the £100 premium a lot easier to stomach, unless you're likely to be playing older or less demanding games that won't take full advantage of the GPU's

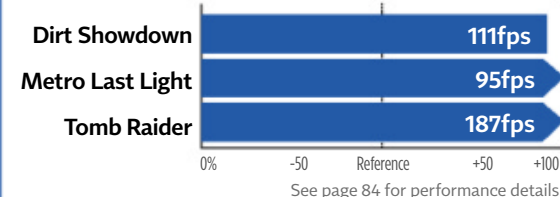
Yet it would be unfair to leave the RTX 2060 Super Mini out of the running entirely. It's not cheap, but it's also a capable 1440p card, and it's easier to live with in terms of quietness and coolness: with core temperatures ranging from 28°C at idle to 69°C at load, this is a much better-ventilated graphics card than AMD's reference models. Keep it in mind, especially if you're planning a more compact PC, or want to try ray-tracing and DLSS.

James Archer



SPECIFICATIONS

GPU Nvidia GeForce RTX 2060 Super • MEMORY 8GB GDDR6 • GRAPHICS CARD LENGTH 210mm • WARRANTY Five years RTB • DETAILS www.zotac.com • PART CODE ZT-T20610E-10M



CPU AIR COOLER

DEEPCOOL

Gamerstorm Fryzen



£80 • From www.amazon.co.uk

VERDICT

This AMD-only cooler is skilfully designed, but its actual cooling performance is nothing special

JUST IN TIME for a whole new generation of AMD Ryzen processors, Deepcool has launched the Fryzen air cooler, which ignores the usual platform-agnosticism of third-party coolers to cater specifically for AMD sockets.

In fact, it's as friendly towards the enthusiast Threadripper series of chips as much as it is the mainstream Ryzens, if not even more so. The contact plate is wider than usual, to fully cover the enlarged heat spreaders of Threadripper chips, and all the mounting kit you need for the TR4 socket is included alongside the AM4 socket parts. Often, coolers will claim to support TR4, but make you order a separate mounting kit for it.

COVER UP

Otherwise, the Fryzen presents a familiar air cooler setup. There's a single 120mm intake fan that's clipped – extremely securely – on to the radiator fin stack, with six nickel-plated heatpipes running from top to bottom on both sides. There are some neat touches, however: we like how the fan is integrated into a slightly chunky shroud, which extends over the top of the radiator to hide some of its more unsightly aspects. There are also channels cut into the radiator fins to allow for a screwdriver to easily access the tension screws during installation.

On that note, setup is a breeze, especially for TR4 sockets: all you have to do is apply thermal paste to the processor (the Fryzen doesn't have this pre-applied, but a tube of

paste is included), screw in four standoffs, affix a couple of mounting brackets to them, then use those tension screws to secure the cooler on top.

For AM4 sockets, the process is a little more involved, although at least part of this includes ditching the default cooler mounts that AMD uses for its heinous clip-on system. Once those are uninstalled, it's a matter of using the mounting plate to slide longer standoffs through the now-empty holes in the motherboard, before essentially performing the same steps as the TR4 socket requires.

From there, you can simply connect to the motherboard's 4-pin CPU fan connector to get things going, but the Fryzen also has addressable RGB lighting support: the central 'X' shape on the fan shroud is lined with lighting strips. Compared to a lot of AIO watercoolers we've tested, setting this up is straightforward, too: there are a few extra cables involved, but they're thin enough for easy tidying, and the inline controller is small enough to tuck away easily.

THE COLDEST PROFESSION

We usually test coolers with an Intel Core i7-4771K, which obviously isn't an option here, so we installed the Fryzen over the new Ryzen 7 3700X (page 18). Unfortunately, it didn't have the most auspicious of starts: at stock speeds, we recorded an idle core temperature of 41°C. That's 2°C hotter than with the Noctua NH-U12S, a cooler that's been around since the first Ryzen chips launched in 2017.

The Fryzen's load temperature range of 72-73°C is at least on equal footing with the NH-U12S, but its peak of 81°C is surprisingly higher than the older cooler's 76°C maximum. This is in spite of the Fryzen having a chunkier radiator and more heatpipes, which should help disperse heat more effectively.

Further complicating matters is that the Fryzen performed much better, comparatively speaking, with the Ryzen 7 3700X overclocked to 4.2GHz. The idle temperature was left unchanged at 41°C, and although load temperatures rose to



80-81°C, both idle and load temperatures were now dead even with those of the NH-U12S. This time, however, the Fryzen managed to keep a much lower peak temperature – 82°C – than the NH-U12S's 89°C.

The Fryzen therefore meets expectations for a Ryzen cooler, even if it doesn't particularly exceed them. £80 is a decent price for a TR4-capable air cooler, too.

That said, it's also more expensive than both the Noctua NH-U12S (which was made for the AM4 socket) and its TR4 variant model, the NH-U12S TR4-SP3. These don't have the same good looks or addressable RGB lighting, but they'll keep chips cool just as well. At default fan speeds, the Fryzen tends to run significantly louder than the NH-U12S as well; if you're not overclocking, we'd even recommend using software or a fan controller to slow it down.

FAN OUT

Alternatively, you could just save yourself the bother – and £20 – and get one of the Noctua coolers instead. Outside of extra visual flair and a single better result in our overclocked CPU testing, there's not much that makes the Fryzen worth buying over those models. This is a respectable cooler, but never acts like a truly great one.

James Archer



SPECIFICATIONS

FANS 1x 120mm • FAN SPEED 500-1,800rpm • SOCKET AMD TR4/AM4/AM3+/AM3/AM2+/AM2/FM2+/FM2/FM1 • DIMENSIONS 124x165x82mm • WEIGHT 1.2kg • WARRANTY One year RTB • DETAILS www.gamerstorm.com • PART CODE Fryzen



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/PCSPECIALIST



@PCSPECIALIST



1TB SSD

GIGABYTE Aorus NVMe Gen4 SSD

★★★★☆

£261 • From www.scan.co.uk

VERDICT

The arrival of PCI-E 4.0 SSDs proves the new interface's speed, but also its cost

THE FIRST CONSUMER PCI-E 4.0 SSDs are here, and they're being led by the Gigabyte Aorus NVMe Gen4 SSD. These drives take advantage of PCI-E 4.0's vastly improved bandwidth over PCI-E 3.0 – the standard interface motherboards have been using for years – to reach far higher read and write speeds, with this particular drive promising sequential read speeds up to 5,000MB/s and write speeds up to 4,400MB/s.

HARDWARE ACCELERATION

Considering the absolute fastest PCI-E 3.0 SSDs max out at around 3,600MB/s, the shift to 4.0 could be the generational leap forward that storage products have been waiting for. However, there are some barriers to clear first. Most fundamentally, PCI-E 4.0 is currently only natively supported on AMD X570 motherboards, with only a handful of X470 and B450 boards having had the capability unlocked by the manufacturer. If you install a PCI-E 4.0 SSD in a PCI-E 3.0 slot, it will work, but will only perform according to 3.0's capabilities; it's therefore likely that you'll have to upgrade your motherboard before you can enjoy the faster speeds.

Second, these new drives are seriously expensive. The Aorus NVMe Gen4 SSD's 1TB model, which we're testing here, works out at a steep 26.1p per gigabyte – 5p more than the Samsung 970 Evo Plus (*Shopper 375*) and 13p more than the Adata XPG SX8200 Pro (*Shopper 374*). The biggest 2TB model is slightly better value, at 22.4p per gigabyte, but the smallest 500GB model comes in at an obscene 36.6p per gigabyte. If you're factoring in the cost of a new motherboard as well, early adoption of PCI-E 4.0 represents an enormous investment.

The Aorus NVMe Gen4 SSD at least throws in a little bonus: a gleaming, golden heat spreader, which unlike the kind of one-side, stick-on spreader you sometimes see bundled in, encases the whole drive. You'll have to be mindful about installing,

however, as it's a rather bulky 11mm thick, and should your motherboard's M.2 slot lie underneath your graphics card, it might not fit. Still, it's optional, and the SSD itself can be installed and operated normally without any additional cooling.

We're not convinced any extra cooling is necessary after performance testing, either. In CrystalDiskMark's sequential read and write tests, which generally reflect a drive's best speeds, the Aorus NVMe Gen4 SSD hit 4,937MB/s and 4,279MB/s respectively. Even if this write speed is slightly below what's advertised, both results are preposterously fast: the sequential read speed, especially, is nearly 1,500MB/s quicker than the 970 Evo Plus.

The much trickier 4K random test produced a 641MB/s read speed and a 594MB/s write speed, which are clearly diminished but still stand far higher than any PCI-E 3.0 drive we've tested. By comparison, the 970 Evo Plus scored a 338MB/s read speed and a 257MB/s write speed, so the Aorus NVMe Gen4 SSD is already shaping up to be much better at difficult, non-sequential transfer tasks.

HOLD FAST

Our own file benchmarks confirm this. The huge-file transfer test didn't initially look all that amazing: with an average read speed of 1,707MB/s and a write speed of 1,787MB/s, it's apparent that you're not going to get anywhere near maximum speeds when shifting one big file. That said, the Aorus NVMe Gen4 SSD remains the fastest SSD on record for this test, with a particularly wide lead on write speed.

In the large files test, it also held up remarkably well, only dropping modestly to a 1,624MB/s read speed and a 1,692MB/s write speed. It was the most difficult small file test, however, that provided the best surprise: NVMe drives generally struggle to break 500MB/s in this, but the Aorus

NVMe Gen4 SSD managed a read speed of 834MB/s and a write speed of 836MB/s.

In summary, this SSD is a record-setter across the board, and suggests that while PCI-E 4.0 makes for some headline-grabbing peak speeds, its true strength lies in how much more resilient it is when faced with the most intensive tasks, as shown in our small-file test and the CrystalDiskMark 4K test.

VENTURING FOURTH

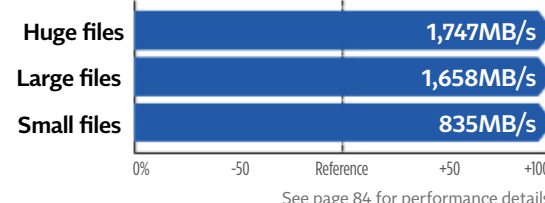
Unfortunately, this performance showing isn't quite enough to disregard the toll that this (and similar PCI-E 4.0 drives) will take on your bank account. There's a certain kick to be had from using the latest and fastest hardware, to be sure, but the reality is that an extra 300MB/s here or there isn't going to produce a regularly noticeable difference unless you routinely have to move hundreds of tiny files at once.

Gigabyte would probably point to the Aorus NVMe Gen4 SSD's imposing sequential speeds as a counterpoint, but for regular PC use it's only rarely going to hit those speeds, and if it does it will be in light tasks where a much cheaper PCI-E 3.0 SSD will already do the job just fine. That's not to rubbish PCI-E 4.0 as a whole – if you happen to have an X570 motherboard and a bit of extra cash, go for it – but for the time being, it's an upgrade that isn't yet worth the expense.

James Archer

SPECIFICATIONS

CAPACITY 1TB • COST PER GIGABYTE £0.26p • INTERFACE NVMe • CLAIMED READ 5,000MB/s • CLAIMED WRITE 4,400MB/s • WARRANTY Five years RTB • DETAILS www.gigabyte.com • PART CODE GP-ASM2NE6100TTTD





1TB SSD

KINGSTON A2000

COMPUTER SHOPPER

★★★★★

BEST BUY

£136 • From www.kingston.com

VERDICT

The A2000 isn't just fast for a cheap SSD; in real-world use, it's among the fastest ever

KINGSTON'S LATEST M.2 SSD hasn't launched with anything approaching the amount of fanfare as PCI-E 4.0 drives, but hype can be deceiving, and this seemingly humble slice of storage is actually one of the best SSDs – of any kind – to launch in months.

In fairness, it has a couple of tricks that keep it from being just another PCI-E 3.0 drive. It ditches 64-layer 3D NAND, used by the vast majority of NVMe SSDs, and uses newer 96-layer memory instead, a much denser form of NAND that crams in more memory per stack. The main advantage of this – the possibility of higher capacities in the same

We can't speak for the slowest and smallest version of the A2000, but the good news is that at least the 1TB model shows those numbers to be on the cautious side. CrystalDiskMark recorded a sequential read speed of 2,281MB/s and a sequential write speed of 2,183MB/s, both slightly above Kingston's own estimates.

This would point towards the A2000 being, if nothing else, a decent budget SSD. However, we think that too would be underselling it. In CrystalDiskMark's 4K random test, it managed a read speed of 572MB/s and a write speed of 505MB/s: both faster than we'd expect from

well above its price range. Again, write speed was the star, averaging 739MB/s, while read speed ended up at 572MB/s. Adata's SSD recorded a 426MB/s read and a 439MB/s write speed, so the gap was narrower, but it's still a clear victory for the A2000.

The performance of this SSD is unprecedented; not in a sense of pure speeds, as there are plenty of PCI-E 3.0 drives that are faster in sequential tests, but in the way that it defies underwhelming sequential speeds to sprint past its rivals in more true-to-life file-transfer tests. We've tested plenty of SSDs that wowed in CrystalDiskMark only to crumble in our own tests, but never one that essentially does it the other way around.

The performance of this SSD is unprecedented; it sprinted past its rivals in more true-to-life file-transfer tests

form factors – won't be felt much by a drive that only comes in 250GB, 500GB and 1TB models, but 96-layer NAND also happens to be cheaper to produce. The benefit, in theory, is that those savings are passed on to the customer, resulting in cheaper SSDs.

POCKET PROTECTOR

Sure enough, the A2000's second trick is its competitive pricing. Not so much for the 250GB model, which is a middling 22.1p per gigabyte, but the 500GB works out at 17p per gigabyte and the 1TB model we tested is just 13.6p. That's even less than the Adata XPG SX8200 Pro (Shopper 374), an SSD that was notable for its great value.

Look closer at the specs, and you'll see another reason why it might be so cheap. The 500GB and 1TB models both have a maximum stated read speed of 2,200MB/s, and a write speed of 2,000MB/s; miles off the XPG SX8200 Pro and the Samsung 970 Evo Plus (Shopper 375). The 250GB model aims even lower, listed at a 2,000MB/s read speed and just a 1,100MB/s write speed.

the premium end of the market. Write speed, in particular, is nearly twice what the XPG SX8200 Pro achieved in the same test.

This wasn't an outlier result, either. Our file transfer tests indicate the A2000 really is that fast in realistic conditions, even if it doesn't hugely impress in synthetic sequential tests. In the huge-file test, it breezed past both the XPG SX8200 Pro and the 970 Evo Plus with a 1,621MB/s read speed and a 1,480MB/s write speed, both of which also showcase a much smaller proportional drop from maximum speeds than we typically see.

COMPETITIVE SPIRIT

Somehow, it even produced a higher average write speed in the large files test, with 1,525MB/s; read speeds had no such luck, but still came in at an excellent 1,572MB/s. At this kind of pace, the A2000 is even nipping at the heels of the Gigabyte Aorus NVMe Gen4 SSD (opposite), which has a whole generation's advantage in its PCI-E 4.0 support.

Things slowed down considerably in the small files test, but the A2000 still performed

A-RATED

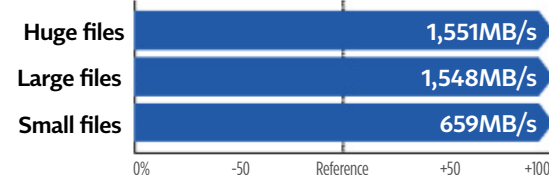
It's decently durable, too. Even the runt-of-the-litter 250GB model has a respectable 150TBW (terabytes written) rating, while the 500GB model sits at 350TBW and the 1TB model at 600TBW. Most users will reach the end of their five-year warranty well before having to worry about writing damage.

Maybe it's the 96-layer NAND, maybe it's the Silicon Motion SM2263ENG controller, but whatever the true cause of the A2000's data-shuffling prowess, it's a superb performer for very little money. And since it's both faster and even more affordable than the XPG SX8200 Pro, it's our new M.2 SSD Best Buy.

James Archer

SPECIFICATIONS

CAPACITY 1TB • COST PER GIGABYTE £0.14p • INTERFACE NVMe • CLAIMED READ 2,200MB/s • CLAIMED WRITE 2,000MB/s • WARRANTY Five years RTB • DETAILS www.kingston.com • PART CODE SA2000M8/1000G



See page 84 for performance details

D-LINK DCS-8515LH Pan & Tilt



£87 • From www.safe.co.uk

VERDICT

You can scan around a room to see what's going on, but a fixed-lens camera is more practical for security

MOTORISED SECURITY CAMERAS used to be all the rage but recently they've been replaced with cheaper fixed-lens models. It's interesting to see the DCS-8515LH, which is comparatively cheap and gives a full view of your room, thanks to its motorised body.

ON THE TURN

Controlled through the clunky but functional mydlink app, the DCS-8515LH takes a couple of minutes to set up and get connected to your network. Once added to the app, the first thing the DCS-8515LH does is take a panoramic photo of your room, moving the camera through its entire 340° horizontal range.

The photo is used to let you tap the exact spot that you want to move the camera to. It's a good idea in theory, although the image that appears in the app is exceptionally wide and not very tall, so it can be hard to work out what you're looking at.

This photo also doesn't take in height, even with the camera able to move 105° vertically. If you want to look up you have to touch the live-view image and swipe your finger on the screen. You can also move side to side with this feature, but it requires a lot of swiping.

Where you place your camera is important. Placing our DCS-8515LH on a shelf at waist height, we found it couldn't see the floor with the lens at its lowest position, but it could look all the way up to the ceiling.

Given that more interesting things are likely to happen on the floor, placing the camera lower down (or wall- or ceiling-mounting it) makes more sense. The field of view is also quite narrow, with the camera not showing much at each position, requiring you to use pan and tilt to see more.

In addition to moving your camera manually, you can save up to four preset locations that get their own thumbnail image, and a home position for the camera. These make it easier to move the DCS-8515LH around and jump to the important areas in your house.

You can set the camera to return to the home position automatically after 60 seconds of no activity, which

we recommend doing; without this, you can leave the camera at an odd angle and miss important movement from the camera's motion detection system.

When the DCS-8515LH detects motion, it pings you an alert. By default, the camera detects motion anywhere in its field of view, but you can use the Active Area setting to choose which parts of the image will pick up motion.

Be careful with this setting. If you move the camera, the Active Area moves too, which may mean that you're no longer monitoring parts of the image that are important. For example, you may no longer be covering a doorway. Again, it's a good reason to have the auto home feature turned on.

HARD ACT TO FOLLOW

Alternatively, you can turn on Auto Tracking, where the camera will follow a moving subject around. It's neat, but the danger here is that any motion detected by the camera starts a recording, so you get more recordings. With fixed cameras, it's far easier, as you just select the areas you want to monitor.

You can't schedule when the camera can and can't record, although you can manually put the camera into privacy mode using the option buried in the camera's settings. This slides a shutter over the camera so you know it's not monitoring.

There's a microSD card slot on the camera, which you can use for storing locally recorded video clips, and the DCS-8515LH also supports cloud recording. You get one day of video history for free for up to three cameras, and can upgrade if you want more video: seven-day history is £2.29 per month for up to three cameras (or £22 per year), and Premium gives you 14-day history for up to five cameras for £4.49 per month (£44 per year). You can't set the camera to record to both the SD card and the cloud at the same time, which is a shame.

The app provides a very basic interface for accessing video clips, with just a list available with



thumbnails of each clip next to them.

There tend to be lots of clips, too, as motion events invariably trigger multiple recordings. Footage can be downloaded to your phone so that you can save evidence.

DARK MATTER

With a 720p resolution only, the DCS-8515LH's video lacks the detail of Full HD cameras. The camera struggles somewhat with bright windows, and can compensate by making the main image a little dark. Even so, you can spot facial details and individuals easily enough.

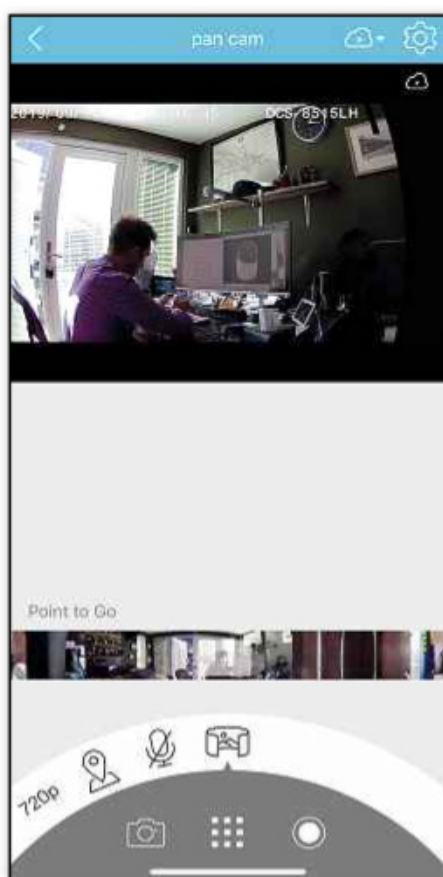
At night, the camera turns on its IR LEDs, which light up a room but soften the image, slightly blurring facial details. This is an issue that affects all IR cameras, however.

There are Skills for Amazon Alexa and Google Assistant so that you can view the video feed on a smart display; however, you can't control the camera's pan and tilt functions from these devices.

Having motorised pan and tilt feels like a good thing, but the reality is that it often proves to be a limitation. With a camera that moves, setting up activity zones is hard, as the view can change affecting these zones. In addition, although the DCS-8515LH can provide a full horizontal view of your room, the narrow field of view means that you have to pan and tilt to see more.

As a result, the fixed Nest Cam Indoor will be more practical, and you get a better app and smarter cloud recording – including only getting notifications when a person is spotted – thrown into the mix.

David Ludlow



↑ The app to control the DCS-8515LH cam is functional at best

SPECIFICATIONS

VIDEO RESOLUTION 720p • **CLOUD STORAGE** Yes (one day free, subscriptions available) • **NETWORKING** 802.11n • **WARRANTY** One year RTB • **PART CODE** DCS-8515LH



CCL COMPUTERS



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VERDICT

The Nitro VG270UP is an outstanding gaming monitor that won't break the bank

EVEN TWO YEARS after its release, the Acer Predator XF270HUA is still one of the very best gaming monitors you can buy. Times move on, however, and the Nitro VG270UP has a very good chance of supplanting it. Acer's newest monitor is cheaper, but very similar to the XF270HUA on specs.

These include a 27in IPS panel running at a sharp 2,560x1,440 resolution, a fast 144Hz refresh rate and support for both AMD FreeSync and Nvidia G-Sync. There's even a comparable, although not identical, three-sided borderless design.

FIXED POINT

Admittedly, this design doesn't exhibit the same degree of quality as that of the XF270HUA; the stand in particular is made of flimsy plastic. Adjustments are limited, too, with only the ability to tilt the screen back by up to 20° and no option to swivel, rotate or tweak the height of the monitor. Thankfully, you get a 100x100mm VESA mount at the back, which allows you to install your own stand.

Despite the awful stand, the Nitro VG270UP looks nice. It's easy to use, too, with the onscreen display accessed via a clickable joystick, and four physical buttons mounted on the rear of the screen in the bottom right-hand corner.

Like the Gigabyte Aorus AD27QD (Shopper 379), you can alternatively tweak the display settings via desktop software. In fact, the concept has been implemented even better here, as you don't need an additional USB connection between your PC and the monitor; everything can be done over the HDMI or DisplayPort cable. It works across all GPUs, too.

Less impressive is how the software lacks some key options, such as the ability to create separate custom colour profiles. Nonetheless, it's a worthy addition and allows the adjustments of most of the monitor's core features quickly and easily.

Connections come in the way of two HDMI ports, one DisplayPort socket and a 3.5mm headphone jack. There's also a set of 2W speakers, but no onboard USB ports. It's still a decent enough selection, but keep in mind that you'll need to use the DisplayPort input to make use of G-Sync. FreeSync will work on any of the three ports.



That 1440p screen only uses an 8-bit panel, but colour accuracy and overall image quality are stupendously good. With the monitor set to sRGB mode, average delta-E comes in at a fabulously low 0.62 – the lowest we've ever seen from a gaming monitor, including the XF270HUA – while sRGB gamut coverage hits 94.7%.

The contrast ratio isn't bad, either, at 1,067:1, although you'd get inkier blacks from a VA panel monitor such as the Samsung C27CHG70. Peak brightness, meanwhile, depends heavily on other settings: at most it's 380cd/m², which is perfectly respectable, although enabling Visual Response Boost mode to reduce motion blur drops it down to 148cd/m² on the normal setting and 81cd/m² on the extreme setting.

DRIVE TIME

The main weakness here is brightness uniformity. The model we tested had an 18% deviation from the centre point at the top left corner in a 5x3 grid. However, panels do and will vary in this respect, so your particular model may differ.

This monitor doesn't support HDR, but that isn't a particularly big issue. Most displays at this price offer HDR400, which is largely pointless because it only requires peak brightness of 400cd/m², 95% Rec.709 (sRGB in other words) and 8-bit colour, all of which fall short of the requirements of the main HDR10 and Dolby Vision standards.

Overall, we were very happy indeed with the Nitro VG270UP's colour performance, and its gaming performance is even better. Making it as good as possible involves turning on Visual Response Boost, which, as mentioned, cuts the brightness while also

lowering the refresh rate from 144Hz to 120Hz. Even so, it's worth doing if you're fond of fast-paced competitive games: it enables the superlatively fast 1ms GTG response time, and minimises motion blur.

Alternatively, you can set pixel overdrive to extreme while keeping the 144Hz refresh rate. This makes the IPS panel as responsive as the absolute best TN panels, and input lag is practically non-existent. However, the extreme overdrive setting can also add noticeable inverse ghosting, so it's better to use a lower setting in less twitchy games.

PLAYING IN TIME

Happily, FreeSync and G-Sync both work in a wide 40–144Hz range. Some other reviewers have reported flickering issues being introduced when using syncing tech, but this appears to be solely an issue with early manufacturing batches. We didn't experience any issues whatsoever.

Is the Nitro VG270UP as good as the Predator XF270HUA? Not quite. The latter's fully adjustable stand, superior brightness uniformity and more adept handling of inverse ghosting keeps it on top of the pile. This is a close second, however, especially as it's about £150 cheaper while still delivering on colour and gaming performance.

Christopher Minasians

SPECIFICATIONS

SCREEN SIZE 27in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY IPS • REFRESH RATE 144Hz • VIDEO INPUTS HDMI, DisplayPort • WARRANTY Two years RTB • DETAILS www.acer.co.uk • PART CODE UM.HV0EE.P01

CONNECTION PORTS



ACTION CAMERA

DJI Osmo Action

COMPUTER SHOPPER
BEST BUY

★★★★★

£279 • From www.amazon.co.uk

VERDICT

DJI's first proper action camera isn't an awkward first attempt – it gives even GoPro a run for its money

DJI IS RIGHTLY famous for its drones, but it's also been quietly building a reputation for standalone cameras of late. It's now gone all in with its first full-on GoPro rival: the DJI Osmo Action.

This is no token gesture. Not only is the Osmo Action a direct challenger to the flagship GoPro Hero 7 Black (*Shopper 372*), it also pretty much matches it feature for feature, with 4K recording and an advanced, built-in electronic stabilisation algorithm DJI calls RockSteady.

That's not the only exciting feature about the Osmo Action, however. It also has two full-colour screens, voice control and built-in waterproofing, and it can record HDR footage at up to 4K as well.

RUGGED GAME

As soon as you pick it up, it becomes immediately apparent that DJI is serious about taking GoPro on head-to-head. Physically, the design is broadly similar to the classic GoPro design. It's a small, rugged-feeling brick with a lens that protrudes from its left side, a touchscreen at the rear and a smaller, non-touchscreen colour display at the front.

As with more recent GoPro Hero cameras, the Osmo Action doesn't have a tripod thread built into the main body of the camera. Instead, mounting is achieved via a plastic cage that wraps around the camera's edges and clamps to it tightly via a clasp at the top. This can be attached to most standard action-camera mounts.

During our time with the Osmo Action, we had it mounted on a PGYTEch rucksack strap mount, on which it fits perfectly. That's great news if you already have some mounts from an old action camera hanging around in a drawer.



The camera is covered in textured grey rubber and plastic and feels solidly made, too. Like the GoPro Hero 7 Black, it's fully waterproof to a depth of 11 metres; that's thanks to sealed flaps covering the battery compartment, USB and microSD ports. Shutter and power buttons adorn the top panel and are easily operated with gloves on, and there's also a quick settings button on the left for switching between the camera's various modes and user presets.

Fire up the camera and the UI is a doddle to get to grips with, with most settings a single swipe or prod away, and it's a lot smoother and more intuitive than the rather fiddly GoPro interface. There are plenty of settings and modes to play around with, too.

SMOOTH OPERATOR

We're also happy to see that stabilisation can be applied to any recording setting, right up to 4K at 60fps. That stabilisation is very impressive, too. When shoulder-mounted during bicycle rides, it completely smoothed out all the lumps and bumps in the road to provide rock-solid footage.

In addition to 60fps, you can shoot 4K at 30fps, 25fps and 24fps; in 2.7K mode, you can shoot at 60fps, 50fps, 48fps, 30fps, 25fps and 24fps, while 1080p and 720p footage can be captured at up to 240fps for slow-motion playback.

Other modes include HDR – although shooting in this mode disables stabilisation – and there's also timelapse, hyperlapse and slow motion. There's a host of still image options, too, including manual exposure settings and auto bracketing medium shots. The resolution of those images, incidentally, is nine megapixels, and images can be recorded in RAW or JPEG modes.

You can pull footage directly from the camera's SD card or via a direct USB Type-C connection for editing but, like the DJI Osmo Pocket (*Shopper*

374), the Osmo Action is designed to be paired with the DJI Mimo app for easy editing on your smartphone or tablet.

The star feature is that full-colour front screen, especially for those interested in using the camera for vlogging. It isn't activated all the time – you need to switch it on with a quick two-fingered double-tap on the rear touchscreen – but it's a real help when you want to address the camera and ensure you're fully in-frame at all times.

Image quality is largely the same as that of the Osmo Pocket, since it uses the same 1/2.3in Sony IMX377 sensor. This means that, despite a relatively bright aperture of f/2.8, in low light you'll still see plenty of image noise, both in video and stills. In good light, however, detail is crisp and well resolved, and colour reproduction is solid, too.

Importantly, the stabilisation is good enough to flatten out most severe lumps and bumps, and footage looks almost as smooth as if the camera were mounted in a mechanical gimbal system.

GREAT OUTDOORS

One other feature that widens the possibilities for creative shots – if you want longer shutter speeds for increased motion blur in video, for example, or long-exposure waterfall images in daylight – is that the lens housing can be entirely unscrewed and replaced with a neutral density filter.

Given that this is DJI's first foray into the world of action cameras, the Osmo Action is a brilliant debut. It shoots detailed, smooth 4K footage at 60fps, has a range of useful modes, and is waterproof without needing a case – all while, perhaps most appealingly, being cheaper than the Hero 7 Black.

Jonathan Bray

SPECIFICATIONS

SENSOR 1/2.3in CMOS • **SENSOR PIXELS** 12 megapixels • **MAX RECORDING RESOLUTION** 4K (60fps) • **AV** CONNECTIONS None • **DIMENSIONS** 42x66x35mm • **WEIGHT** 134g • **WARRANTY** One year RTB • **DETAILS** www.dji.com/uk • **PART CODE** CP.OS.00000020.01

WIRELESS SMART SPEAKER

PURE DiscovR



£230 • From www.currys.co.uk

VERDICT

A well-designed, feature-packed smart speaker, but its underwhelming sound quality doesn't justify the price

WITH A STYLISH design and features to spare, the Pure DiscovR sits at the premium end of the smart speaker spectrum. It's also unusual: unlike most Alexa-powered speakers, the DiscovR has a built-in battery, allowing you to move it around the house or take it into the garden without needing a mains socket.

This no doubt contributes to its high price, but there's no disputing the DiscovR looks smart for the money. Its square enclosure is made of matt aluminium with a non-slip rubber base and is softened by heavily rounded edges. Encased within is the speaker housing, which rises smoothly from its aluminium shell when you push down on the top panel.

UPS AND DOWNS

It's one of the more pleasing speaker designs around, and it's not just for show. Pushing the speaker housing back into the device manually disconnects the microphone, preventing Alexa from listening when you want some privacy, as well as switching the speaker off. It would be even better if it were motorised and remotely controllable, but that's a small complaint.

The controls for the DiscovR sit on top of the speaker housing and offer a bewildering number of touch-sensitive buttons for those who prefer not to be vocal with their audio equipment. From this panel, you can mute the mic, play, pause or skip tracks, adjust the volume, select the input source, activate Alexa without the wake word, and set up to four presets for quick access to your favourite playlists, stations or commands. For a smart

speaker, where physical controls are usually limited, that's impressive.

You can also activate the Discovery feature, which is something of a party piece. Whack the star-shaped button while a radio channel is playing, and the DiscovR will take note of the song and add it to a Spotify playlist. It's by no means essential, but it reduces the likelihood of you missing a catchy tune simply because you didn't hear the artist name or track title.

To make the most of this expansive feature set, you'll need to download the Pure DiscovR app and connect your accounts (Spotify and Amazon Music are both compatible). You'll also need the Alexa app to make full use of Amazon's

while the bass is impressively punchy for such a small speaker, the overall effect is the audio equivalent of a sandwich with too little filling.

There's another, less positive, reason the DiscovR has so many device-mounted controls. The Pure app is sparse, serving mostly as a means by which to set up the DiscovR and maintain a connection between speaker, smartphone and external apps. You can adjust

Worryingly, the DiscovR can falter when performing its most fundamental job: playing music

virtual assistant. With AirPlay 2 also being an option, it almost seems a shame that Pure didn't cover every base with Google Assistant support. Still, Alexa can be used to control both the speaker and any other compatible hardware, such as smart home devices.

An even bigger draw than the Discovery feature is the speaker's wireless abilities. It's far from the first battery-powered Alexa speaker, but there's not a great deal of them to choose from, and with up to 15 hours of battery life the DiscovR competes with models such as the UE Megablast (*Shopper 362*) on longevity.

DRY RECEPTION

Unfortunately, there's no waterproofing, so you'll have to be a lot more careful about getting caught in the rain than with the Megablast. It's not ideal for taking too far away from civilisation, either: without a solid internet connection, this effectively becomes an overpriced Bluetooth speaker.

More worryingly, the DiscovR can falter when performing its most fundamental job: playing music. It can fill a room, but volume isn't everything and most of the time it sounds too bright. An overpowering treble response dominates at both low and high volumes, and

the volume and check the battery life, but don't expect to spend any time fiddling with equalisers or browsing built-in playlists.

SMARTER CHOICES

The end result is a smart speaker that, for all its neat tricks and arsenal of controls, feels more like an attempt to convert Pure's existing DAB radio userbase into smart speaker users than it does a serious attempt to rival the likes of UE, JBL and Amazon.

The DiscovR might have done a decent job of it, too, were it not for the uninspiring sound quality and unreasonable price. It's well made and brimming with features, giving Alexa legs in the form of portability, and in that respect it's almost worth £230. The DiscovR is first and foremost a speaker, however, and in that regard it simply doesn't deserve the high price.

Will Georgiadis



SPECIFICATIONS

DRIVERS 3 • **RMS POWER OUTPUT** 45W • **DOCK** CONNECTOR None • **WIRELESS** 802.11ac Wi-Fi, Bluetooth • **DIMENSIONS** 140x110x110mm • **WEIGHT** 970g • **WARRANTY** Two years RTB • **DETAILS** www.pure.com • **PART CODE** DiscovR

OVER-EAR BLUETOOTH HEADPHONES

AKG N700NC M2



£269 • From www.samsung.com

VERDICT

These headphones' noise cancelling isn't the best, but their sound quality just might be

AKG'S LONG HISTORY in studio headphones is well established, but it's not quite as well known that the brand is today part of Samsung-owned Harman. That's why you'll see AKG-tuned earbuds supplied with Samsung's top-end smartphones, and it's a relationship that has helped the firm gain a foothold in the high-tech headphone market.

This is where its latest AKG N700NC M2 headphones sit. They're the latest attempt by Samsung/AKG to dislodge the Bose QuietComfort 35 II (*Shopper 362*) and the Sony WH-1000XM3 (*Shopper 375*) from their positions as the best noise-cancelling headphones money can buy.

WELL WORN

As a direct rival to those most popular of headphones, it shouldn't come as any surprise to find that the core feature set of the AKG N700NC M2 makes for familiar reading. This is a pair of primarily wireless headphones that use Bluetooth 4.2 to connect to and receive audio from your smartphone.

Like the QuietComfort 35 II, they're over-the-ear models that fold away neatly and have active noise cancellation that cuts down on background noise such as aeroplane engines and train clatter. They're battery-powered, too, and will give you 23 hours of playback with Bluetooth and noise cancellation enabled, and up to 32 hours with Bluetooth off when listening via an analogue 3.5mm cable.

In the box is a 2.5mm-to-3.5mm cable that allows you to do just that, and this is complemented by a USB Type-C charging cable, a double-pronged airline adaptor and a compact, semi-hard case to stow the headphones in after use.

At £269, the AKG N700NC M2 are unusually cheap for a pair of flagship wireless ANC headphones; most headphones of this ilk generally come in at £329 or more. While that's good to see, they're still a touch more expensive than the WH-1000XM3 and the QuietComfort 35 II, which have both been discounted since launch from £330 to £260.

That's not much of a discrepancy, however, and there's plenty about these headphones that make them worth considering. They're very well

made, for starters. They're more robust-feeling than the QuietComfort 35 II and their slightly more compact memory foam earpads are very comfortable, too. If you have large ears, you might want to try before you buy, because there's less room inside the cups for your lugs to breathe.

AMBIANCE CHASER

AKG has also kept the controls simple, with no fiddly touch-sensitive areas to worry about setting off by accident. The left earcup gives you three buttons for pause and play, volume and skip, and on the right earcup is the combined power and pairing switch, as well as a button that activates the AKG's Talk Thru and Ambient Aware functions.

You can choose which feature is assigned to the button in the accompanying smartphone app. Choose Talk Thru and, when you hit the button, the music is muted dramatically, and the external microphones are activated so you can carry out a conversation without having to remove the headphones. Ambient Aware mode leaves the music volume largely as it is, but mixes in a little external audio so you're not completely sealed off from the outside world.

What you don't get with the AKG N700NC M2 is a digital assistant activation button or any kind of adjustability for the noise cancellation beyond the two ambient sound options. It is possible to create your own EQ settings through the app, however.

Possibly the most disappointing element of the AKG N700NC M2 is the strength of the active noise cancellation. We compared the headphones back to back with a pair of the QuietComfort 35 II on the London Underground and, while the AKG's noise cancellation was reasonably effective at cutting out the clatter and roar of the train on the tracks, it fell well short of the standards set by Bose's



headphones. Suffice to say the N700NC M2 won't beat the WH-1000XM3, either, as these have even more effect ANC than the QuietComfort 35 II.

Sound quality, on the other hand, is a different matter entirely. In less extreme environments, where the noise cancellation level isn't as critical, the N700NC M2 truly shine: performance is superb across the audio spectrum, and especially in the bass. Many headphones struggle with reproducing the sound of a double bass sound, getting all boomy or simply not injecting the audio with enough oomph, but this isn't the case with the N700NC M2, which absolutely nail the sense of solidity, control and clarity.

INSTRUMENTAL SUCCESS

They repeat this performance through the mid range, too, extending well at the top end and performing well with pretty much any musical genre we threw at them. Heavy metal is dispatched with as much clarity and authority as classical; these are multi-talented headphones that never seem to be unsettled by anything, and they're simply a joy to listen to.

The Sony WH-1000XM3 still have better noise cancellation, which might be preferable if you travel regularly or commute via train, but the N700NC M2 win out on sheer audio quality. Since they're also comfortable and finely crafted, they are absolutely worthy of your consideration.

Jonathan Bray



SPECIFICATIONS

HEADPHONES SUBTYPE Over-ear • PLUG TYPE 3.5mm • WEIGHT 277g • CABLE LENGTH 1m • WARRANTY One year RTB • DETAILS www.akg.com • PART CODE GP-N700HAHCIWA

SAMSUNG Galaxy Note 10+

COMPUTER SHOPPER
BEST BUY

★★★★★

£999 • From www.amazon.co.uk

VERDICT

Bigger is best for the Note 10+, a luxury phablet that excels in almost every area

THAT PLUS SYMBOL isn't a typo; there really is an even bigger version of Samsung's annual phablet update, so if you don't fancy spending £869 on the Galaxy Note 10, you can drop £999 on the Note 10+ instead.

That's quite the surprise for Samsung to keep up its voluminous sleeves, especially as this is the firm's best-looking smartphone to date. It has an enormous 6.8in display – with a higher resolution than that of the 6.3in Note 10, at 3,040x1,440 – as well as a glossy Gorilla Glass rear, rounded silver-tinted edges and corners, and four cameras neatly arranged in a vertical line on the back.

WAVING THE WAY

Despite the huge screen – which also has an in-display fingerprint sensor, a Note series first – the Note 10+ doesn't feel particularly hefty. It weighs a manageable 196g and measures 162x77x7.9mm, which isn't that much bulkier than most flagship smartphones. The only things we didn't like about the design are the removal of the 3.5mm headphone jack, and how the top and bottom edges are square and sharp; the latter can dig into your hand a bit too much.

The signature S Pen stylus is still here, slotting neatly into the bottom-right corner. It's had a minor upgrade, too, with what Samsung calls 'Air Actions': performing gestures with the stylus, almost like a magic wand, will perform certain actions in compatible applications. In the camera app, for instance, you can switch between shooting modes by holding the S Pen's button and waving it from side to side. Alternatively, waggle your hand up and down and the app will alternate between the front and rear cameras, and you can also rotate the stylus clockwise or anti-clockwise to zoom in and out.

It's certainly a neat little party trick, and it definitely comes in handy when your phone is mounted on a tripod or out of arm's reach. We only wish you had greater control with the zooming function – at the moment, you can only zoom in and out in small 0.1x increments, which is rather slow.



The S Pen isn't just about waggly gimmicks, however, and is actually a tremendously useful note-taking device. With up to 10 hours of standby time, you can scribble even while the phone is locked, and use it to outline a specific portion of the screen that you want to screenshot. You can also use the S Pen to highlight extracts of a web page or document in order to translate the text to your desired language.

CONNECTING THE DOTS

It's worth noting that although the Galaxy Note 10+ has a sharper screen than the 2,280x1,080 Note 10, it's not a case of the pricier version getting an upgrade, as it's the

standard version getting a downgrade. Previous Note handsets have used QHD displays all the way back to 2014; something to consider, if you're looking to upgrade from a previous model.

In any case, the Dynamic AMOLED panel in the Note 10+ performs very well. Colour reproduction is superb, striking a perfect balance between eye-popping saturation and colour accuracy. It reached 96.2% of the sRGB colour gamut in the Natural screen profile, and brightness peaked at a searing 715cd/m² with the auto-brightness setting engaged.

There's support for HDR 10+ too, so movies and TV shows on Netflix and Prime Video that support this standard look

spectacular. Colours seem to leap from the screen and, because it

uses AMOLED technology, you can expect an impeccable, inky black level response and essentially perfect contrast.

TOP OF THE CLASS

Both the Galaxy Note 10+ and the standard Galaxy Note are the first phones to be powered by Samsung's own Exynos 9825 chip, which is built using a more efficient 7nm manufacturing process, and consists of a quad-core Cortex-A55, dual-core Cortex-A75 and another dual-core custom CPU.





With every day of using it, we're convinced that this might be the finest smartphone ever made, by any manufacturer

The Note 10+ also benefits from a generous 12GB of RAM for multitasking, rather than the 8GB of RAM in the regular model. As for storage, you're restricted to 256GB, but with the option to expand this by a further 1TB via microSD. The Note 10+ battery is also larger, at 4,200mAh, and supports charging speeds up to 45W, although the included charger is only 25W.

Unsurprisingly, the Note 10+ eases past last year's Note 9 (*Shopper 370*) on speed, although its Geekbench 4 scores of 4,557 in the single-core test and 10,367 in the multicore test put it on even terms with the Galaxy S10+, so the Exynos 9825 isn't a major advancement for Samsung handsets in general. Still, there's no shame in that, as the both the Note 10+ and Galaxy S10+ are about the most powerful Android handsets on the market.

Gaming performance is equally impressive, even on the high-resolution screen. This is another area where the Galaxy Note 10+ is much improved over the Note 9, managing a near-perfect 57fps average in the GFXBench Manhattan onscreen test.

Stamina hasn't taken a hit, either. In our video rundown test, with the screen set to the phone's native resolution and at 170cd/m² brightness, the Note 10+ lasted 19h 56m on a single charge. Dial the resolution down to FHD+, and we managed to squeeze out almost an extra hour under the same conditions.

IMITATION GAME

Equally impressive as the phone's performance and battery life is the simplicity and responsiveness of the phone's user interface. The Note 10+ uses Android 9.0 – an upgrade to Android 10 is pencilled in for the near future – but with Samsung's own One UI launcher placed over the top.

We first tapped away at this new interface with Samsung's trio of Galaxy S10 phones earlier in the year, and it remains the best software Samsung has ever used on any of its phones. The UI has a clean, simple look to it

and is remarkably easy to navigate. It can also be customised to your liking, allowing you to adjust the phone's vibration intensity and the size of the app icons, which are a little large by default.

There are still a few minor issues in some areas, and it doesn't quite match the sheer simplicity of the Google Pixel 3's Pixel Launcher. For one thing, Samsung insists on preloading the phone with its own versions of applications – such as the browser, email and calendar apps – which simply aren't anywhere near as good as the default Google apps.

GO WIDE

A long vertical strip of cameras can be found on the back, which includes the same dual-aperture (f/1.5, f/2.4) 12-megapixel sensor and 2x telephoto zoom lens from last year's handset. What's new is the addition of a 123° wide-angle camera, as well as a special depth-sensing unit for more effective blurred background photography, which is exclusive to the Note 10+.

Most importantly, image quality is sublime: pictures are packed with detail, texture and punchy colours. No matter the lighting conditions, the Note 10+ is capable of capturing some truly exceptional photos, especially when you use the wide-angle lens for your scenery shots.

There's no shortage of shooting modes, either. You can easily adjust the level of background blur with the Live focus mode for stills and video, record 240fps super-slow-mo footage, brighten up images with the Night mode, and tinker with more intricate settings in the Pro mode. That's not forgetting about the new filters you can apply to images and video, too, such as the black and white 'colour pop' and a vaporwave-inspired 'glitch' filter.

We particularly enjoyed playing with the new 'AR doodle' feature, which allows you to draw whatever you like on the screen with the S Pen before recording your video. Draw glasses and a silly moustache on someone's face,

for instance, and your doodles will accurately track the person and follow them around as soon as you tap the shutter button.

STABLE HAND

In fact, there's so much stuff on offer here that it can be a little bit daunting at first. It's clear that Samsung is trying to squeeze as many features into its native camera app as possible, but we think that most, if not all, of these different shooting modes can serve a useful purpose.

When it comes to video, the Galaxy Note 10+ can record 4K footage at 60fps, although optical image stabilisation is only available at 1080p. You can, however, enable Samsung's 'Super steady' feature in the camera settings, which essentially applies electronic image stabilisation to all recording modes. The footage isn't quite as rock-steady as if it was strapped to a dedicated gimbal, but it does the job.

The recording quality, on the other hand, is superb. Footage is crisp and detailed, with excellent dynamic range, especially if you film in 4K with HDR 10+ enabled. However, this feature is restricted to 30fps, and most third-party video players don't support HDR 10+ playback at the time of writing.

GRAND STATURE

It's abundantly clear that the Galaxy Note 10+ is Samsung's best phone yet. With every day of using it, we're also increasingly convinced that it might be the finest smartphone ever made, by any manufacturer: nothing else takes as well-rounded an approach as this.

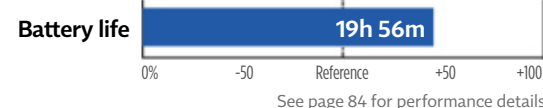
It looks gorgeous, the screen is sharp and vibrant, performance is superlative, battery life is tremendous and the cameras take great photos. The Note 10+ might require two hands and a mountain of cash, but for now, Android handsets don't get much better than this.

Nathan Spendelow



SPECIFICATIONS

PROCESSOR Octa-core 2.4GHz Samsung Exynos 9825 • **SCREEN SIZE** 6.8in • **SCREEN RESOLUTION** 3,040x1,440 • **REAR CAMERAS** 12 megapixels, 16 megapixels, 12 megapixels • **STORAGE** 256GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 162x77x7.9mm • **WEIGHT** 196g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** www.samsung.com • **PART CODE** SM-N975FZSDBTU



How iiyama's monitors are helping to transform social gaming

The electronics company's tech is powering London esports venue, Platform

The gaming industry is now one of the biggest media industries globally, predicted to hit revenues of \$180 billion by 2021. One contributing factor to that success is the phenomenon that is esports, which now boasts around 450 million followers worldwide.

However, the outdated perception of gaming hasn't quite caught up with its mainstream success – the stereotype of a gamer surrounded by pizza boxes in a dingy bedroom or esports café still prevails.

Tackling that stereotype head-on is the team from London's first bar and restaurant dedicated to video games and esports, Platform. There, Guillaume Borkhataria and Tomaso Portunato are working in partnership with display manufacturer, iiyama, to create a gaming destination in the heart of London's trendy Shoreditch.

An entertainment hub designed for all skill levels, it's a place where novice gamers and expert gamers alike can socialise in a low-pressure environment, play games, eat good pizza (that won't linger in abandoned takeaway boxes for weeks) and have a few drinks. "We are busy every day, and it's lovely to see a diverse range of people, from groups of women to office workers and even three generations of a family playing games. And this is exactly the inclusive, laid back atmosphere we wanted to create," says Borkhataria, head of partnerships and experience at Platform.

It's all in the tech

A fashionable location, good food and drink, and a friendly atmosphere can go a long way to

making a venture like Platform work, but great equipment and displays are the real key to its success. Platform is powered by a host of high-performance PCs with the latest games and peripherals,

including the iiyama G-Master gaming displays.

Conceptualised when iiyama staff hobby gamers realised many people were using its commercial displays for tournaments, the iiyama G-Master range was designed for everyone from the casual to the professional gamer, across console and PC. Steve Kilroy, regional manager for iiyama, explains: "Key to development was making sure we did not go super high-end and high in price. We needed a great feature set that offered super-fast response times, a range of resolutions, easily customisable screen modes and high quality delivered at an accessible price point."

This quality and flexibility made iiyama the perfect fit for Platform. The venue needed a high-performance esports grade display with high resolution, low lag and fast response times, as well as larger screens for spectators and social gaming. As Borkhataria explains: "We have a responsibility to our customers to offer the best experience possible and that means being able to show off the games in the best possible light."

Platform is designed so that the space can function as an events stage with a number of PCs linked up





ready for pro esports tournaments and events, but the same space is open to the public for some fun competitive gaming. You then have carefully crafted spaces with tiered seating for console and retro gaming dotted around, with big iiyama commercial displays on the walls to live stream events and esports tournaments from around the globe.

The venue uses a range of 144hz 27" displays for the PC setups, larger 55" screens for the social gaming areas and a selection of big screens for spectators. They run tournaments and events on the iiyama GB2760HSU-B1 HD 144hz G-Master screens, which offer Freesync technology, 1ms response time and handy features such as a height-adjustable stand. Iiyama screens also use cutting-edge technology to ensure the experience is lag-free and avoids defects and tearing, and a vast array of inputs make them ideal for PC or console gaming.

What next?

Gaming at Platform is a social entertainment experience and a day out for families, friends and co-workers. "It was great to visit Platform recently," says Steve Kilroy. "It was a busy lunch day and really nice to see a group of office workers



on an iiyama 55" screen playing FIFA, another group of people retro gaming and a group of young lads on the racing simulators."

But Platform and iiyama want to take this success further, expanding and delivering their model to more cities and towns, bringing people together to game socially across the country. The goal is for Platform to become the go-to social gaming hub, professional esports venue and choice for competitive esports locally and nationally. If these ambitions are realised and esports continues on its upwards trajectory, it won't be long before heading down to your local esports arena to cheer on your favourite gamers is just as common as going to watch your local football team.

Discover more about iiyama's 27" G-Master gaming monitor at scan.co.uk

In association with



SAMSUNG Galaxy A50



£278 • From www.amazon.co.uk

VERDICT

The Galaxy A50 is yet another long-lasting Samsung success, and it's incredibly good value, too

AS EXCELLENT AS the Galaxy Note 10+ is (page 38), Samsung's smartphones don't begin and end with its high-end models. Just last month we saw the brilliant mid-range Galaxy A70, and now it's the turn of the even cheaper Galaxy A50.

Like the A70, the A50 gets off to a good start by essentially copying the Galaxy S10's design. That means there's virtually no bezel to speak of, save for a very small chin at the bottom, and although the curved back panel is made of plastic, it's comfortable enough to avoid feeling too cheap.

Most excitingly for a handset of this price, the fingerprint reader is built into the screen, meaning that it doesn't appear on the handset itself. Just push your thumb against the bottom of the screen, and the phone unlocks, perhaps a hair slower than with a regular one, but it's still a great feature at this price.

There's more, too: expandable storage, a headphone jack and dual SIM support, to name but a few. There's no waterproofing, which is a shame, nor any wireless charging support, but at least the latter is to be expected at this price.

LED TO GLORY

The Super AMOLED screen certainly doesn't disappoint. It's a sizable 6.4in panel running at 2,340x1,080, an even higher resolution than that of the Galaxy Note 10. Moreover, it covers a full 100% of the sRGB colour gamut, while peak brightness hits 560cd/m², and contrast is perfect as well.

In short, it's as good as you can expect for under £300, and the inclusion of a fingerprint sensor makes it even better.

On the internals side, the Galaxy A50 is powered by a 2.3GHz Exynos 9610 processor, with 4GB of RAM and 128GB of internal storage. In day-to-day use, this feels buttery smooth, unlocking quickly and jumping between apps with ease.

It also blasted through our benchmarks – relatively speaking, anyway – with Geekbench 4 scores of 2,387 in the single-core test and 6,504 in the multicore test. It's therefore more powerful than the Google Pixel 3a (*Shopper 378*) and, rather surprisingly, the

Galaxy A70, which is itself unusual in that it forgoes an Exynos chip in favour of the Qualcomm Snapdragon 675. Of its mid-range rivals, only the Xiaomi Pocophone F1 (*Shopper 377*) is significantly faster, thanks to the latter's flagship-grade Snapdragon 845.

For gaming, conversely, the Galaxy A50 comes out slightly behind most of its peers. With 22fps in the GFXBench Manhattan onscreen test, it again beats the Galaxy A70, but the Pixel 3a, Nokia 8.1 and especially the Pocophone F1 can all run games more smoothly. Still, the Galaxy A50 will cope decently with most titles; it will only struggle with the most intensive 3D games.

It also has an ace up its sleeve, in the form of battery life. Lasting 21h 21m in our video playback test, it leads the Pocophone F1 by several hours, although the A70 gets its own back here, too, with a 25h 22m record that we suspect will take phone manufacturers some time to beat.

RULE OF THREE

The Galaxy A50 also treats us to not one, not two, but three rear-facing cameras. The main 25-megapixel, f/1.7 camera is supported by an ultra-wide eight-megapixel affair and a five-megapixel, f/2.2 depth sensor.

This makes it a pretty good match for the £329 Huawei P30 Lite's triple-camera array, although while the Galaxy A50's outdoor shots look pretty good from a distance, when you zoom in, it's clear that the Huawei P30 Lite has the edge.

Which isn't to say the Galaxy A50 is bad, by any

means. And, given Huawei's uncertain Android future, you may well consider the slight loss in fidelity a price worth paying.

On low-light indoor shots, the cameras are more evenly matched, with both providing images filled with detail, accurate colours and very little noise.

For video, the Galaxy A50 is capable of shooting in 1080p at 30fps. If you want 4K or 60fps (not both at the same time, mind), you'll need to spend extra on the Galaxy A70. That said, the video quality is pretty good, and the image stabilisation seems

solid enough for shaky hands.

The front-facing selfie camera deserves a little shout-out, too. It's a 25-megapixel affair with an f/2.0 aperture. This might be overkill for Skype calls and selfies, however, and even with beauty mode switched off Samsung still insists on taking away all your wrinkles and giving you a weird, alien glow in the Samsung camera app.

COST EFFECTIVE

However, if that's all you can say that's wrong with the Galaxy A50, then Samsung is doing something very right. This only extends the South Korean manufacturer's hot streak for top-notch smartphones, offering as it does a great screen and high performance for under £300.

Alan Martin



SPECIFICATIONS

PROCESSOR Octa-core 2GHz Qualcomm Snapdragon 675 • **SCREEN SIZE** 6.7in • **SCREEN RESOLUTION** 2,400x1,080 • **REAR CAMERAS** 32 megapixels, 8 megapixels, 5 megapixels • **STORAGE** 128GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 164x77x7.9mm • **WEIGHT** 183g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** www.samsung.com • **PART CODE** SM-A705FZWUBTU



MOTOROLA One Action

COMPUTER
SHOPPER
RECOMMENDED

★★★★★

£220 • From www.amazon.co.uk

VERDICT

There are a few fancy camera tricks on this budget phone, but its real value comes from the essentials

MOTOROLA HAS, LIKE Samsung, been on a strong run of smartphone form recently, although its latest effort, the One Action, doesn't appear to make things easy for itself, appearing on the market for the same price as the Moto G7 (Shopper 376). Why bother with this when there's already a good budget handset, from the same manufacturer, for the same price?

The answer lies, at least in part, in the design. This could much more easily pass for the premium flagship than the Moto G7, adopting a taller 21:9 display with a pinhole camera cutout in the top-left corner. The contoured glass chassis is extremely swish for the money as well.

Nevertheless, all the ports and controls are where you'd expect them. The left edge hosts the nano-SIM card slot, which also includes a space for a microSD card if you want to augment the 128GB of internal storage. The USB Type-C charging port is in the usual place at the bottom of the phone, the power and volume rocker keys are on the right edge, and a 3.5mm audio jack sits on the top.

UP TO THE NINES

That 6.3in screen runs at 2,520x1,080, the same resolution as the standard Samsung Galaxy Note 10, although, being an IPS panel, it won't match the best OLEDs on quality. Regardless, the One Action's screen is pretty good overall, covering 93% of the sRGB colour gamut and having a measured contrast ratio of 1,253:1. The maximum screen brightness of 418cd/m² also helps boost readability in bright environments.

As with the more expensive One Vision (Shopper 381), the 21:9 aspect ratio has the benefit of squeezing more content from Facebook and Twitter feeds on to the screen at once, not to mention the fact that you can watch 21:9 content on Netflix and Amazon Prime Video without any pesky letterboxing.

Interestingly, the One Action also has the same SoC as the One Vision: not the usual Snapdragon fare, but a Samsung-made Exynos 9609. Powering it to Geekbench 4 scores of 1,606 in the single-core test and 5,362 in the multicore test, it's notably faster than the

Moto G7 and even the pricier One Vision.

Gaming performance is encouraging, too, with the GFXBench Manhattan onscreen test returning an average frame rate of 21fps. That might not sound like much, but this is a pretty demanding test of a phone's GPU, so you shouldn't encounter any glaring issues when running graphically intensive games.

The One Action's battery life is also close to that of the One Vision, ultimately lasting for 14h 21m during our video rundown test. While this means you'll be able to get through a full day on a single charge, we've seen plenty of handsets – including cheap ones – break the 20-hour barrier, so this result isn't particularly outstanding. It is an improvement on the Moto G7, however, which didn't even make it to 12 hours.

LIGHTS, CAMERAS, ACTION

Motorola is finally following the multi-camera trend, equipping the One Action with a trio of rear cameras. Rather than use the One Vision's 48-megapixel sensor, Motorola's latest handset incorporates a 12-megapixel (f/2.2) camera, alongside a 5-megapixel depth-sensing lens for more effective blurred background portrait photography.

The third and final 'action' camera uses an ultrawide, 117° lens to squeeze four times more of the scene into one frame. The sensor has also been rotated by 90°, allowing you to film landscape video while holding your phone in portrait mode.

It's a unique proposition, to be sure, although there is one small problem: if you want to film in portrait mode, you have to hold the One Action horizontally, which is just awkward.

Still, the One Action benefits from a long list of video-recording features: you can record 4K video in

21:9 format and Full HD footage at a silky smooth 60fps. Rock-steady video stabilisation is available for Full HD shooting modes with both the rear and 12-megapixel front cameras, too.

It comes as a bit of a shame, then, that the video quality of this action camera isn't entirely what it's hyped up to be. Footage does look nice and smooth, and having the opportunity to squeeze more stuff in the frame is most welcome, but the detail is sorely lacking. The Moto G7's video captures punchy, vibrant-looking colours, while the One Action's output looks unremarkably drab.

Thankfully, the One Action is more adept at taking pictures. In a reversal of fortune, it does a better job at shooting stills than the Moto G7: images are filled with detail, with superb colour rendition and a well-judged HDR mode. In low light, everything looks just as good, with none of the excess noise that spoils image quality on the Moto G7.

ONE-UP

This superior photo-taking ability proves to be the final blow in the contest between the One Action and the Moto G7. Despite the former having the odd silly gimmick, it's the better device in just about everything except video.

What's more, it's not just a Moto G7-beater: the One Action is a great budget smartphone in general, with the credentials to take on even more expensive models.

Nathan Spendelow



SPECIFICATIONS

PROCESSOR Octa-core 2.2GHz Samsung Exynos 9609 • **SCREEN SIZE** 6.3in • **SCREEN RESOLUTION** 2,520x1,080 • **REAR CAMERAS** 12 megapixels, 5 megapixels, 16 megapixels • **STORAGE** 128GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 160x71x9.2mm • **WEIGHT** 176g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** Two years RTB • **DETAILS** www.lenovo.com • **PART CODE** PAFY0012GB

Battery life



See page 84 for performance details

ANDROID 9.0 TABLET

VANKYO MatrixPad Z4



£90 • From www.amazon.co.uk

VERDICT

This dreadful slate only serves as proof that a low price and good value are not synonymous

£90 FOR A 10.1in Android tablet sounds too good to be true – and it is. The MatrixPad Z4 is a miserable product that struggled to complete our benchmarks and, astonishingly, manages to feel even cheaper than its extremely low cost of entry.

At a glance, the Vankyo MatrixPad Z4 is a pretty standard-looking tablet. The bezels are a bit thick, and it's made of plastic, but there's nothing immediately untoward considering the price. It's when you pick it up that the first signs of doubt appear. The plastic is smooth, but it feels insubstantial, as if the whole thing were hollow. Also, if there's one thing you can usually say for plastic-backed tech, it's that it doesn't leave unsightly fingerprints – but here, weirdly, it does.

Worse is the screen, which feels like it has a kind of rubbery resistance when you swipe. Sometimes this, combined with the extremely slow internals, makes things so bad that entering a pattern to unlock the tablet just doesn't register the final line.

SHOW OF BLEAKNESS

The MatrixPad Z4 does have one thing going for it: connectivity. Both a 3.5mm headphone jack and a microSD card (up to 128GB cards are supported) are in place, alongside the power switch, volume rocker and microUSB charging port. Unusually, the microUSB port is on the side rather than the bottom, which makes for a slightly awkward position for the charging cable when used in portrait mode.

From the unpleasant build quality to a screen so dim that it made us break our own battery-testing rules, the Vankyo MatrixPad Z4 is a top-to-bottom stinker

The screen, however, has problems besides its uncomfortable surface. For starters, its peak brightness is a pathetic 162cd/m², while only 74% of the sRGB colour gamut is covered and contrast is a poor 592:1. Besides looking ugly in general, the display's low brightness and reflective surface make it difficult to use in the sunlight.

Even the £50 Amazon Fire 7 (*Shopper* 379) has a contrast ratio of 1,205:1, and manages to hit a peak luminance of 374cd/m², so the low price isn't a good enough excuse.

That said, a display of this quality could be forgiven if performance was up to par.

Unfortunately, saying the MatrixPad Z4 is a pig to use would require an apology to pigs.

There's likely a reason you haven't heard of the Rockchip RK3066 processor before. Performance is consistently awful, slowing things down to a halt in just about everything. Tap on the Google Play icon and it finally loads after about six seconds. It takes a total of three seconds for the keyboard to slowly stutter on to the screen after pressing the search bar.

RUNNING HOT, LEFT COLD

Even transition screens on the homescreen leave a ghostly trail as you see more frames of the movement than you should. Things get marginally better as it warms up, but it's not great – and speaking of warming up, watching YouTube videos for a minute causes the plastic back panel to noticeably heat up.

It barely spluttered its way through Geekbench 4, ending up with a dire single-core result of 402 and a multicore test score of 998. Even the Fire 7 managed 638 and 1,656 respectively, and we had to dive pretty deep

into the archives to find a device that last failed to break four figures in the multicore portion. That would be the Nokia 2 (*Shopper* 365), a smartphone that cost £100 when it launched in 2017.

Not that we'd recommend gaming on either of them, but the Fire 7 also beats the MatrixPad Z4 in the GFXBench Manhattan benchmark. Amazon's tablet produced 12fps in the onscreen test, while Vankyo's coughed out 7fps.

Battery life is also a disappointment, with the MatrixPad Z4 giving up after 7h 32m of video playback. That's not the worst battery

life we've ever seen in a tablet but, seeing how dim the screen is, it's still disappointing – we normally run this battery test at 170cd/m², which the display can't even reach.

NO VANKYO

From the unpleasant build quality to a screen so dim that it made us break our own battery-testing rules, the Vankyo MatrixPad Z4 is a top-to-bottom stinker. The only reason it avoids the one-star fate is that, despite everything, it does technically work as advertised, and if you just want something extremely basic to keep younger kids occupied, this may be up to the job.

Even so, you could say the same of the Fire 7, which is cheaper, and if you can wait for the next Amazon sale you'll more than likely be able to get the superior Fire HD 10 for a similar price. Do not seriously consider buying this tablet; if you have anything but the lowest standards, you might as well be setting your money on fire. At least then you'd get a decent level of brightness.

Alan Martin



SPECIFICATIONS

PROCESSOR Dual-core 1.5GHz Rockchip RK3066 • **SCREEN SIZE** 10.1in • **SCREEN RESOLUTION** 1,280x800 • **REAR CAMERA** 8 megapixels • **STORAGE** 32GB • **WIRELESS DATA** None • **NFC** No • **DIMENSIONS** 250x171x90mm • **WEIGHT** 490g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** Three years RTB • **DETAILS** www.ivankyo.com • **PART CODE** MatrixPad Z4



FITNESS TRACKER

HUAWEI Band 3 Pro



£55 • From www.amazon.co.uk

VERDICT

This fitness band isn't the most accurate at tracking, but for the low price it's still a good buy

THE HUAWEI BAND 3 Pro has nearly everything you could plausibly want in a fitness band, including GPS, a heart-rate monitor and a vibrant AMOLED screen. More importantly, it does this at a price where you'd get change from three £20 notes.

There are no physical buttons on this otherwise conventionally designed wearable. The closest thing is a single touch-sensitive button under the main screen. Although we like the clean, symmetrical look, we also wouldn't have minded one or two extra buttons on the side. Touchscreen controls can get tricky to use when sweating, swimming or just out in the rain.

STRAP ARTIST

Even so, using the Band 3 Pro as an everyday fitness tracker is an understated pleasure. Your wrist will occasionally buzz with notifications, if they're enabled, but otherwise it's seen and not heard, only springing into life if you move your wrist sharply. The 0.9in AMOLED screen is sharp and easily readable, too.

Its one drawback is the lack of automatic brightness adjustment, which can be bothersome if you're wearing it while trying to sleep. There is an option to reduce brightness at night, buried in the settings – bafflingly not enabled by default – but it's not a perfect solution.

The onboard software is also fairly bare bones, with just three faces to choose from, and there are no widgets for weather or water consumed. Instead, you just have pages for steps, heart rate, sleep, workout and messages. There's no support for music – even just as a remote control for your phone – and no guided breathing exercises or the like, as you get on some rivals.

The biggest issue, however, is with distance accuracy. At the end of a 5km run, the Band 3 Pro had measured us as

having travelled only 4.56km. Some heavy tree cover might have interfered here, but that's not a very reassuring excuse. Another run, this time for 3.75km, only registered as 3.41km – again, falling short by about 10%.

Conversely, heart-rate tracking is pretty reliable. Some peaks can be a little on the low side, but averages are accurate and there are no odd jumps or dips when reviewing post-workout data.

The Huawei Band 3 Pro falls into the same trap as all slim fitness bands: there just isn't enough space on the screen to show all the key running metrics at a glance. Instead, six data fields are shown across three screens, which can be cycled through with a tap. Suffice to say, this isn't ideal for serious runners, especially as you can't change the order in which they appear.

Fortunately, the design isn't too bad here, as the touch button for stopping and starting is sufficiently far removed from the main panel that you won't end up accidentally ending your run early. And even if you do tap it by accident, you need to hold it for the duration of a three-second countdown for anything to happen.

LONG-DISTANCE RUN

One area where the Band 3 Pro really excels is battery life. Despite having a tiny 100mAh cell, Huawei reckons it will last up to three weeks on a single charge or

around seven hours of GPS tracking. From our experience this seems optimistic, but not hugely so. After a week of normal use with some GPS tracking occasionally thrown in, we still had plenty of charge left.

It's also worth noting that the Band 3 Pro is both cheaper and more fully featured than the Fitbit Inspire HR (Shopper 377).

However, the latter has the benefit of both the Fitbit



app and community, which do a much better job of making fitness fun.

The Huawei Band 3 Pro makes you use Huawei Health, which isn't an entirely bad app but lacks a web interface, a similarly enthusiastic userbase to Fitbit's and support for interfacing with third-party apps. There's no option to export data to Strava, Runkeeper, Endomondo or anything else.

This alone might be a deal-breaker to some, although if you just want to track things by yourself, it does the trick, letting you easily keep tabs on your steps, exercise and sleep from the main menu. Tapping on a run, for example, offers you a granular breakdown of your heart rate, pace and cadence over the duration, with insights about how your fitness compares with your gender and age peers.

BATTLE OF THE BANDS

This kind of simple but effective usability goes a long way towards making the Band 3 Pro a nice little fitness band, in spite of our concerns about its GPS accuracy. It's particularly good value, too. Ultimately the Inspire HR is a far better device in most regards, but then it is a lot more expensive, at £90. Huawei's wearable is therefore a good-value alternative.

Alan Martin



SPECIFICATIONS

PEDOMETER Yes • **HEART-RATE MONITOR** Yes • **DISPLAY SIZE** 0.9in • **RESOLUTION** 240x120 • **OS** **SUPPORT** Android, iOS • **BATTERY LIFE** Three weeks • **WARRANTY** One year RTB • **DETAILS** consumer.huawei.com • **PART CODE** 55023002

COMPACT SYSTEM CAMERA

CANON PowerShot G5 X Mark II



£829 • From www.amazon.co.uk

VERDICT

A tiny camera that shoots the best stills and videos you'll get from something this size

MASS MARKET COMPACT cameras may be in decline, but Canon is betting that the high-end combination of a small, convenient body with good image quality might show there's life in them yet. The PowerShot G5 X Mark II is therefore designed to lure in travelling photographers, or perhaps professionals looking for a take-anywhere camera that shoots better images than a smartphone, without the hassle of a DSLR.

The G5 X Mark II follows the 2015 G5 X, and keeps things interesting by redesigning its predecessor as it heads out to pasture. Gone is the faux DSLR shape with the electronic viewfinder (EVF) hunched over the middle of the lens; instead, the EVF is now a spring-loaded number recessed in the camera.

There are a few changes inside, too. Resolution is fractionally down on the original G5 X: where the Mark I had 20.2 effective megapixels, the Mark II has 20.1. The sensor is the same size as that in the original G5 X, but it's now a stacked CMOS unit, which means, in theory, faster data readout and therefore better performance.

FUN SIZED

The result of hiding the EVF is that the G5 X Mark II looks a lot more like a traditional compact camera, albeit one with a lens that protrudes a little from the body, even when it's retracted. The protruding lens is functional, however; as on the original G5 X, there's a multifunction ring that can be used to set shutter or aperture values.

The body is otherwise pared back and pleasing to hold. The rubber grip isn't a patch on the ergonomics of full-size DSLRs, but the G5 X Mark II is nonetheless comfortable, and the dimensions of the camera are kept slimline



by the omission of a proper flash hotshoe on the top of the camera. A double-jointed spring-loaded flash is all you get, which will reduce the appeal of the G5 X Mark II for those hoping to use external lights.

The camera is otherwise well appointed with controls. The top, apart from the obvious shutter release and zoom control, has a pair of control wheels, one for selecting the camera mode from the usual suspects – the full range

burst settings and flash control, and is surrounded by a thumbwheel. The latter is small – about the diameter of a 1p coin – but with a knurled edge and pleasing click as it turns, it's easy enough to use.

Otherwise, the rear of the G5 X Mark II is occupied chiefly by its touchscreen. At 3in, it's not the biggest, but it's comfortable, and its 1.04-million-pixel-resolution makes it an accurate gauge of sharpness.

Still images are outstanding, and it's impressive that it can shoot quality 4K video in such a compact body

of PASM modes, plus a dedicated video mode, exposure bracketing and various scene options – and a larger one beneath for exposure compensation.

The latter is particularly useful, especially with the G5 X Mark II offering live exposure simulation, as it means you can get your exposure dead-on in camera rather than doing it yourself with processing work afterwards.

GOT THE TOUCH

The back of the camera again has a practical, rather than overbearing, set of controls. The direction pad works as a series of shortcuts to features such as focus mode,

The pop-up EVF is novel and at first a little confusing. Simply pulling the lever on the side of the camera to pop it up doesn't activate it; you need to grab the edges of the EVF screen with your thumb and forefinger and pull it towards you to bring it to life. Once it's going, you'll find a 0.39in EVF with a healthy resolution of 2.36 million pixels. Wisely, Canon hasn't attempted to shoehorn all the information from the main touchscreen on to the EVF, so you only get the bare necessities: shutter speed, aperture, shots remaining and just a few others.

POINTS OF INTEREST

The EVF works well, particularly in conjunction with the G5 X Mark II's superb implementation of touch to focus, where the rear screen works as a trackpad, allowing you to pull the autofocus point around with the camera lifted to your eye. It quickly became our preferred way of working, not least when bright sunlight made the rear monitor hard to see.

The lens is practical – a 5x zoom, equivalent in 35mm terms to 24mm at wide-angle and 120mm when zoomed in. Aperture-wise, you get f/1.8 at wide-angle and a stop slower f/2.8 zoomed in. An f/2.8 120mm lens helps keep ISO under control in a wide range of circumstances.





Speaking of controlling ISO, the G5 X Mark II ranges from ISO 125 all the way up to ISO 25,600, which is some going for a 1.0-type sensor.

At the lower end of that range, image quality is exemplary. 'DSLR-like' is only a slight exaggeration but, shooting in the G5 X Mark II's Raw mode, we returned sharp, clear images with absolutely loads of detail. Ramping up the ISO returned extremely impressive results. Assuming you don't want to crop, you'll find little to differentiate images between the lowest ISO of 125 and ISO 1600 – a roughly five-stop range. At ISO 3200 and beyond images degrade fast; noise is chunky and produced desaturated images with bland colours and poor detail. ISOs 12,800 and 25,600, as expected, are for use in emergencies only.

Stay in the G5 X Mark II's sweet spot, and there's loads to like. Not least is its ability to shoot up to 30fps. Unsurprisingly, this comes with some compromises, not least a lengthy wait while the camera sorts the data you've just thrown at it. It's handy for those looking to catch split-second moments; the G5 X Mark II saves about 20 frames before you push the shutter, so even if your reactions aren't fast enough, you stand a good chance of capturing the moment anyway.

These bursts are saved as grouped files from which Raw (or JPEG) files can be extracted on the camera. If you'd rather use a traditional burst mode, you can do so. The G5 X Mark II shot a still impressive 21.5fps for a little under 2.5 seconds, making this a capable camera for sporting types, even if the reach of the lens doesn't quite match up.

SHARP EYES

Autofocus performance is excellent, with face recognition and subject tracking working well in our tests. For those partial to manual focus the option is there, but focus pushes forwards and backwards very slowly, so you'll need your subject to be stock still to use it. Focus peaking is a useful inclusion, but only works in manual focus mode.

The PowerShot G5 X Mark II has received a good kick in the pants when it comes to its video modes. 4K is welcome if inevitable, with 25fps the only available frame rate. Full HD can be shot at 50 or 100fps for a slow-motion effect, and in our tests, quality was excellent. There's an automatic timelapse builder, which shoots still files then collates them into a finished video.

An integrated ND filter allows you to shoot longer shutter speeds when it's bright.

The tilting, flipping monitor on the back allows you to shoot selfie videos, which will be appreciated by vloggers and, all in all, the G5 X Mark II is a more than capable video performer for a compact. Don't forget that at this price it's competing with some arguably better alternatives, not least the Fujifilm X-T30 (Shopper 378), which will shoot cinema 4K at a wider range of frame rates on a bigger sensor, through a wider range of lenses.

LITTLE EMPEROR

Ultimately, the PowerShot G5 X Mark II is very good for a compact, and that's not to damn with faint praise. Its still images are outstanding at a much wider range of ISOs than we'd expect, and it's impressive that it can shoot quality 4K video in such a compact body. It's convenient as well, and its low 340g weight gives it a lot of appeal.

We like the physical controls, which will allow experienced photographers to get it set up as they like, and we also like both the big rear monitor and convenient EVF, which make the camera easy to use.

If you're after a camera about the size of a box of matches, and want the best possible image quality and control, the G5 X Mark II is probably it, not least because of the big price difference between it and its Sony rival, the RX100 VI. If you're prepared to tolerate more weight and a more cumbersome body, inevitably you're better advised to opt for a DSLR, but meet the G5 X Mark II on its own terms and it might be the best compact camera ever made. You'll have to decide if that cuts the mustard.

Dave Stevenson

SPECIFICATIONS

SENSOR RESOLUTION 20.1 megapixels • **SENSOR SIZE** 13.2x8.8mm • **FOCAL LENGTH MULTIPLIER** 2.7x • **VIEWFINDER** Electronic (2.36 million dots) • **LCD SCREEN** 3in (1.04 million dots) • **VIEWFINDER MAGNIFICATION** (35mm-EQUIVALENT, COVERAGE) 1x, 100% • **WEIGHT** 340g • **DIMENSIONS** 61x111x46mm • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **PART CODE** G5 X Mark II



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Choosing a... PC system

01 A basic PC costing around £350 will be able to run everyday office, multimedia and education software and will easily cope with surfing the internet. It might even be able to run some modern games.

Many PCs can be sold either with or without a monitor. If you don't like the display the manufacturer is offering, you can always use your current one, or buy another one separately.

02 If you want to play games, you'll have to upgrade the graphics card. Budget cards such as the Nvidia GeForce GTX 1050 will cope well with many 3D games, but to play the latest 3D games smoothly (and enjoy the best-quality graphics) it's worth upgrading to a more powerful card such as the Nvidia GeForce GTX 1070.

03 All modern PCs come with at least a dual-core processor and are capable of most tasks. Anyone who regularly undertakes demanding tasks such as video editing and encoding should consider a hexa-core or even an octa-core processor.

04 There are plenty of good reasons to upgrade the PC's memory or hard disk. If you'll use your PC for gaming, video editing or other demanding tasks, you'll need at least 8GB of RAM and a large hard disk; 1TB should suffice. Many new PCs have an SSD, which speeds up the time it takes for your PC to boot and for programs to load.

05 Having plenty of USB ports is always useful, as most computer

peripherals attach to these ports. Most new PCs come with USB3 or the latest USB3.1 ports, which provide faster data transfers when used with supported devices than the older USB2 standard.

06 Most new PCs now come with Windows 10 pre-installed. Don't be too easily swayed by the inclusion of other software, though, as it may be that you'll never use it.

07 While most PCs come in cases of a similar size, some have more compact mini tower or mini PC cases. These smaller PCs will fit under your TV or on your desk more easily, but bear in mind that they're significantly harder to upgrade than full-size machines.

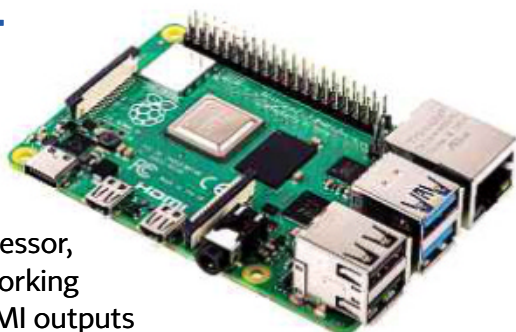
PCs

RASPBERRY PI

4 Model B

★★★★★

£34 • thepihut.com



COMPUTER SHOPPER
BEST BUY

A faster processor, quicker networking and dual HDMI outputs

make the Pi 4 a much better desktop computer than previous Pi models, and it hasn't lost any appeal as a cheap hobbyist board, either. 4K video implementation could be better – we had issues getting smooth playback in Raspbian – but that's the only noteworthy concern.

PROCESSOR 1.5GHz quad-core Broadcom BCM2711 • **RAM** 1GB • **USB PORTS** 1x USB Type-C (power), 2x USB2, 2x USB3 • **STORAGE** MicroSD card slot • **DISPLAY** None • **OPERATING SYSTEM** Raspbian • **WARRANTY** One year RTB • **DETAILS** www.raspberrypi.org • **PART CODE** Pi 4 Model B • **FULL REVIEW** Sep 2019

ACER Chromebox CXI3

★★★★★

£528 • uk.insight.com

COMPUTER SHOPPER
RECOMMENDED

An absolutely tiny Chrome OS system, the Chromebox CXI3 is compact enough to attach to the back of a monitor. Even better, it has more power than most Chromeboxes, thanks to its Core i5 processor, and is loaded with useful ports in spite of its minimal size. It's cheap, too, although we'd recommend investing in a better mouse and keyboard than the bundled peripherals.



PROCESSOR Quad-core 1.6GHz Intel Core i5-82500U • **RAM** 8GB • **FRONT USB PORTS** 2x USB3 • **REAR USB PORTS** 3x USB3, 1x USB Type-C • **TOTAL STORAGE** 64GB SSD • **DISPLAY** None • **OPERATING SYSTEM** Chrome OS • **WARRANTY** One year RTB • **DETAILS** www.acer.com • **PART CODE** DT.ZOSEK.001 • **FULL REVIEW** Aug 2019

CCL Paladin

★★★★★

£1,670 • www.cclonline.com

NEW ENTRY



COMPUTER SHOPPER
BEST BUY

The Paladin is stuffed with AMD's latest technology, including the excellent octa-core Ryzen 7 3700X CPU and a 4K-capable Radeon RX 5700 XT graphics card. Storage is another highlight: the SSD isn't a PCI-E 4.0 model, which the motherboard is compatible with, but it's still very fast and offers an enormous 1TB of space by itself.

PROCESSOR Octa-core 3.6GHz AMD Ryzen 7 3700X • **RAM** 16GB • **FRONT USB PORTS** 2x USB2, 2x USB3 • **REAR USB PORTS** 2x USB2, 2x USB3, 2x USB3.1, 1x USB Type-C • **TOTAL STORAGE** 1TB SSD, 2TB hard disk • **GRAPHICS CARD** 8GB AMD Ryzen 7 3700X • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three years collect and return • **DETAILS** www.cclonline.com • **PART CODE** GAME-PBME 0202 0304 0100 0200 0200 0000 0200 01 • **FULL REVIEW** Nov 2019

PALICOMP AMD Abyss

★★★★★

£700 • www.palicomp.co.uk

COMPUTER SHOPPER
BEST BUY

At this price, you'd seriously struggle to find a more comprehensively capable desktop system than Palicomp's AMD Abyss. It can multitask with serious applications just as well as it can run games, and with its large, fast NVMe SSD, it won't be slowed down by storage. There's a lot of room for future upgrades, too.



PROCESSOR Hexa-core 3.6GHz AMD Ryzen 5 2600X • **RAM** 8GB • **FRONT USB PORTS** 2x USB2, 1x USB3 • **REAR USB PORTS** 2x USB2, 2x USB3, 2x USB3.1, 1x USB Type-C • **TOTAL STORAGE** 512GB SSD, 1TB hard disk • **GRAPHICS CARD** 8GB AMD Radeon RX570 Armor 8GB OC • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** Three years RTB • **DETAILS** www.palicomp.co.uk • **PART CODE** RYZ6 • **FULL REVIEW** Apr 2019

Choosing a... Laptop

01 A basic laptop costing around £300 will run everyday office, multimedia and education software, but it won't be suitable for 3D gaming or processor-intensive tasks such as video editing. Many laptops at this price have a 15.6in screen and weigh over 2kg, so they're best used around the house and for occasional journeys.

02 If you want to play modern games, you'll need a laptop with a dedicated graphics chip such as the Nvidia GeForce GTX 1060M. Good gaming laptops tend to have large 15.6 or 17in screens and weigh around 3kg, so they're best suited to use at home.

03 If you want a laptop that you can take everywhere, look for a model that weighs less than 2kg. For the best

portability, buy one that has a 13.3in or 14in screen. In general, the smaller and lighter the laptop, the more expensive it is, especially if it has plenty of processing power.

04 Battery life is extremely important for a laptop, particularly if you'll be carrying it around. We'd expect all but the biggest and heaviest to last for at least five hours on a single charge, but for an ultraportable that you carry everywhere, eight hours and above is more desirable.

05 Laptops use mobile versions of processors to conserve power, and these lag behind desktop chips when it comes to performance. For a budget Windows laptop, an Intel Core i3 processor will do the job, but if you

want better performance, you should look for an Intel Core i5 or Core i7 model instead. We recommend a minimum of 4GB of RAM, although 8GB is better for multitasking.

06 Most budget and mid-range laptops use a mechanical hard disk for storage. You'll want at least 500GB, but 1TB or more is better. Solid-state drives (SSDs) have faster performance, making your computer quicker to boot and more responsive. They have lower capacities, though. You'll need at least 128GB.

07 Convertibles and 2-in-1 laptops can change from laptop mode to tablet mode. We've listed our favourite models later on in this guide in the Tablets section.

LAPTOPS

HP Envy 13



£849 • store.hp.com



There are plenty of great ultraportables available these days, but most of them cost well over £1,000. The Envy 13 is an extremely attractive alternative: it's slim and light, weighing just 1.2kg, but it has plenty of power and high-end features including a fingerprint reader and dedicated graphics, and what's more, it's relatively affordable.



PROCESSOR Quad-core 1.6GHz Intel Core i5-8250U • **RAM** 8GB • **DIMENSIONS** 307x212x14.9mm • **WEIGHT** 1.2kg • **SCREEN SIZE** 13.3in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Nvidia GeForce MX150 • **TOTAL STORAGE** 256GB SSD • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** One year RTB • **DETAILS** www.hp.com • **PART NUMBER** ah0001na • **FULL REVIEW** Sep 2019

ACER Aspire 5



£598 • www.amzn.to/2MS5lqc



The Aspire 5 is the epitome of the sensible mid-range laptop. It's not ultra-stylish and it doesn't have a professional-quality display, but for the price it offers reliable performance in a variety of workloads, and it will last a full day on battery power without much trouble.



PROCESSOR Quad-core 1.6GHz Intel Core i5-8250U • **RAM** 8GB • **DIMENSIONS** 382x263x21mm • **WEIGHT** 2.2kg • **SCREEN SIZE** 15.6in • **SCREEN RESOLUTION** 1,920x1,080 • **TOTAL STORAGE** 256GB SSD • **OPERATING SYSTEM** Windows 10 Home • **WARRANTY** One year RTB • **DETAILS** www.acer.com • **PART CODE** A515-51-50YS • **FULL REVIEW** Oct 2018

HUAWEI MateBook 14



£1,500 • consumer.huawei.com



The MateBook 14 is the biggest and best of Huawei's 2019 ultraportables. Like the more expensive MateBook X Pro, it can be equipped with a Core i7 processor, but an airier chassis means that performance isn't compromised to prevent heat build-up. Other highlights include long battery life and Nvidia's updated MX250 GPU.



PROCESSOR Quad-core 1.8GHz Intel Core i7-8565U • **RAM** 16GB • **DIMENSIONS** 308x224x15.9mm • **WEIGHT** 1.5kg • **SCREEN SIZE** 14in • **SCREEN RESOLUTION** 2,160x1,440 • **GRAPHICS ADAPTOR** Nvidia GeForce MX250 • **TOTAL STORAGE** 512GB SSD • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** Two years RTB • **DETAILS** consumer.huawei.com • **PART CODE** KLV-W29 • **FULL REVIEW** Jun 2019

ASUS ROG Strix Scar III



£2,599 • www.amzn.to/2Mxdeoy



The ROG Strix Scar III compromises nothing in its pursuit of top-quality portable gaming. While this means a high price, it also means a 240Hz display, an incredibly powerful Core i9 processor and Nvidia's high-end RTX 2070 GPU. Despite not being a true thin-and-light gaming laptop, it's not too heavy and unwieldy, either.



PROCESSOR Octa-core 2.3GHz Intel Core i9-9980H • **RAM** 32GB • **DIMENSIONS** 360x275x24.9mm • **WEIGHT** 2.57kg • **SCREEN SIZE** 15.6in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** 8GB Nvidia GeForce RTX 2070 • **TOTAL STORAGE** 1TB SSD • **OPERATING SYSTEM** Windows 10 Home • **PARTS AND LABOUR WARRANTY** One year RTB • **DETAILS** www.asus.com • **PART CODE** G531GW-AZ055R • **FULL REVIEW** Oct 2019

Choosing a... NAS device

01 A network-attached storage (NAS) device lets you store documents, media, and other files on its hard disks so you can share them with other devices on your network. Some have disks already installed, while others are empty enclosures into which you install your own disks. Buying an empty NAS can often be the more cost-effective option, as they're usually less expensive and give you the freedom to add disks at a later date.

You should buy one with a Gigabit Ethernet interface, as these provide the highest transfer speeds. To use a NAS device at these speeds, you'll need computers with Gigabit Ethernet network adaptors and a Gigabit Ethernet switch or router. Computers with Fast Ethernet adaptors

can still access the NAS device, but only at the much slower speed of 100Mbit/s.

02 The amount of network storage you need depends on the types of files you use. If you want to store Word and Excel documents, for example, a 1TB device will be fine. In fact, a 1TB device should be sufficient for a family's entire media collection, regardless of how many music and video files everyone owns. Small businesses should consider higher storage capacities, depending on the nature of the business.

03 If you can see no end to your storage needs, you should buy an upgradable NAS device. Many have a USB port for adding an external disk. Devices such as

Synology's barebones NAS kits have spare disk trays for cheaper and faster upgrades.

04 If you want extra protection for your data, look for a device that supports RAID. RAID 1 and RAID 5 arrays reduce the available capacity by duplicating data, but you won't lose it if a disk fails.

05 If you need access to your files while you're away, look for a NAS device with an FTP server. Some can also share a USB printer across your network.

A NAS device with a Universal Plug and Play (UPnP) or DLNA media server can stream your music, photos and videos to a network media player, so you can enjoy your media collection in another room.

STORAGE

SYNOLOGY DiskStation DS418j

★★★★★

£284 • www.broadbandbuyer.com

COMPUTER SHOPPER
BEST BUY

When a tiny two-bay NAS won't cut it, the fast, high-capacity DiskStation DS418j

is an excellent upgrade, especially as it can automatically convert old hard disks to be compatible with this NAS's hardware and features.



3.5in HARD DISK BAYS (FREE) 4 (4) • NETWORKING 1x 10/100/1,000 Ethernet • DLNA MEDIA SERVER Yes • PRINT SERVER Yes • DIMENSIONS 184x168x230mm • WEIGHT 2.21kg • WARRANTY Two years RTB • DETAILS www.synology.com • PART CODE DS418j • FULL REVIEW Jan 2018

INTEL Optane Memory 32GB

★★★★★

£60 • www.currys.co.uk

COMPUTER SHOPPER
RECOMMENDED

An interesting twist on M.2 SSDs, Optane Memory isn't so much a dedicated storage drive as a large cache for your existing hard disk, accelerating its read speeds to NVMe levels at a much lower price.



CAPACITY 32GB • PRICE PER GIGABYTE £1.88 • INTERFACE M.2/NVMe • WARRANTY Five years RTB • DETAILS www.intel.com • PART CODE MEMPEK1W032GAXT • FULL REVIEW Sep 2017

ADATA XPG SX8200 Pro 1TB

★★★★★

£134 • www.ebuyer.com

COMPUTER SHOPPER
BEST BUY

The Adata XPG SX8200 Pro is outrageously

good value for the performance it delivers. It's as fast as or faster than top-tier SSDs from Samsung and WD, but costs far less across all its capacity options.



CAPACITY 1TB • COST PER GIGABYTE £0.13p • INTERFACE M.2/NVMe • WARRANTY Five years RTB • DETAILS www.xpg.com • PART CODE ASX8200PNP-1TT • FULL REVIEW Apr 2019

ADATA SD600Q 480GB

★★★★★

£64 • www.alternate.co.uk

COMPUTER SHOPPER
RECOMMENDED

Put aside your fears about external SSDs being too expensive compared to hard disks – this 480GB drive is excellent value, and decently quick.



CAPACITY 480GB • COST PER GIGABYTE £0.13p • INTERFACE USB3 • CLAIMED READ 440MB/s • CLAIMED WRITE 430MB/s • WARRANTY Three years RTB • DETAILS www.adata.com • PART CODE ASD600Q-480GU31-CBL • FULL REVIEW Aug 2019

SAMSUNG Portable SSD X5 1TB

★★★★★

£439 • www.scan.co.uk

COMPUTER SHOPPER
BEST BUY

For when you absolutely need to shift files as quickly as possible, there's the X5. Its use of the Thunderbolt 3 interface makes it the fastest external SSD ever.



CAPACITY 1TB • COST PER GIGABYTE £0.44p • INTERFACE Thunderbolt 3 • WARRANTY Three years RTB • DETAILS www.samsung.com/uk • PART CODE MU-PB1T0B/WW • FULL REVIEW Dec 2018

SAMSUNG 970 Evo Plus 500GB

★★★★★

£106 • www.amzn.to/2CrstZB

COMPUTER SHOPPER
RECOMMENDED

A significant write speed upgrade helps make the 970 Evo Plus a superlatively speedy M.2 SSD, and at prices much lower than the original 970 Evo's equivalent capacities.



CAPACITY 500GB • COST PER GIGABYTE £0.21p • INTERFACE M.2/NVMe • CLAIMED READ 3,500MB/s • CLAIMED WRITE 3,300MB/s • WARRANTY Five years RTB • DETAILS www.samsung.com/uk • PART CODE MZ-V75500BW • FULL REVIEW May 2019

Choosing an... Intel motherboard

01 It's essential that you buy the right type of motherboard for your processor. For example, Intel's Skylake, Kaby Lake and Coffee Lake processors all use the same LGA 1151 socket, but because each CPU generation introduced new chipsets, you'll need to get a Z370 motherboard for a Coffee Lake chip, a Z270 board for a Kaby Lake chip and so on.

02 All current Intel processors have built-in graphics chipsets, so if you want to use your chip's built-in graphics, make sure the motherboard has the video outputs, such as DVI, HDMI and DisplayPort. If you want to play the latest games, you'll need to fit a dedicated graphics card in the motherboard's PCI

Express x16 slot, although this may block one of your other slots.

03 Normal tower cases can accommodate ATX motherboards, which provide the most expansion slots. A microATX motherboard will let you build your PC in a smaller case, but if you opt for a microATX board, make sure it has all the features you need built in as there won't be much room for expansion cards.

04 If you want to install lots of expansion cards, look for a motherboard that offers plenty of PCI and PCI-E x1 slots. Some motherboards also have PCI Express x4 slots and extra PCI Express x16 slots. PCI Express x1 and x4

cards also work in PCI Express x16 slots. If you need a lot of storage, a motherboard with plenty of SATA2 and SATA3 ports is essential. SATA2 is fine for optical drives and hard disks, but to make the most of an SSD you need SATA3.

05 All motherboards have built-in audio chipsets, but some support only 5.1 surround sound rather than 7.1. If you're connecting to older surround-sound amplifiers that don't have HDMI, look for an optical or coaxial S/PDIF output. All motherboards have Ethernet ports and most have the faster Gigabit version. You may also find it useful to buy a board with built-in Wi-Fi so you don't have to use up a USB port or PCI slot with an adaptor.

COMPONENTS

AMD Ryzen 9 3900X

★★★★★

£546 • www.amzn.to/2m4KUOi



COMPUTER SHOPPER
RECOMMENDED

Forget the Intel Core i9-9900K – this 12-core monster of a CPU performs far better for similar money. There is a drawback, in that it's not very overclocking-friendly, but that's partly because it's so fast to begin with. Pair it with some good RAM, and you're already most of the way to a capable home workstation.

SOCKET AM4 • CORES 12 • FREQUENCY 3.8GHz • INTEGRATED GRAPHICS None • WARRANTY Two years RTB • DETAILS www.amd.com • PART CODE 100-100000023BOX • FULL REVIEW Nov 2019

AMD Radeon RX 5700

★★★★★

£290 • shop.amd.com



COMPUTER SHOPPER
BEST BUY

AMD's 7nm GPU is cheaper than the GeForce RTX 2060 and the RTX 2060 Super, yet is just as comfortable with gaming at 1080p and 1440p. This price only seems to apply for the reference design rather than partner versions, but the blower-style cooler is the only real downside.

GPU AMD Radeon RX 5700 • MEMORY 8GB GDDR6 • GRAPHICS CARD LENGTH 268mm • WARRANTY One year RTB • DETAILS www.amd.com • PART CODE Radeon RX 5700 • FULL REVIEW Oct 2019

AMD Ryzen 7 2700X

★★★★★

£192 • www.amzn.to/2JvaEyCk



COMPUTER SHOPPER
BEST BUY

AMD's second generation of Ryzen processors gets off to an auspicious start with the mighty Ryzen 7 2700X. It's faster than Intel's equivalent Core i7-8700K at stock speeds, despite being cheaper, and temperatures stay low even when overclocking.

SOCKET AM4 • CORES 8 • FREQUENCY 3.7GHz • INTEGRATED GRAPHICS None • WARRANTY Two years RTB • DETAILS www.amd.com • PART CODE YD270XBGAFOX • FULL REVIEW Aug 2018

THERMALTAKE View 37

★★★★★

£110 • www.scan.co.uk



COMPUTER SHOPPER
BEST BUY

A spacious, feature-rich chassis for both ATX- and EATX-based builds, the View 37 comes with a gull-wing side window that's perfect for showing off your handiwork.

CASE TYPE Mid-tower • MOTHERBOARD TYPE ATX, EATX, microATX, Mini-ITX • SUPPLIED FANS 2x 140mm • MAX DRIVE BAYS 7x 3.5in, 11x 2.5in • DIMENSIONS 525x261x538mm • WEIGHT 11.8kg • WARRANTY Three years RTB • DETAILS www.thermaltake.com • PART CODE CA-1J7-00M1WN-00 • FULL REVIEW Dec 2018

ASUS ROG Strix Flare

★★★★★

£120 • www.game.co.uk



COMPUTER SHOPPER
BEST BUY

Besides being a comfortable and responsive gaming keyboard, thanks to its reliable Cherry MX Red switches, the ROG Strix Flare is loaded with useful features and extras: there's a set of dedicated media controls and a USB2 pass-through port, among others.

KEYBOARD SHAPE Full size • NUMBER PAD Yes • CONNECTION 1x USB2 • MEDIA KEYS Pause/play, mute, skip, volume • USB PORTS 2x USB2 • WARRANTY One year RTB • DETAILS www.asus.com/uk • PART CODE 90MP000MO-BOEA00 • FULL REVIEW Oct 2019

MSI MPG Z390 Gaming Edge AC

★★★★★

£140 • www.scan.co.uk



COMPUTER SHOPPER
BEST BUY

From built-in 802.11ac Wi-Fi and Bluetooth to high-end audio connectivity, the MPG Z370 Gaming Edge AC is stuffed with features. Add in a good price, easy overclocking and a well-designed BIOS, and it's perfect for premium Intel-based builds.

PROCESSOR SOCKET LGA1151 • DIMENSIONS 305x244mm • CHIPSET Intel Z390 • MEMORY SLOTS 4 • PCI-E x16 SLOTS 3 • PCI-E x1 SLOTS 3 • PCI SLOTS 0 • USB PORTS 2x USB2, 2x USB3, 1x USB3.1, 1x USB Type-C • VIDEO OUTPUTS 1x HDMI, 1x DisplayPort • WARRANTY One year RTB • DETAILS www.msi.com • PART CODE MPG Z390 Gaming Edge AC • FULL REVIEW Apr 2019

Choosing a... Custom PC spec

01 Building your own PC is often cheaper than buying a pre-made system, and gives full control over the components. You don't need any special computer knowledge: just a few spare hours, a screwdriver and your choice of parts. Even things such as liquid-cooling systems can be found in user-friendly, easy-to-install packages, and for the most part it's as simple as inserting each component into a particular slot.

02 Arguably the most important component is the CPU. These days you can get a quad-core chip even on a tight budget, which should provide more than enough brainpower for simple tasks such as web browsing, but hexa-core and octa-core chips are better for tougher jobs such as media editing, gaming and content creation.

The CPU will also determine which motherboards you can choose from. Intel CPUs will only work with boards that use an Intel chipset, like Z390, Z370 and B360, while AMD processors need AMD chipsets, such as X470 and B450.

03 When choosing a motherboard, think about both the size of the PC's chassis (smaller cases won't fit larger ATX or EATX boards, for instance) and how many

additional components you'll want to install. For systems with a lot of expansion cards (such as graphics cards, sound cards or Wi-Fi cards), it's best to go with ATX motherboards and larger. For simpler builds, microATX or Mini-ITX boards could well provide all the connectivity you need. Keep in mind, too, that if you want to try overclocking, only certain Intel chipsets will support it, such as Z370 and Z390. AMD is more relaxed, enabling overclocking on all its Ryzen-compatible chipsets, except A320 and A300.

04 While CPU integrated graphics will suffice for everyday browsing, a dedicated graphics card is essential for high-quality gaming. These can be installed in a PCI-E x16 slot on your motherboard, and have the bonus of adding more display outputs to use – just make sure the card will fit inside your chosen case.

05 On the subject of cases, personal taste will factor highly here: nobody wants an ugly PC. That said, picking a chassis with adequate space for components is vital. As already mentioned, an ATX motherboard likely won't fit in a mini-tower case, and if you want to install a lot of hard disks, you'll need a case with sufficient drive bays.

06 Every PC requires RAM and a PSU. Performance doesn't vary much between specific models, but generally you should aim for 8GB of RAM for a basic build and 16GB for higher-end systems, and at least a 550W, Bronze-certified PSU. It's better to buy a higher-wattage PSU than you strictly need, as it will allow you to add more components in the future. Also, check which RAM is compatible with your motherboard before buying, although for all current models it's probably going to be DDR4.

07 Our recommended storage setup comprises both an SSD and a larger mechanical hard disk. By installing Windows (and a few choice applications) on the SSD, you can ensure fast booting and loading times, while the HDD is a cost-effective way of storing lots of files. Alternatively, you could buy a hard disk, and then install an Intel Optane Memory module to accelerate its write speeds to SSD levels, although since SSDs are barely more expensive than Optane drives, this is perhaps better for situations when you want to upgrade from an existing hard disk, rather than when you're building a whole new system. In the latter case, an SSD/HDD combo is better all round. See page 58 for our recommended storage drives.

BUDGET PCs

AMD Ryzen 3 2200G

★★★★★

£77 • www.amzn.to/2TmlHh



This plucky quad-core chip is decently fast, comes bundled with its own cooler and – unlike most Ryzen chips – includes integrated Radeon RX Vega graphics. It's therefore particularly ideal if you don't need the added power of dedicated graphics.



SOCKET AM4 • **CORES** 4 • **FREQUENCY** 3.4GHz • **INTEGRATED GRAPHICS** AMD Radeon RX Vega 8 • **WARRANTY** Three years RTB • **DETAILS** www.amd.com • **PART CODE** YD2200C5FBB0X • **FULL REVIEW** Jul 2018

ASROCK Fatal1ty AB350 Gaming-ITX/ac

★★★★★

£96 • www.cclonline.com



Tiny it may be, but the AB350 makes the most of what space it has available. Multiple display outputs, a rear-mounted M.2 port and onboard Wi-Fi mean it almost has the specs of a respectable ATX model.



PROCESSOR SOCKET AM4 • **DIMENSIONS** 170x170mm • **CHIPSET** AMD B350 • **MEMORY SLOTS** 2 • **PCI-E X16 SLOTS** 1 • **PCI-E X1 SLOTS** 0 • **PCI SLOTS** 0 • **USB PORTS** 2x USB2, 2x USB3, 1x USB Type-C • **VIDEO OUTPUTS** 2x HDMI • **WARRANTY** One year RTB • **DETAILS** www.asrock.com • **PART CODE** 90-MXB5P0-A0UAYZ • **FULL REVIEW** Jul 2018

SILVERSTONE Precision Series PS15

★★★★★

£40 • www.scan.co.uk



As long as you work within its limit as a microATX chassis, the PS15 is a great fit for budget builds. Despite costing a pittance, it's well designed and can take a multitude of fans and radiators, so all-in-one watercooling is a possibility for future upgrades.



CASE TYPE Mini tower • **MOTHERBOARD TYPE** MicroATX, Mini-ITX • **SUPPLIED FANS** 1x 120mm • **MAXIMUM DRIVE BAYS** 1x 3.5in, 3x 2.5in • **DIMENSIONS** 381x192x351mm • **WEIGHT** 3.5kg • **WARRANTY** One year RTB • **DETAILS** www.silverstonetk.com • **PART CODE** SST-PS15B-G • **FULL REVIEW** Aug 2019

ZOTAC GeForce GTX 1050 Ti Mini

★★★★★

£140 • www.amzn.to/2Qi7bG7



An optional purchase, thanks to the Ryzen CPU's onboard graphics, but if you'd like a spot of 1080p gaming capability, the GTX 1050 Ti is the best budget GPU around. Zotac's compact design will allow it to easily fit in small cases, too.



GPU Nvidia GeForce GTX 1050 Ti • **MEMORY** 4GB GDDR5 • **GRAPHICS CARD LENGTH** 145mm • **WARRANTY** Five years RTB • **DETAILS** www.zotac.com • **PART CODE** ZT-P10510A-10L • **FULL REVIEW** Nov 2017

MID-RANGE PCs

AMD Ryzen 7 2700X

★★★★★

£192 • www.amzn.to/2JvaEyC



AMD's second generation of Ryzen processors gets off to an auspicious start with the mighty Ryzen 7 2700X. It's faster than Intel's equivalent Core i7-8700K at stock speeds, despite being cheaper, and temperatures stay nice and low even when overclocking.

SOCKET AM4 • **CORES** 8 • **FREQUENCY** 3.7GHz • **INTEGRATED GRAPHICS** None • **WARRANTY** Two years RTB • **DETAILS** www.amd.com • **PART CODE** YD270XBGAFFBOX • **FULL REVIEW** Aug 2018



MSI B350M Mortar

★★★★★

£100 • www.amzn.to/2zuBbF1



A near-perfect motherboard for AMD Ryzen-based microATX systems. It's remarkably well equipped for connectivity and upgradability, and comes close to much more expensive mobos in performance benchmarks.

PROCESSOR SOCKET AM4 • **DIMENSIONS** 244x244mm • **CHIPSET** AMD B350 • **MEMORY SLOTS** 4 • **PCI-E X16 SLOTS** 2 • **PCI-E X1 SLOTS** 2 • **PCI SLOTS** 0 • **USB PORTS** 2x USB2, 3x USB3.1, 1x USB Type-C • **VIDEO OUTPUTS** 1x HDMI, 1x DisplayPort, 1x DVI-D • **WARRANTY** One year RTB • **DETAILS** www.msi.com • **PART CODE** B350M Mortar • **FULL REVIEW** Jul 2018



AMD Radeon RX 5700

★★★★★

£290 • shop.amd.com



AMD's 7nm GPU is cheaper than both the GeForce RTX 2060 and the RTX 2060 Super, yet is just as comfortable with gaming at 1080p and 1440p. This low price only seems to apply for the reference design rather than partner versions, but the blower-style cooler is the only real downside.

GPU AMD Radeon RX 5700 • **MEMORY** 8GB GDDR6 • **GRAPHICS CARD LENGTH** 268mm • **WARRANTY** One year RTB • **DETAILS** www.amd.com/uk • **PART CODE** Radeon RX 5700 • **FULL REVIEW** Oct 2019



COOLER MASTER MasterBox K500

★★★★☆

£75 • www.scan.co.uk



Great looks, a full set of pre-installed fans, high build quality and a spacious interior: the MasterBox K500 is a commendable all-rounder. It's not the best on storage capacity, but you can still add at least a couple of SSDs and hard disks each.

CASE TYPE Mid-tower • **MOTHERBOARD TYPE** ATX, microATX, Mini-ITX • **SUPPLIED FANS** 3x 120mm • **MAX DRIVE BAYS** 3x 3.5in, 2x 2.5in • **DIMENSIONS** 260x190x280mm • **WEIGHT** 6.2kg • **WARRANTY** Two years RTB • **DETAILS** www.cooler-master.com • **PART CODE** MCB-K500D-KGNN-S00 • **FULL REVIEW** Jan 2019



PREMIUM PCs

AMD Ryzen 9 3900X

★★★★★

£546 • amzn.to/2m4KUOi



Forget the Intel Core i9-9900K – this 12-core monster of a CPU performs far better for similar money. There is a drawback, in that it's not very overclocking-friendly, but that's partly because it's so fast to begin with. Pair it with some good RAM, and you're already most of the way to a capable home workstation.

SOCKET AM4 • **CORES** 12 • **FREQUENCY** 3.8GHz • **INTEGRATED GRAPHICS** None • **WARRANTY** Two years RTB • **DETAILS** www.amd.com • **PART CODE** 100-100000023BOX • **FULL REVIEW** Nov 2019



ASUS ROG Strix Flare

★★★★★

£120 • www.game.co.uk



Besides being a comfortable and responsive gaming keyboard, largely thanks to its always-reliable Cherry MX Red switches, the ROG Strix Flare is loaded with useful features and cool extras: there's a set of dedicated media controls and a USB2 pass-through port, among others.

KEYBOARD SHAPE Full size • **NUMBER PAD** Yes • **CONNECTION** 2xUSB2 • **MEDIA KEYS** Pause/play, mute, skip, volume • **USB PORTS** 2x USB2 • **WARRANTY** One year RTB • **DETAILS** www.asus.com/uk • **PART CODE** 90MP000MO-BOEA00 • **FULL REVIEW** Oct 2019



THERMALTAKE View 37

★★★★★

£110 • www.scan.co.uk



A spacious, feature-rich chassis for both ATX- and EATX-based builds, the View 37 comes with a gull-wing side window that's perfect for showing off your handiwork.

CASE TYPE Mid-tower • **MOTHERBOARD TYPE** ATX, EATX, microATX, Mini-ITX • **SUPPLIED FANS** 2x 140mm • **MAXIMUM DRIVE BAYS** 7x 3.5in, 11x 2.5in • **DIMENSIONS** 525x261x538mm • **WEIGHT** 11.8kg • **WARRANTY** Three years RTB • **DETAILS** www.thermaltake.com • **PART CODE** CA-1J7-00M1WN-00 • **FULL REVIEW** Dec 2018



AMD Radeon RX 5700 XT

★★★★★

£329 • shop.amd.com



The standard RX 5700 is better value for lower resolutions, but if you want to play at 4K without the expense of Nvidia's top RTX graphics cards, the RX 5700 XT's higher core count and clock speeds make it a great choice.

GPU AMD Radeon RX 5700 XT • **MEMORY** 8GB GDDR6 • **GRAPHICS CARD LENGTH** 272mm • **WARRANTY** One year RTB • **DETAILS** www.amd.com/uk • **PART CODE** Radeon RX 5700 XT • **FULL REVIEW** Oct 2019



Choosing a... Display

01 A basic 24in LCD monitor costs around £100. It will be fine for typical Windows work but is likely to have poor viewing angles, so you'll need to sit straight on for the best picture quality. Its colour accuracy may not be very good, either.

02 A VGA input lets you use the monitor with any PC, but the quality may not be as good as it is over DVI or HDMI. Both are digital connections and require a compatible graphics card but they avoid the need for digital-to-analogue or analogue-to-digital conversions, which can reduce image quality. A digital connection achieves the best picture automatically, so you won't have to adjust clock or phase settings as you do with analogue connections.

Many DVI and all HDMI connections support HDCP, which lets you watch protected video content, such as Blu-ray movies. DisplayPort is becoming more popular, but you'll need a graphics card with a DisplayPort output (mini or full-size) to use this input on your monitor.

03 A larger monitor will be easier on the eye and may have a higher resolution. Most monitors have a resolution of at least 1,920x1,080 (1080p), which provides lots of room for working with multiple windows at the same time. For even higher resolutions, you'll need a larger display. Some 27in and 30in screens have 2,560x1,600 or even 4K resolutions. You'll need a graphics card with a dual-link DVI output and a dual-link DVI

cable or either HDMI or DisplayPort to use a monitor at these resolutions.

04 If you want better picture quality, look for a monitor with a high contrast ratio. The higher the ratio, the whiter the whites and the blacker the blacks. You'll also be able to see more fine detail in images with high contrast levels. Viewing angles are important, as wider angles mean you don't have to sit directly in front of the monitor to get the best picture. Wider viewing angles also allow more people to view the screen at the same time.

Fast response times reduce ghosting, but don't be dazzled by the numbers. A response time of 25ms or quicker is fine for all applications.

DISPLAYS

LG 34GK950F

★★★★★

£1,150 • www.overclockers.co.uk



LG's curved ultrawide monitor is as versatile as it

is vibrant. HDR is supported (if only to the DisplayHDR 400 standard), colours are accurate, and both AMD FreeSync and Nvidia G-Sync can smooth out games.



SCREEN SIZE 34in • RESOLUTION 3,440x1,440 • REFRESH RATE 144Hz • SCREEN TECHNOLOGY IPS • VIDEO INPUTS HDMI, DisplayPort • WARRANTY Three years collect and return • DETAILS www.lg.com • FULL REVIEW Jun 2019

Iiyama G-Master Black Hawk G2530HSU-B1

★★★★★

£130 • www.box.co.uk



A fine alternative monitor to the AOC G2460VQ6, also with a 75Hz refresh rate as well as FreeSync support for tear-free gaming on AMD graphics cards. The slim-bezel design is good for the money, too.



SCREEN SIZE 24in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY TN • VIDEO INPUTS HDMI, DisplayPort, VGA • WARRANTY Two years onsite • DETAILS www.iiyama.com • PART CODE G2530HSU-B1 • FULL REVIEW Mar 2019

EIZO ColorEdge CG279X

★★★★★

£1,699 • www.wexphotovideo.com



This professional-quality monitor benefits from automatic calibration,

ensuring practically perfect colour accuracy and wide coverage of the sRGB, DCI-P and Adobe RGB gamuts. It's a worthwhile investment for editing photos and videos.



SCREEN SIZE 27in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY IPS • REFRESH RATE 60Hz • VIDEO INPUTS VGA, HDMI, DisplayPort, DVI, USB Type-C • WARRANTY Five years RTB • DETAILS www.eizoglobal.cpm • FULL REVIEW Jun 2019

AOC CQ32G1

★★★★★

£340 • www.box.co.uk



AOC has a habit of making great-value, large-screened VA monitors,

and the CQ32G1 is another to add to the list. A 144Hz gaming display first and foremost, it's as fast and good-looking as it needs to be, and supports both AMD FreeSync and, unofficially, Nvidia G-Sync.



SCREEN SIZE 31.5in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY VA • REFRESH RATE 144Hz • VIDEO INPUTS HDMI, DisplayPort • WARRANTY One year repair and replace • DETAILS eu.aoc.com • FULL REVIEW Nov 2019

Philips Brilliance 241B7QPJKEB

★★★★★

£180 • www.uk.insight.com



IPS monitors generally look great, but it's hard to find one at a low price. Enter the

Brilliance 241B7QPJKEB: a colour-accurate IPS display for well under £200. It's well designed, too, with a collapsible webcam and a greatly adjustable stand.



SCREEN SIZE 24in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY IPS • REFRESH RATE 60Hz • VIDEO INPUTS HDMI, DisplayPort, VGA • WARRANTY Three years RTB • DETAILS www.philips.co.uk • FULL REVIEW Jun 2018

Iiyama ProLite XUB2792UHSU

★★★★★

£384 • www.amzn.to/2TTIMac



If you don't need all the bells and whistles of a curved ultrawide, the ProLite

XUB2792UHSU nails the basics at a very attractive price. 4K sharpness, high brightness and full sRGB colour gamut coverage add up to a superb monitor.



SCREEN SIZE 27in • RESOLUTION 3,840x2,160 • SCREEN TECHNOLOGY IPS • REFRESH RATE 60Hz • VIDEO INPUTS DisplayPort, HDMI, DVI • WARRANTY Three years onsite • DETAILS www.iiyama.com • FULL REVIEW Nov 2019

Choosing a... Laser printer

01 Laser printers used to be much more expensive than inkjets and were typically restricted to offices. They are now much more affordable, however, and offer several benefits over inkjets, including lower per-page printing costs and faster print speeds.

02 A decent laser printer will typically cost around £80, and will happily print hundreds of black-and-white pages per hour. If documents are your priority, you'll want a high minimum speed and low print costs. However, you'll probably be limited to black-and-white printing at this price.

03 Although you can still buy single-function laser printers, multifunction

peripherals (MFPs) are now far more common. These models can scan and photocopy documents as well as print them, and some of them also have fax capabilities. Laser MFPs start from around £200.

04 Heavy-duty office lasers designed for printing thousands of pages per month can cost thousands of pounds. They use large individual toner drums, which can cut running costs. Automatic duplex (double-sided) printing is also common here.

05 Although laser printers are more suited to printing text than graphics, many are still able to produce high-quality photographs. Speed isn't a priority here – instead choose a printer that reproduces

subtle tones well. You can't determine this by looking at the specifications; only hands-on testing will do, so remember to check our reviews before you buy. Borderless printing (up to the edge of the paper) should also be possible.

06 If you want to print from multiple devices, make sure you look for extended connectivity. Decent laser printers can be shared on your local network and have USB ports for direct printing, memory card slots for printing images from a digital camera, and iOS, Android or Google Cloud Print support for printing from mobile devices such as smartphones or tablets. An LCD preview screen offers greater control for this method of printing.

PRINTERS & SCANNERS

EPSON WorkForce WF-7710DWF

★★★★★

£148 • www.amzn.to/2JVd3B



COMPUTER SHOPPER
BEST BUY

The WorkForce WF-7710DWF allows you to print at the larger A3+ paper size, as well as fax and scan at A3, so it's great for home office users who require a bit more flexibility from their MFP.

TECHNOLOGY Piezo inkjet • MAXIMUM PRINT RESOLUTION 4,800x2,400dpi • DIMENSIONS 340x567x452mm • WEIGHT 18.7kg • MAXIMUM PAPER SIZE A3+ • WARRANTY One year RTB • DETAILS www.epson.co.uk • PART CODE C11CG36411 • FULL REVIEW Nov 2018

EPSON EcoTank ET-M3180

★★★★★

£406 • www.printerland.co.uk

NEW ENTRY



COMPUTER SHOPPER
RECOMMENDED

If you need to pump out black-and-white documents, the ET-M3180 is a great alternative to a bulky laser MFP. This ADF-equipped printer and scanner is impressively fast and, like the rest of the EcoTank range, has incredibly low per-page running costs.

TECHNOLOGY Piezo inkjet • MAXIMUM PRINT RESOLUTION 2,400x1,200dpi • DIMENSIONS 375x347x346mm • WEIGHT 7.2kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY Three years onsite • DETAILS www.epson.co.uk • PART CODE C11CG93402BY • FULL REVIEW Nov 2019

HP OfficeJet Pro 7720

★★★★★

£120 • www.currys.co.uk



COMPUTER SHOPPER
BUSINESS BUY

The OfficeJet Pro 7720 strikes a fine balance between price, performance and features, making it ideal for home offices and small businesses – especially those that could use A3 printing.

TECHNOLOGY Thermal inkjet • MAXIMUM PRINT RESOLUTION 4,800x1,200dpi • SCANNER RESOLUTION 1,200x1,200dpi • DIMENSIONS 307x445x585mm • WEIGHT 15.5kg • MAXIMUM PAPER SIZE A3 (print only) • WARRANTY Three years RTB • DETAILS www.hp.co.uk • PART CODE Y0S18A • FULL REVIEW Dec 2017

CANON Pixma TS205

★★★★★

£29 • www.ebuyer.com



COMPUTER SHOPPER
RECOMMENDED

It has a basic feature set and isn't very fast, but the Pixma TS205's print quality makes it a bargain. Replacement ink cartridges are the biggest expense, but that's fine if you're only printing at home occasionally.

TECHNOLOGY Thermal inkjet • MAXIMUM PRINT RESOLUTION 4,800x1,200dpi • DIMENSIONS 131x426x255mm • WEIGHT 2.5kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year RTB • DETAILS www.canon.co.uk • PART CODE 2319C008 • FULL REVIEW Sep 2019

CANON imageFormula DR-C230

★★★★★

£267 • www.ebuyer.com



COMPUTER SHOPPER
RECOMMENDED

This sheet-fed document scanner is perfect for getting through stacks of documents without having to manually scan each page. It's pleasantly fast and pairs with Canon's powerful CaptureOnTouch Pro software, which does a fine job of processing your scans.

TECHNOLOGY Dual CIS sheet-fed scanner • SCANNER RESOLUTION 600x600dpi • DIMENSIONS 231x291x530mm • WEIGHT 2.8kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year RTB • DETAILS www.canon.co.uk • PART CODE 2646C003 • FULL REVIEW Feb 2018

EPSON EcoTank ET-7750

★★★★★

£539 • www.jessops.com



COMPUTER SHOPPER
RECOMMENDED

Like all EcoTank MFPs, the ET-7750 offsets its high price with low running costs, and this specific model delivers sharp, solid colours that suit photo printing well.

TECHNOLOGY Piezo inkjet • MAXIMUM PRINT RESOLUTION 5,760x1,440 • SCANNER RESOLUTION 1,200x2,400dpi • DIMENSIONS 168x526x415mm • WEIGHT 10.5kg • MAXIMUM PAPER SIZE A3 • WARRANTY One year RTB • DETAILS www.epson.co.uk • PART CODE C11CG16401CE • FULL REVIEW Sep 2018

Choosing a... Wireless router

01 Wireless routers each use a number of Wi-Fi standards, so you shouldn't have any trouble connecting your computer or phone wirelessly if you get an 802.11n or 802.11ac router. Nearly all routers support 802.11n, so even a cheap model should provide decent performance.

You can expect a transfer speed of around 40Mbit/s at a distance of 10m from any modern 802.11n router. The very latest routers use the 802.11ac standard, which provides tremendously fast transfer speeds. Some devices still don't support the 802.11ac standard, so check the specifications before you buy.

02 If you subscribe to an ADSL broadband service, you should buy

a wireless router that has a built-in ADSL modem. This will cost more than the equivalent cable router, but it allows you to connect your router directly to your broadband connection without having to use a separate modem.

03 Most 802.11n wireless routers use the 2.4GHz frequency band. This has good range but it can be prone to interference if it's positioned close to a lot of other 2.4GHz devices, such as other routers and baby monitors. If you have trouble getting a consistent signal or you want faster speeds for video streaming, for example, it's worth buying a dual-band router that can use both the 2.4GHz and 5GHz bands.

Alternatively, a high-gain antenna can boost signals and improve ranges and throughputs to the entire house. You can also add a high-gain antenna to a PC's network adaptor. If wired network speeds are a priority, you should look for a router with a Gigabit Ethernet connection.

04 Many routers come with built-in USB ports that let you connect a USB drive and use the router as a network storage device. If you want to share a USB printer over your network, look for a wireless router that has a USB print server.

Finally, if you're interested in making voice calls over the internet, buy a router with built-in VoIP support (and phone sockets) because this can save you money.

NETWORKS

BT Complete Wi-Fi

★★★★★

£5 per month • www.bt.com

COMPUTER SHOPPER
RECOMMENDED

There are better-featured mesh systems available, but the Complete Wi-Fi is decently quick on both the 5GHz and 2.4GHz bands, and is well worth it for BT Plus customers in particular.

WI-FI STANDARD 802.11ac • **STATED SPEED** 1,733Mbit/s (5GHz), 385Mbit/s (2.4GHz) • **USB PORTS** 1 • **WALL MOUNTABLE** No • **WARRANTY** Under rental contract • **PART CODE** BT Complete Wi-Fi • **FULL REVIEW** Mar 2019



TP-LINK Archer C5400

★★★★★

£240 • www.currys.co.uk

COMPUTER SHOPPER
RECOMMENDED

Although this isn't the fastest £200-plus router, it's still speedy, and comes with an impressive array of features, from parental controls and filters to BT YouView support and smart home integration.

MODEM Gigabit Ethernet • **WI-FI STANDARD** 802.11ac • **STATED SPEED** 2x 2,167Mbit/s (5GHz), 2x 1,000Mbit/s (2.4GHz) • **USB PORTS** 1x USB2, 1x USB3 • **WALL MOUNTABLE** Yes • **WARRANTY** One year RTB • **PART CODE** C5400 • **FULL REVIEW** May 2018



YUBICO YubiKey 5 NFC

★★★★★

£38 • www.yubico.com

COMPUTER SHOPPER
RECOMMENDED

Like the YubiKey 4 before it, this USB stick conveniently stores all the cryptographic data you need to add two-factor authentication to a PC or laptop; and this time, there's NFC, allowing you to use it with mobile devices via a single tap.

USB TYPE Type-A • **OS SUPPORT** Windows 10, macOS, iOS 11 and later, Android • **WARRANTY** One year RTB • **DETAILS** www.yubico.com • **PART CODE** YubiKey 5 NFC • **FULL REVIEW** Apr 2019



TP-LINK Deco M5

★★★★★

£160 (triple pack) • www.amzn.to/2L05qMi

COMPUTER SHOPPER
BEST BUY

Provided you're willing to tinker with a few settings, the Deco M5 is the most feature-rich mesh Wi-Fi system around, even if it's not strictly the fastest. Get the triple pack for the best coverage throughout the house.

MODEM Gigabit Ethernet • **WI-FI STANDARD** 802.11ac • **STATED SPEED** 867Mbit/s (5GHz), 400Mbit/s (2.4GHz) • **USB PORTS** 0 • **WALL MOUNTABLE** No • **WARRANTY** Three years RTB • **DETAILS** www.tp-link.com • **PART CODE** 210380 • **FULL REVIEW** Dec 2017



D-LINK DIR-1960

★★★★★

£113 • uk.insight.com

COMPUTER SHOPPER
BEST BUY

The DIR-1960 is a simple yet speedy router that can optionally be turned into a mesh system (provided you buy the additional satellites, of course). Either way, you can also take advantage of built-in Alexa and Google Assistant controls.

MODEM Gigabit Ethernet • **WI-FI STANDARD** 802.11ac • **STATED SPEED** 1,300Mbit/s (5GHz), 600Mbit/s (2.4GHz) • **USB PORTS** 1x USB2 • **WALL MOUNTABLE** Yes • **WARRANTY** Two years RTB • **DETAILS** www.d-link.com • **PART CODE** DIR-1960 • **FULL REVIEW** Nov 2019



NETGEAR Orbi Outdoor RBS50Y

★★★★★

£238 • www.amzn.to/2MZg5YB

COMPUTER SHOPPER
RECOMMENDED

This weatherproof Wi-Fi extender is a perfect addition to mesh systems that can't quite cover a garden. It has similar internal specifications to the brilliant Orbi RBK50, meaning high speeds and reliable connections.

WI-FI STANDARD 802.11ac • **STATED SPEED** 1x 866Mbit/s (5GHz) 1x 1,733Mbit/s (5GHz), 1x 400Mbit/s (2.4GHz) • **USB PORTS** 0 • **WALL MOUNTABLE** Yes • **WARRANTY** Two years RTB • **DETAILS** www.netgear.co.uk • **PART CODE** RBS50Y • **FULL REVIEW** Jul 2019



Choosing a... Smart thermostat

01 A smart thermostat can save you a lot of money by intelligently controlling your heating.

Most smart heating devices are designed to be used with hot water central heating systems, with the boiler directly controlled by the system. These typically require a relay to be wired into your boiler, with a wireless thermostat giving you direct control. Smartphone apps then tie into the system to give you remote control. While it's possible to fit controls yourself, you may want to pay an experienced plumber to do the job: expect to pay around £150 for a typical installation.

If you have electric heating, there are very few choices, and the big names (Nest, Honeywell and so on) do not directly support these systems.

02 Want smart hot water control? If you want to remotely set schedules and disable hot water while you're away, choose your smart system carefully, as many don't have this option. Hot water control usually requires a second relay to be wired into the boiler.

03 What kind of heating system do you want? There are two main choices: a central system and one with individual radiator controls. The former replaces your existing thermostat, and lets you set one temperature for your entire house. The latter requires each radiator valve to be replaced with a smart valve so that each room and radiator can have its own individual control.

This option is more expensive to install but will provide you with greater savings.

04 Do you use a smart personal assistant? Make sure that your smart thermostat supports the one that you use. Amazon Alexa, powered by the Echo and Echo Dot, is the best-supported system; Apple's HomeKit, powered by Siri, isn't so well supported; Google Assistant, built into Google Home, is just gaining traction and supports Nest only.

05 If you want your smart heating system to do more, look for IFTTT support. With this handy system, you can set automatic rules, such as turning the heating off if the outside temperature rises.

SMART HOME

AMAZON Echo Dot 3rd Generation

★★★★★

£35 • www.amzn.to/2VVI5Bs

COMPUTER SHOPPER
BEST BUY

A souped-up speaker means the latest Echo Dot is finally a viable music

player, in addition to the best-value Echo speaker and smart home controller. Buy multiple devices and you can scatter them throughout your home, maximising Alexa coverage.



DRIVERS 1 • **RMS POWER OUTPUT** Not stated • **WEIGHT** 300g • **NETWORKING** Bluetooth, 802.11n Wi-Fi • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Echo Dor 3rd Generation • **FULL REVIEW** Aug 2019

NEST Cam IQ Outdoor

★★★★★

£299 • nest.com/uk

COMPUTER SHOPPER
RECOMMENDED

While this is an expensive replacement for the old Nest Cam Outdoor, its image quality is without equal. Facial and sound recognition have also been improved, and it's now much harder for thieves to remove the camera from its mount.



VIDEO RESOLUTION 4K sensor, 1080p recording • **CLOUD STORAGE** Yes (subscription required) • **NETWORKING** 802.11ac • **WARRANTY** One year RTB • **PART CODE** Nest Cam IQ Outdoor • **FULL REVIEW** Jul 2018

TADO Smart Thermostat

★★★★★

£145 • www.amzn.to/2ZxwlfZ

COMPUTER SHOPPER
BEST BUY

A flexible and stylish-looking smart heating system, the Tado Smart Thermostat distinguishes

itself with a clever geolocation feature that turns on your heating when you enter a room and switches it off, saving money, when you leave.



REMOTE THERMOSTAT Yes • **HOT WATER SUPPORT** Yes • **INDIVIDUAL RADIATOR CONTROL** Yes • **VOICE ASSISTANT SUPPORT** Alexa, Google Assistant, Siri • **APPS** iOS, Android and web • **FULL REVIEW** Jan 2018

NEOS Smartcam

★★★★★

£20 • shop.neos.co.uk

COMPUTER SHOPPER
RECOMMENDED

The Smartcam is a tremendous bargain of an indoor security camera. In many ways, it's not all that advanced – footage is only shot at up to 15fps, for instance – but the 1080p resolution, night-vision mode and free cloud storage make for a nifty little package.



VIDEO RESOLUTION 1080p • **CLOUD STORAGE** Yes (free) • **NETWORKING** 802.11n • **WARRANTY** One year RTB • **PART CODE** NS-CAM-02 • **FULL REVIEW** Jun 2019

GOOGLE Home Hub

★★★★★

£119 • www.currys.co.uk

COMPUTER SHOPPER
BEST BUY

The first truly excellent smart screen, Google's Home Hub is both a

multitalented smart home controller and a very clever device in itself, jumping seamlessly between providing mapped-out travel routes, playing YouTube videos and showcasing photo albums.



DRIVERS 1 • **RMS POWER OUTPUT** Not stated • **DOCK CONNECTOR** None • **WIRELESS** 802.11ac Wi-Fi, Bluetooth 5.0 • **DIMENSIONS** 118x179x67mm • **WEIGHT** 480g • **WARRANTY** One year RTB • **PART CODE** Home Hub • **FULL REVIEW** Feb 2019

RING Video Doorbell 2

★★★★★

£149 • www.box.co.uk

COMPUTER SHOPPER
BEST BUY

This is the best of the new breed of smart, camera-equipped doorbells: it's easy to install, comes with a bundled chime, and has fairly low subscription costs for storing footage in the cloud.



VIDEO RESOLUTION 1080p • **CLOUD STORAGE** Yes • **NETWORKING** 802.11n • **WARRANTY** Two years parts and theft protection • **PART CODE** 8VR1S7-0EU0 • **FULL REVIEW** Dec 2018

Choosing a... Smartphone

01 A smartphone's operating system (OS) dictates its basic features and which third-party software you can install. There are three main contenders: Apple's iOS, which is found on the iPhone, Google's Android, which is used by various handset manufacturers, and Windows Phone, which has few options, especially since Microsoft has discontinued support for its OS. Apple iOS and Google Android both have thousands of apps available.

02 All smartphones have colour screens, but their resolutions vary. Basic models have 1,280x720 pixels, but text can be indistinct. Look for a display that has at least 1,920x1,080 pixels so it's easier to read text

and watch Full HD videos. Don't worry too much about built-in media players or Office document editors; you can always install apps to replace these with better versions later.

The image quality of smartphone cameras has improved tremendously in recent years, and resolutions have increased to as high as 20 megapixels.

03 Very few modern smartphones have a physical keyboard for entering text; they almost exclusively use touchscreens now. Physical keyboards can aid heavy emailing, but today's touchscreen keyboards work just as well.

Android smartphones and iPhones running iOS 9 or above allow you to install

a variety of custom onscreen keyboards so you can find one that suits you.

04 Be careful when choosing a contract. Look for one that includes a large data allowance if you want to use the internet regularly or you've set your phone to synchronise your contacts, calendar and email through online services.

Built-in Wi-Fi can help you avoid high data charges by connecting to the internet through wireless hotspots when you're out, or your router when you're at home. Android and iPhone handsets can operate as wireless hotspots, letting you connect your laptop to the web over your mobile data connection. There may be an extra charge for this.

SMARTPHONES

MOTOROLA Moto G7 Power

★★★★★

£160 SIM-free; £14-per-month contract • www.carphonewarehouse.com



There's no shortage of Moto G7 variants to choose from, but the Moto G7 Power is easily the best value. It focuses on battery life and is thus one of the longest-lasting smartphones ever - and its performance, display and rear camera are all rather good for the price, too.



PROCESSOR Octa-core 1.8GHz Qualcomm Snapdragon 632 • **SCREEN SIZE** 6.2in • **SCREEN RESOLUTION** 1,520x720 • **REAR CAMERA** 12 megapixels • **STORAGE** 32GB • **WIRELESS DATA** 4G • **NFC** No • **DIMENSIONS** 159x76x9.3mm • **WEIGHT** 193g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** www.motorola.co.uk • **PART CODE** PAE90019GB • **FULL REVIEW** Jun 2019

SAMSUNG Galaxy S10+

★★★★★

£694 SIM-free; £30 up front plus £45-per-month contract • www.amzn.to/2E8ImVE (SIM-free); www.carphonewarehouse.com (contract)



The dazzling 3K display dominates a sleek, luxurious-feeling design, while the Exynos 9820 processor delivers some of the fastest raw performance on any Android handset, ever.



PROCESSOR Octa-core 2.7GHz Samsung Exynos 9820 • **SCREEN SIZE** 6.4in • **SCREEN RESOLUTION** 3,040x1,440 • **REAR CAMERAS** 12 megapixels, 12 megapixels, 16 megapixels • **STORAGE** 128GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 158x74x7.8mm • **WEIGHT** 175g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** www.samsung.com • **PART CODE** SM-G975FZKDBTU • **FULL REVIEW** Jul 2019

VODAFONE Smart V10

★★★★★

£105 SIM-free; £20-per-month contract • www.vodafone.co.uk



Vodafone's budget handset will surprise you: for something that barely costs more than £100 to buy outright, it's rather speedy and has a main camera that can compete with mid-rangers. The slim-bezel look is very welcome, too.



PROCESSOR Quad-core 2GHz Qualcomm Snapdragon 429 • **SCREEN SIZE** 5.9in • **SCREEN RESOLUTION** 1,560x720 • **REAR CAMERAS** 13 megapixels, 5 megapixels • **STORAGE** 32GB • **WIRELESS DATA** 4G • **NFC** No • **DIMENSIONS** 151x70x8.2mm • **WEIGHT** 145g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** Two years RTB • **DETAILS** www.vodafone.co.uk • **PART CODE** Smart V10 • **FULL REVIEW** Oct 2019

GOOGLE Pixel 3a

★★★★★

£399 SIM-free; £23-per-month contract • www.carphonewarehouse.com



The Pixel 3a is a welcome return to mid-range smartphones on Google's part. It's essentially a cheaper version of the flagship Pixel 3, which means a bit less horsepower but the same clean, stock Android and superb camera.



PROCESSOR Quad-core 2.8GHz Qualcomm Snapdragon 845 • **SCREEN SIZE** 5.5in • **SCREEN RESOLUTION** 2,160x1,080 • **REAR CAMERA** 12.2 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 146x68x7.9mm • **WEIGHT** 148g • **OPERATING SYSTEM** Android 9.0 • **WARRANTY** One year RTB • **DETAILS** store.google.com • **PART CODE** Pixel 3 • **FULL REVIEW** Aug 2019

APPLE iPhone XR

★★★★★

£619 SIM-free; £33-per-month contract • www.debenhamsplus.com (SIM-free); www.virginmedia.com (contract)



It's still expensive, but the XR matches the performance of the iPhone XS and XS Max, despite costing hundreds of pounds less, and it has a fantastic camera and display.



PROCESSOR Hexa-core Apple A12 Bionic • **SCREEN SIZE** 6.1in • **SCREEN RESOLUTION** 1,792x828 • **REAR CAMERA** 12 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **NFC** Yes • **DIMENSIONS** 151x76x8.3mm • **WEIGHT** 194g • **OPERATING SYSTEM** iOS 12 • **WARRANTY** One year RTB • **DETAILS** www.apple.com • **PART CODE** iPhone XR • **FULL REVIEW** Mar 2019

XIAOMI Pocophone F1

★★★★★

£288 SIM-free • www.ebuyer.com



The Pocophone F1 is a phenomenal bargain: it has the same Snapdragon 845 chip as a lot of premium handsets, plus dual rear cameras, 64GB of storage and a 6.2in screen, all for a mid-range price.



PROCESSOR Octa-core 2.8GHz Qualcomm Snapdragon 845 • **SCREEN SIZE** 6.2in • **SCREEN RESOLUTION** 2,246x1,080 • **REAR CAMERAS** 12 megapixels, 5 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **NFC** No • **DIMENSIONS** 156x75x9mm • **WEIGHT** 180g • **OPERATING SYSTEM** Android 8.1 • **DETAILS** www.mi.com/uk • **PART CODE** MZB6715EN • **FULL REVIEW** Mar 2019

Choosing a... Tablet

01 All tablets rely on an operating system (OS) to run apps. You have three main choices: Apple's iOS, which runs on the iPad; Android, which Google licenses to various manufacturers; and Windows 10, which has become common in hybrid tablets and convertibles. If you own an Apple or Google smartphone, you can download your apps, music and so on to a tablet that runs the same OS, so it makes sense to stick with a compatible device.

02 It's important to pick a tablet that has a good-quality, high-resolution screen. Many budget tablets have 1,280x800-resolution displays, but better tablets have Full HD 1,920x1,080 panels, and we're

starting to see tablets that have even higher screen resolutions. Some are as high as 2,560x1,600 or even 4K. Entry-level tablets typically use TN panels, which don't have particularly good viewing angles. The viewing angles of IPS panels are much better.

03 If you want to listen to music, watch films and play games, make sure your tablet has plenty of storage. Many tablets come with 8GB or 16GB of internal storage, although some budget models have less. You'll typically pay more for a higher storage capacity. Many tablets also have microSD slots that let you add extra storage, although you won't find one on an iPad. This is a cheap way of boosting storage capacity.

04 Tablets rarely include a SIM card slot. This means you'll have to rely on Wi-Fi to get online, although some tablets let you access the internet through your smartphone. If you want mobile access to the internet, look for 3G- and 4G-ready devices. These almost always cost more than Wi-Fi-only models, but they're great if you use your tablet while commuting or travelling.

05 Your choice of tablet determines the apps you can use on it. You may find that some of the apps you want are available on iOS but not Android, and vice versa. Windows 10, meanwhile, runs traditional desktop applications.

TABLETS

AMAZON Kindle Oasis (2019)

★★★★★

£230 • amzn.to/2mp6ldb

COMPUTER SHOPPER
BEST BUY

With the addition of a blue light filter, the latest Kindle Oasis is as good an e-reader as you can get.

Besides being easier on the eyes when reading at night, it has the physical page-turn buttons that cheaper Kindles lack, and the screen can auto-rotate according to how you're holding it.

PROCESSOR Not stated • **SCREEN SIZE** 7in • **SCREEN RESOLUTION** 300ppi • **REAR CAMERA** None • **STORAGE** 8GB • **WIRELESS DATA** Wi-Fi, Bluetooth • **DIMENSIONS** 159x141x8.4mm • **WEIGHT** 188g • **OPERATING SYSTEM** Kindle OS • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Kindle Oasis (2019) • **FULL REVIEW** Nov 2019



NEW ENTRY

APPLE iPad (2018)

★★★★★

£319 • www.apple.com/uk

COMPUTER SHOPPER
RECOMMENDED

Apple has recalibrated its focus for the latest iPad, keeping the existing design but turning it into an education aid with Apple Pencil support and the Smart Annotation software feature. Even if you're not a teacher or in education, it's still a powerful tablet at a decent price.

PROCESSOR Quad-core Apple A10 Fusion • **SCREEN SIZE** 9.7in • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 8 megapixels • **STORAGE** 32GB • **WIRELESS DATA** None • **DIMENSIONS** 240x170x7.5mm • **WEIGHT** 469g • **OPERATING SYSTEM** iOS 11 • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** iPad • **FULL REVIEW** Aug 2018



APPLE iPad Pro 10.5in

★★★★★

£608 • www.currys.co.uk

COMPUTER SHOPPER
BEST BUY

While it's still stuck with a mobile OS, rather than the productivity-friendly macOS,

there's no arguing with the latest iPad Pro's raw power. An A10X Fusion chip makes it much faster than the 9.7in model in both multitasking and single-threaded applications.

PROCESSOR Hexa-core 2.36GHz Apple A10X Fusion • **SCREEN SIZE** 10.5in • **SCREEN RESOLUTION** 2,224x1,668 • **REAR CAMERA** 12 megapixels • **STORAGE** 64/256/512GB • **WIRELESS DATA** 4G (cellular version) • **DIMENSIONS** 251x174x6.1mm • **WEIGHT** 469g • **OPERATING SYSTEM** iOS 11 • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** 9.7in iPad Pro • **FULL REVIEW** Oct 2017



MICROSOFT Surface Go

★★★★★

£509 • www.microsoft.com

COMPUTER SHOPPER
RECOMMENDED

If you've been craving a tablet with the flexibility of a Surface Pro, without the usual expense, the Surface Go is a perfect fit. It's smaller and uses a less powerful Intel Pentium CPU, but it's still a much more work-ready 2-in-1 than any Android slate.

PROCESSOR Dual-core 1.6GHz Intel Pentium 4415Y • **SCREEN SIZE** 10in • **SCREEN RESOLUTION** 1,800x1,200 • **REAR CAMERA** 8 megapixels • **STORAGE** 128GB • **WIRELESS DATA** No • **DIMENSIONS** 245x175x8.3mm • **WEIGHT** 522g • **OPERATING SYSTEM** Windows 10 S • **WARRANTY** One year RTB • **DETAILS** www.microsoft.com • **PART CODE** MCZ-00002 • **FULL REVIEW** Jan 2019



SAMSUNG Galaxy Tab S3

★★★★★

£350 • www.amzn.to/2WVzER9

COMPUTER SHOPPER
BEST BUY

Yes, it's incredibly expensive for an Android slate, but the Galaxy Tab S3 is pure luxury: the AMOLED display looks exquisite, the stereo speakers sound great, and Samsung's S Pen stylus is included as standard.

PROCESSOR Quad-core 2.2GHz Qualcomm Snapdragon 820 • **SCREEN SIZE** 9.7in • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 13 megapixels • **STORAGE** 32GB • **WIRELESS DATA** None (4G optional) • **DIMENSIONS** 2937x169x6mm • **WEIGHT** 429g • **OPERATING SYSTEM** Android 7.0 • **WARRANTY** One year RTB • **DETAILS** www.samsung.com/uk • **PART CODE** SM-T820 • **FULL REVIEW** Aug 2017



AMAZON Kindle (2019)

★★★★★

£70 • www.amzn.to/2x9nnhM

COMPUTER SHOPPER
BEST BUY

Some key upgrades make the base Kindle a much more tempting prospect. There's a new reading light on the front, plus Bluetooth connectivity and the ability to download and listen to Audible audiobooks.

PROCESSOR Not stated • **SCREEN SIZE** 6in • **SCREEN RESOLUTION** 256ppi • **REAR CAMERA** None • **STORAGE** 4GB • **WIRELESS DATA** Wi-Fi only • **DIMENSIONS** 160x113x8.7mm • **WEIGHT** 174g • **OPERATING SYSTEM** Kindle OS • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Kindle (2019) • **FULL REVIEW** Aug 2019



Choosing a... TV

01 A 32in Full HD TV costs around £200, but premium larger 4K models can be closer to £2,000. TVs look much smaller in the shop than in your home, so measure the space available before you buy.

Curved TVs are becoming increasingly more common, but bear in mind that these typically take up more floor space than a traditional flat set.

02 A 1,920x1,080-resolution TV can display a 1080p image. You can still buy TVs with a 720p (1,366x768) resolution, but they're no cheaper and the image won't be as sharp. 3,840x2,560 Ultra HD resolution, or 4K, TVs are finally available at reasonable prices, although you'll still pay a premium for one over a 1080p model.

03 Consider the number of inputs you'll need to connect the rest of your equipment. Two HDMI ports should be the bare minimum, but many TV sets come with four HDMI connectors. You'll need HDMI 2.0 if you want a future-proof 4K TV, as this is the only way to get 60fps video playback from external sources at such a high resolution.

If you want to plug a PC into your TV, you'll need to use either HDMI or VGA inputs. Be aware that some TVs only let you use a PC on an analogue input, and others won't display the Windows desktop at the TV's highest resolution.

04 The contrast ratio tells you the difference between the darkest

and the brightest shades that the screen will be able to display. The higher the number, the darker the blacks and the brighter the whites. Buy a TV with High Dynamic Range (HDR) support for the best picture from supported services.

05 HD content is now becoming fairly widespread, but if you want Ultra HD content your options are more limited. Most Ultra HD TVs have Netflix built into their smart TV systems, but only BT is currently providing live Ultra HD video, with BT Sport Ultra HD.

Ultra HD Blu-ray players give you an amazing picture, and Amazon's Fire TV set-top box will stream its Prime Video service and Netflix at Ultra HD resolutions.

HOME CINEMA

PHILIPS 55PUS6753/12

★★★★★

£549 • www.amzn.to/2HwzUka

COMPUTER SHOPPER
RECOMMENDED

This Philips set doesn't have the best

implementation of HDR we've seen on a TV, but otherwise, the 55PUS6753/12 is a fantastic 4K screen for a relatively low price.



SCREEN SIZE 55in • NATIVE RESOLUTION 3,840x2,160 • VIDEO INPUTS 3x HDMI, 5x component • TUNER Freeview HD • DIMENSIONS 781x1,244x266mm • WARRANTY One year RTB • DETAILS www.philips.co.uk • PART CODE 55PUS6753/12 • FULL REVIEW Dec 2018

SAMSUNG HW-N850

★★★★★

£649 • www.box.co.uk

COMPUTER SHOPPER
BEST BUY

There's no ultra-high-tech trickery

here: just a soundbar, subwoofer and their combined 14 drivers blasting out pristine-quality audio, with Samsung's usual high standards for connectivity.



SPEAKERS 14 • RMS POWER OUTPUT 372W • DIMENSIONS 1,230x83x136mm (soundbar), 203x400x416mm (subwoofer) • NETWORKING 802.11n Wi-Fi, Bluetooth • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE HW-N850 • FULL REVIEW Feb 2019

SONY KD-55XF9005

★★★★★

£999 • www.johnlewis.com

COMPUTER SHOPPER
RECOMMENDED

Direct-lit backlighting, excellent upscaling and beautifully smooth motion make the KD-55XF9005 a worthy alternative to high-end OLED TVs, even though it only has a VA panel.



SCREEN SIZE 55in • NATIVE RESOLUTION 3,840x2,160 • VIDEO INPUTS 4x HDMI • TUNER Freeview HD • DIMENSIONS 771x1,228x258mm • WARRANTY One year RTB • DETAILS www.sony.co.uk • PART CODE KD-55XF9005 • FULL REVIEW Aug 2018

POLK AUDIO Command Bar

★★★★★

£165 • www.amzn.to/33TdAv4

COMPUTER SHOPPER
BEST BUY

This is a genius combination of soundbar and smart speaker, and for a low price too. It's great for films, TV and music, and you can use Alexa as a voice-activated remote control.



SPEAKERS 3 • RMS POWER OUTPUT 260W • DIMENSIONS 1,091x102x51mm (soundbar), 367x188x368mm (subwoofer) • WEIGHT 2.3kg (soundbar), 3.9kg (subwoofer) • DOCK CONNECTOR None • NETWORKING 802.11ac Wi-Fi • WARRANTY Three years RTB • DETAILS en.polkaudio.com • PART CODE COMMANDUK • FULL REVIEW Oct 2019

PHILIPS 65OLED803

★★★★★

£1,999 • www.currys.co.uk

COMPUTER SHOPPER
RECOMMENDED

If you've got the budget for an OLED TV, this is a great pick. The panel technology's built-in strengths, such as perfect blacks and wide viewing angles, are aided by Philips' exemplary image processing engine, resulting in truly wonderful picture quality.



SCREEN SIZE 65in • NATIVE RESOLUTION 3,840x2,160 • VIDEO INPUTS 4x HDMI, 1x Component • TUNER Freeview HD • DIMENSIONS 824x1,449x280mm • WARRANTY One year RTB • DETAILS www.philips.co.uk • PART CODE 65OLED803/12 • FULL REVIEW Apr 2019

SONOS Beam

★★★★★

£399 • www.sonos.com

COMPUTER SHOPPER
RECOMMENDED

The Beam could join a home cinema setup on sound quality alone, but it's loaded with smart features, too. It can adjust sound output to the size and layout of a room, for example, and form a multiroom system with other Sonos speakers.



SPEAKERS 5 • RMS POWER OUTPUT Not stated • DIMENSIONS 651x100x69mm • WEIGHT 2.8kg • DOCK CONNECTOR None • NETWORKING 802.11ac Wi-Fi, Ethernet • WARRANTY One year RTB • DETAILS www.sonos.com • PART CODE BEAM1UK1 • FULL REVIEW Apr 2019

Choosing a... Bluetooth speaker

01 Bluetooth speakers come in all shapes and sizes, so you'll need to decide what you want to do with the speaker before you buy. If you don't plan to take your music outdoors or around the house, look for a wired speaker. These are typically cheaper than speakers with built-in batteries.

If you do want a portable speaker, however, pay particular attention to how much it weighs. Ruggedised models should be able to survive accidental drops, water spills and unexpected rain showers.

02 Many of the cheapest Bluetooth speakers use the lossy A2DP Bluetooth protocol, which is prone to compressing your music and discarding detail compared with the original recording.

It's hard to tell the difference when listening to pocket-sized speakers, but if you're looking for a speaker to fill a room, an aptX-compatible device is a better option. This Bluetooth protocol retains more detail than the A2DP profile, although you'll need to use it with a compatible smartphone in order to get the benefits.

03 As with any audio product, the number and size of speaker drivers can have a significant impact on the quality of sound you get from a Bluetooth speaker. Typically, the presence of multiple drivers enables the manufacturer to tune each one for specific frequencies, directing high-end sounds towards a tweeter and sending the mid-range frequencies to the main driver.

Single-driver speakers with larger driver cones can be just as capable of producing fantastic audio, however.

04 Most Bluetooth speakers have at least one auxiliary input for a wired 3.5mm audio jack, in case you want to listen to music from a device that doesn't have Bluetooth.

There are other extra features to look out for, though. Speakers with built-in batteries may have a USB port for charging your smartphone, or a built-in microphone to turn it into a speakerphone when a paired smartphone receives a call. Not all speakers have physical controls; many rely on your paired device's controls for adjusting the volume or muting playback.

AUDIO

CREATIVE Outlier Air

★★★★★

£70 • uk.creative.com

COMPUTER SHOPPER
BEST BUY

A marvellous set of true wireless



headphones, the Outlier Air combine a lively and dynamic sound with a comfy (if large) design and long battery life. Bluetooth aptX support is worth the money in particular.

HEADPHONES SUBTYPE In-ear headset • PLUG TYPE None • WEIGHT 10g • CABLE LENGTH N/A • WARRANTY Two years RTB • DETAILS uk.creative.com • PART CODE Outlier Air • FULL REVIEW Jul 2019

SONY WH-1000XM3

★★★★★

£270 • www.amzn.to/2HHUG1J

COMPUTER SHOPPER
BEST BUY

Bose's QuietComfort headphones have at last been toppled from the ANC



throne. The WH-1000XM3 headphones don't just sound outstanding, with very effective noise cancellation, but they're smartly designed and come with a host of extras.

HEADPHONES SUBTYPE Over-ear headset • PLUG TYPE 3.5mm jack plug (optional) • WEIGHT 255g • CABLE LENGTH 1.2m • WARRANTY One year RTB • DETAILS www.sony.co.uk • PART CODE WH-1000XM3 • FULL REVIEW May 2019

IKEA Symfonisk

★★★★★

£150 • www.ikea.com

COMPUTER SHOPPER
BEST BUY

Ikea, with a little help from Sonos, has produced two great-sounding wired speakers. The cheaper 'bookshelf' model is slim and subtle, but it's worth paying extra for the 'lamp' model, which both sounds fuller and doubles as a working lamp.



SPEAKERS 2 • RMS POWER OUTPUT Not stated • WEIGHT Not stated • NETWORKING Wi-Fi • WARRANTY One year RTB • DETAILS www.ikea.com • PART CODE Symfonisk • FULL REVIEW Nov 2019

ESCAPE P9

★★★★★

£999 • www.stoneaudio.co.uk

COMPUTER SHOPPER
BEST BUY

A dramatically loud, rain-resistant upright speaker, the Escape P9 is something nice and different for outdoor use – provided you have plenty of cash to burn.



SPEAKERS 3 • RMS POWER OUTPUT 300W • DOCK CONNECTOR None • NETWORKING Bluetooth • DIMENSIONS 731x220x220mm • WEIGHT 1.2kg • WARRANTY One year parts and labour • DETAILS www.escapespeakers.com • PART CODE P9 • FULL REVIEW Sep 2019

UE Boom 3

★★★★★

£129 • www.johnlewis.com

COMPUTER SHOPPER
BEST BUY

This IP67-rated Bluetooth speaker is a comprehensive upgrade on the Boom 2: it's more durable, looks better, has longer wireless range and sounds even better.



SPEAKERS 4 • RMS POWER OUTPUT Not stated • DOCK CONNECTOR None • NETWORKING Bluetooth (SBC) • DIMENSIONS 184x73x73mm • WEIGHT 608g • WARRANTY Two years RTB • DETAILS www.ultimateears.com • PART CODE 984-001360 • FULL REVIEW Jan 2019

BOWERS & WILKINS 607

★★★★☆

£399 • www.veybridge-audio.co.uk

COMPUTER SHOPPER
RECOMMENDED

Inspired by the classic 600 series, the wired 607s deliver an exciting and enthusiastic sound profile that reveals the tiniest details in every recording.



SPEAKERS 4 • RMS POWER OUTPUT 125W • WEIGHT 4.7kg per speaker • NETWORKING None • WARRANTY One year RTB • DETAILS www.bowers-wilkins.eu • PART CODE 607 • FULL REVIEW Jun 2019

Choosing a... Media streamer

01 Media streamers have come a long way from the hard disk-based set-top boxes of a few years ago. They now come in two main forms: flash drive-sized dongles that plug directly into the HDMI port in the back of your TV, and larger microconsoles that sit under it. Whichever model you choose, it will stream content from the internet rather than storing media files locally.

02 Most streamers use their own operating system, which you can navigate with a bundled remote control, but Google's Chromecast dongle requires a paired smartphone, tablet or laptop to stream content on the big screen. If you're looking to set up Netflix for

someone who doesn't have a smartphone, buy a standalone streamer such as a Roku or Amazon Fire TV device.

03 A media streamer is only as good as the services it supports, although a device that offers more services won't necessarily offer more high-quality content than a media streamer with fewer channels. Instead, look out for major channels such as Netflix, Amazon Instant Video, BBC iPlayer, Sky Go and YouTube. If any of these are missing, the remaining channels aren't likely to be much cop.

04 Although nearly all streamers now pull content from the web, they're still capable of playing content stored locally

from a networked PC or NAS device. Not all streamers are capable of playing all media file formats, however. If you have a lot of MKV or MOV files, check that your chosen streamer supports them before you buy. These are typically the file formats devices struggle with the most.

05 Media streamers aren't just for video, either. Many support online music services including Spotify, Rdio and TuneIn Radio. Others essentially use the same hardware as a smartphone and are capable of running apps or playing games. Some of the most powerful are compatible with dedicated game controllers, but these are typically sold as optional accessories rather than bundled with the streamer.

VIDEO

AMAZON Fire TV Stick 4K

★★★★★

£50 • www.amzn.to/2Y6q8wh

COMPUTER SHOPPER
RECOMMENDED

From set-top box to dangling dongle and now an ultra-compact stick, Amazon's 4K media streamer gets sleeker with every generation. It's also been updated with a new remote, which includes a microphone for Alexa voice commands.



VIDEO OUTPUTS HDMI 2.0 • **NETWORKING** 802.11ac Wi-Fi • **DIMENSIONS** 108x30x14mm • **STREAMING FORMATS** UPnP, AirPlay, DLNA, Plex • **INTERNET STREAMING SERVICES** Amazon Video, Netflix, BBC iPlayer, ITV Hub, All 4, My5 • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Fire TV Stick 4K • **FULL REVIEW** May 2019

DJI Osmo Pocket

★★★★★

£329 • www.amzn.to/2vl53Ba

COMPUTER SHOPPER
RECOMMENDED

A cleverly made alternative to action cameras, the DJI Osmo Pocket isn't intended for extreme sports, but its mechanical stabilisation ensures smooth, great-looking footage for life-logging videos.



SENSOR 1/2.3in CMOS • **SENSOR PIXELS** 12 megapixels • **MAXIMUM RECORDING RESOLUTION** 4K (60fps) • **AV CONNECTIONS** USB Type-C • **DIMENSIONS** 122x37x38mm • **WEIGHT** 116g • **WARRANTY** One year RTB • **DETAILS** www.dji.com • **PART CODE** CP.ZM.00000097.01 • **FULL REVIEW** Apr 2019

NVIDIA Shield TV (2017)

★★★★★

£189 • www.johnlewis.com

COMPUTER SHOPPER
BEST BUY

A good media streamer/Android games console hybrid made even better by a more comfortable controller, a wider range of streaming sources and smart home integration.



VIDEO OUTPUTS HDMI 1.4 • **NETWORKING** 802.11ac Wi-Fi, 10/100/1,000 Ethernet, Bluetooth 4.1 • **DIMENSIONS** 159x98x26mm • **STREAMING FORMATS** Plex, Kodi • **INTERNET STREAMING SERVICES** Netflix, Amazon Instant Video, Google Play Movies and TV, Google Play Music, YouTube, BBC iPlayer • **WARRANTY** Two years repair and replace • **DETAILS** www.nvidia.co.uk • **PART CODE** 945-12897-2505-000 • **FULL REVIEW** May 2017

GOPRO Hero 7 Black

★★★★★

£319 • www.amzn.to/32hWxC9

COMPUTER SHOPPER
BEST BUY

The Yi 4K+ is cheaper, but no other action camera comes close to the video quality of the Hero 7 Black. That's largely down to its new electronic image stabilisation, which keeps footage looking unbeatably smooth.



SENSOR 1/2.3in CMOS • **SENSOR PIXELS** 12 megapixels • **MAXIMUM RECORDING RESOLUTION** 4K (60fps) • **AV CONNECTIONS** Micro HDMI • **DIMENSIONS** 45x62x32mm • **WEIGHT** 116g • **WARRANTY** One year RTB • **DETAILS** www.gopro.com • **PART CODE** CHDX-701-RW • **FULL REVIEW** Feb 2019

APPLE TV 4K

★★★★★

£179 • www.apple.com/uk

COMPUTER SHOPPER
RECOMMENDED

This big update adds 4K content (including, for the first time, Amazon Video support). The best part is that if there's a 4K version of content you've previously purchased in HD, Apple will upgrade it free of charge.



VIDEO OUTPUTS HDMI 2.0a • **NETWORKING** 802.11ac Wi-Fi, 10/100/1,000 Ethernet • **DIMENSIONS** 35x98x98mm • **STREAMING FORMATS** AirPlay, others via apps • **INTERNET STREAMING SERVICES** iTunes, Apple Music, Netflix, Amazon Instant Video, Now TV, BBC iPlayer, ITV Hub, All 4 • **WARRANTY** One year RTB • **DETAILS** www.apple.com/uk • **PART CODE** Apple TV 4K • **FULL REVIEW** Jan 2018

SAMSUNG Gear 360 (2017)

★★★★★

£155 • www.amzn.to/2wesOMX

COMPUTER SHOPPER
BEST BUY

Samsung's updated 360° camera improves on the original in every way: it's more portable, supports live video stream, and is no longer limited to Samsung Galaxy phones. Best of all, it's cheaper than the previous model was at launch.



SENSOR RESOLUTION Dual 8.4 megapixels • **SENSOR SIZE** Not disclosed • **VIEWFINDER** None • **LCD SCREEN** 0.5in 72x32 PMOLED • **DIMENSIONS** 100x46x45mm • **WEIGHT** 130g • **WARRANTY** One year RTB • **DETAILS** www.samsung.com/uk • **PART CODE** SM-R210NZWABTU • **FULL REVIEW** Oct 2017

WHAT IS AVAXHOME?

AVAXHOME-

the biggest Internet portal,
providing you various content:
brand new books, trending movies,
fresh magazines, hot games,
recent software, latest music releases.

Unlimited satisfaction one low price

Cheap constant access to piping hot media

Protect your downloadings from Big brother

Safer, than torrent-trackers

18 years of seamless operation and our users' satisfaction

All languages

Brand new content

One site



AVXLIVE ICU

AvaxHome - Your End Place

We have everything for all of your needs. Just open <https://avxlive.icu>

Choosing a... Digital camera

01 A basic digital camera will suit someone who wants to take pictures to view on their computer and create 7x5in prints. It should cost around £80, but there may be hidden downsides such as slow performance and very basic user controls.

02 Spend a little more and you'll get a higher resolution. A 16-megapixel sensor has the potential to produce sharp prints up to A3 size, but only if it and the lens are of a suitably high quality. Very high resolutions in compact cameras tend to boost noise more than detail levels, so many of the best models strike a sensible balance by using a 12-megapixel sensor.

Back-illuminated CMOS sensors tend to produce less noise than CCDs, but

check our reviews to find out how a particular model performs.

03 A 3x zoom lens provides you with reasonable scope for framing your shots, but a larger range can do wonders for your photography. Most compact cameras can manage a 5x zoom, while pocket-size ultra-zoom cameras can provide 24x zoom ranges.

Numbers such as 28-105mm tell you the wide-angle and telephoto limits of the zoom range. Big zooms require optical image stabilisation to avoid blur due to camera shake when zoomed right in.

04 Most cameras now have a 3in screen. Look out for 900,000-dot resolutions

or higher for a sharper picture. A touchscreen is useful for moving the autofocus point.

05 Leave some room in your budget for a memory card, as the bundled memory provided with a camera is never enough. A 16GB card costs less than £10. You may also need to buy batteries.

06 Don't forget that a camera's specification tells you very little about its image quality. You'll need to read our reviews for that. With a compact camera, we believe the user shouldn't have to grapple with complicated controls in order to take great pictures in a range of lighting conditions.

PHOTOGRAPHY

CANON EOS R

★★★★★

£3,069 • www.johnlewis.com



This is Canon's first mirrorless full-frame camera, but you wouldn't know it. Image quality is among the very best, and the included kit lens does a fantastic job. You can also get it body-only and attach your own RF-mount lenses.



SENSOR RESOLUTION 30.3 megapixels • **SENSOR SIZE** 36x24mm • **FOCAL LENGTH MULTIPLIER** 1x • **VIEWFINDER** Electronic (3.6 million dots) • **LCD SCREEN** 3.2in (2,100,000 dots) • **VIEWFINDER MAGNIFICATION (35mm-EQUIVALENT, COVERAGE)** 0.76x, 100% • **WEIGHT** 580g • **DIMENSIONS** 98x136x84mm • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **FULL REVIEW** Sep 2019

FUJIFILM X-T3

★★★★★

£1,549 • www.amzn.to/2Fccak5



A fantastically versatile mirrorless camera, capable of taking perfect stills as much as it is recording high-quality video. There are plenty of pro-level features, too.



SENSOR RESOLUTION 26.1 megapixels • **SENSOR SIZE** 23.5x15.6mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 2.7x • **VIEWFINDER** Electronic (3.69 million dots) • **LCD SCREEN** 3in (1.04 million dots) • **VIEWFINDER MAGNIFICATION (35mm-EQUIVALENT, COVERAGE)** 0.75x, 100% • **WEIGHT** 539g • **DIMENSIONS** 93x133x59mm • **WARRANTY** One year RTB • **DETAILS** www.fujifilm.com • **FULL REVIEW** May 2019

NIKON Z6

★★★★★

£1,699 • www.jessops.com



If you can't quite afford the exemplary Z7, then the Z6 is the perfect alternative. It's every bit the mirrorless all-rounder, and while it has a lower-resolution sensor than the Z7, this allows it to shoot at a faster rate.



SENSOR RESOLUTION 24.5 megapixels • **SENSOR SIZE** 35.9x23.9mm CMOS • **VIEWFINDER** Electronic (3.69 million dots) • **LCD SCREEN** 3.2in (2 million dots) • **VIEWFINDER MAGNIFICATION (35MM-EQUIVALENT, COVERAGE)** 0.8x, 100% • **WEIGHT** 1,175g • **SIZE (HXWXD)** 101x134x68mm • **WARRANTY** One year RTB • **DETAILS** www.europe-nikon.com • **FULL REVIEW** July 2019

POLAROID Originals OneStep 2

★★★★★

£99 • www.amzn.to/2DQhr05



The OneStep 2 brings back the simple joys of instant photography. Although the stock can get quite pricey, your shots will look just as they would on a classic Polaroid – perfect for sharing or simply sticking to the fridge.



PHOTO SIZE 3.1x3.1in • **BATTERY LIFE** 15-20 packets of film • **PORTS** 1x Micro USB • **WARRANTY** One year RTB • **DETAILS** www.polaroidoriginals.com • **FULL REVIEW** Jan 2018

SONY A6400

★★★★★

£1,279 • www.amzn.to/2KO1PPj



Sony's tiny mirrorless camera doesn't sacrifice quality in the name of portability. The 1,200-zone metering system helps produce balanced photos, and the A6400 particularly excels at speed-shooting, so it's definitely worth a look for action photography.



SENSOR RESOLUTION 24.2 megapixels • **SENSOR SIZE** 23.5x15.6mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 1.5x • **VIEWFINDER** Electronic (2.36 million dots) • **LCD SCREEN** 3in (921,000 dots) • **LENS MOUNT** E-mount • **WEIGHT** 403g • **DIMENSIONS** 67x120x60mm • **WARRANTY** One year RTB • **DETAILS** www.sony.com • **FULL REVIEW** Oct 2019

PANASONIC Lumix DMC-G80

★★★★★

£599 • www.jessops.com



The G80 is ahead of the pack when it comes to video quality, and its stills look great as well. It's more expensive than the preceding G7, but includes a superior 12-60mm kit lens, among other improvements.



SENSOR RESOLUTION 16 megapixels • **SENSOR SIZE** 17.3x13mm • **FOCAL LENGTH MULTIPLIER** 2x • **VIEWFINDER** Electronic (2.36 million dots) • **LCD SCREEN** 3in (1,040,000 dots) • **LENS MOUNT** Micro Four Thirds • **WEIGHT** 715g with kit lens • **DIMENSIONS** 79x137x130mm • **WARRANTY** One year RTB • **DETAILS** www.panasonic.com/uk • **FULL REVIEW** Jul 2017

Choosing a... Wearable

01 Wearable tech can include anything from chest-strap heart-rate monitors to augmented reality glasses, but the two most common types are smartwatches and fitness trackers. Both are designed to sit unassumingly on your wrist, and are almost always meant to be used in tandem with a paired smartphone.

02 Smartwatches are typically more complex and expensive, though more closely resemble a traditional wristwatch. You can use them to receive and reply to text messages and emails, quickly check maps and even play games – like a smartphone, most smartwatches allow you to install your own choice of apps.

03 Fitness trackers are much more dedicated to healthy pursuits. Step counters, heart-rate monitors and even sleep tracking are all common, and the data collected is fed back to you so you can see how your workout routine or calorie intake is going.

Many smartwatches also contain health-tracking features, but fitness-specific wearables tend to be cheaper, smaller and lighter.

04 When it comes to battery life, it's important for any wearable to last a full day, but if it's a smartwatch then you can get away with having to charge it overnight. With fitness trackers, it's better if it lasts for several days off

a single charge, so you can wear it to bed and benefit from sleep tracking.

05 Look out for waterproofing as well. Wearables that don't mind a few lengths of the pool can be used for swimming or just timekeeping, and at the very least we expect a fitness tracker to be able to deal with rain or sweat.

06 Different smartwatches use different operating systems, which determine which apps you can install on your device, as well as compatibility with smartphones. Android Wear and Tizen smartwatches will work with both Android and iOS phones, but Apple's watchOS will only pair with an iOS handset.

WEARABLES

GARMIN Vivosmart 4

★★★★★

£92 • www.amzn.to/2UYdj4M

COMPUTER SHOPPER
RECOMMENDED

Comfortable, accurate and not too expensive, the Vivosmart 4 is a fine fitness tracker, albeit one without onboard GPS. It's particularly suited to those who don't already exercise but are looking to improve their overall fitness.



PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 0.7in • RESOLUTION 48x128 • OS SUPPORT Android, iOS • BATTERY LIFE Seven days • WARRANTY One year RTB • DETAILS www.garmin.com • PART CODE 010-01995-04 • FULL REVIEW Apr 2019

APPLE Watch Series 4

★★★★★

£399 • www.apple.com/uk

COMPUTER SHOPPER
BEST BUY

The latest Apple Watch is the sleekest and slickest wearable the company has ever made. An edge-to-edge screen and haptic feedback in the crown are just two of the many enhancements.



PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.78in • RESOLUTION 448x368 • OS SUPPORT iOS • BATTERY LIFE 18 hours • WARRANTY One year RTB • DETAILS www.apple.com/uk • PART CODE Apple Watch Series 4 • FULL REVIEW Jan 2019

POLAR Vantage M

★★★★★

£204 • www.amzn.to/2HEqMLJ

COMPUTER SHOPPER
RECOMMENDED

A much-improved design sees the Vantage M become a sleeker and more comfortable running watch than the preceding M430, and multisport tracking goes a lot deeper, too – there's even swim tracking.



PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.2in • RESOLUTION 240x240 • OS SUPPORT Android, iOS • BATTERY LIFE 30 hours • WARRANTY One year RTB • DETAILS www.polar.com • PART CODE Vantage M • FULL REVIEW May 2019

FITBIT Inspire HR

★★★★★

£88 • www.amzn.to/2VsxcRA

COMPUTER SHOPPER
BEST BUY

There's no better sub-£100 fitness tracker for casual users than this. The Inspire HR's simplicity and stylishness give it immediate appeal, and you'll stay for the top-quality mobile app.



PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 0.7in • RESOLUTION 128x72 • OS SUPPORT Android, iOS • BATTERY LIFE Five days • WARRANTY One year RTB • DETAILS www.fitbit.com • PART CODE FB505RGPK-EU • FULL REVIEW Jul 2019

GARMIN Fenix 5 Plus

★★★★★

£479 • www.amzn.to/2kUGgSY

COMPUTER SHOPPER
BEST BUY

You'll have to pay a pretty penny for it, but the variety of features on the Fenix 5 Plus is without peer. One of the most exclusive is its support for full-colour maps, along with the ability to create routes straight from your wrist.



PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.2in • RESOLUTION 240x240 • OS SUPPORT Android, iOS • BATTERY LIFE 18 hours • WARRANTY One year RTB • DETAILS www.garmin.com • PART CODE 010-01988-11 • FULL REVIEW Nov 2019

MOBVOI TicWatch E2

★★★★★

£146 • www.mobvoi.com

COMPUTER SHOPPER
RECOMMENDED

At this price, there's simply no better smartwatch/fitness tracker hybrid than the TicWatch E2. Built-in GPS, IP67 waterproofing and an upgraded battery are all on board, and it's more responsive than most Wear 2100 wearables.



PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.4in • RESOLUTION 400x400 • OS SUPPORT Android, iOS • BATTERY LIFE Two days • WARRANTY One year RTB • DETAILS www.mobvoi.com • PART CODE TicWatch E2 • FULL REVIEW Jun 2019

SOFTWARE

ADOBE Premiere Pro CC 2019

★★★★★

£20 per month • www.adobe.com



This strong update of Premiere Pro CC adds improved Lumetri Color controls and neat integration with the Premiere Rush mobile app, among other tweaks.

OS SUPPORT Windows 10 version 1703 and later, macOS 10.12 and later (10.13 required for hardware acceleration) • **MINIMUM CPU** Intel 6th-gen and later, AMD equivalents • **MINIMUM GPU** Integrated graphics • **MINIMUM RAM** 8GB • **HARD DISK SPACE** 8GB • **DETAILS** www.adobe.com • **PRODUCT CODE** Premiere Pro CC • **FULL REVIEW** Jul 2019

Video-editing software

KASPERSKY Security Cloud

★★★★★

£50 • www.kaspersky.co.uk



It's just as effective as Kaspersky Total Security, but Security Cloud goes a step further by learning your bad security habits and warning you about them.

OS SUPPORT Windows 7/8/10, OS 10.11/macOS 10.12, Android 4.1 and later, iOS 10/11 • **MINIMUM CPU** 1GHz • **MINIMUM GPU** None • **MINIMUM RAM** 1GB (32-bit), 2GB (64-bit) • **HARD DISK SPACE** 1,020MB (Windows), 1,110MB (Mac) • **DETAILS** www.kaspersky.co.uk • **PRODUCT CODE** Security Cloud • **FULL REVIEW** Jan 2018

Security software

NORDVPN

★★★★★

£9 per month • www.nordvpn.com



There are cheaper VPN services available, but none has the flexibility and multi-level security features of NordVPN. It's become much faster than previous versions, too.

OS SUPPORT Windows, macOS, iOS, Android, DD-WRT router • **DETAILS** www.nordvpn.com • **PRODUCT CODE** NordVPN • **FULL REVIEW** Sep 2018

Virtual private network

CYBERGHOST VPN

★★★★★

£2.10 per month • www.cyberghostvpn.com



In addition to safeguarding your privacy, CyberGhost VPN is particularly well suited to unblocking content on different streaming services. Connecting to new servers could be a bit faster, but once you're connected, everything is nice and stable.

OS SUPPORT Windows, macOS, iOS, Android • **DETAILS** www.cyberghostvpn.com • **PRODUCT CODE** CyberGhost VPN • **FULL REVIEW** Nov 2019

Virtual private network



McAfee Internet Security 2019

★★★★★

£8 • www.amzn.to/2X5sQBL



Impressively, the 2019 version takes McAfee Internet Security from an industry damp squib to one of the most reliable security suites on the market. Malware detection is vastly improved and performance is better, too.

OS SUPPORT Windows 7/8/8.1/10, macOS 10.12 and later; Android 4.1 and later, iOS 10 and later • **MINIMUM CPU** 1GHz • **MINIMUM GPU** DirectX 9 • **MINIMUM RAM** 1GB • **HARD DISK SPACE** 500MB • **DETAILS** www.mcafee.com • **FULL REVIEW** Apr 2019

Security software

APPLE macOS 10.14 Mojave

★★★★★

Free • itunes.apple.com



Mojave's small UI improvements and minor added features would disappoint on their own, but together they add up to a great update. It's free, too, so there's no reason not to make the switch.

OS SUPPORT OS X Mountain Lion or later • **MINIMUM CPU** Not stated • **MINIMUM GPU** Integrated graphics • **MINIMUM RAM** 2GB • **HARD DISK SPACE** 12.5GB • **DETAILS** www.apple.com • **FULL REVIEW** Jan 2019

OS update

GAMING

XBOX One S

★★★★★

£200 • www.argos.co.uk



HDR support is great, but it's the 4K Blu-ray player that makes this sleeker, smaller Xbox One really stand out against the competing PS4 Slim.



PROCESSOR Octa-core 1.75GHz Jaguar • **RAM** 8GB DDR3 • **FRONT USB PORTS** 1x USB2 • **REAR USB PORTS** 2x USB2 • **STORAGE** 500GB/1TB/2TB • **WARRANTY** One year RTB • **DETAILS** www.xbox.com • **PART CODE** Xbox One S • **FULL REVIEW** Dec 2016

4K games console

OCULUS Go

★★★★★

£199 • www.overclockers.co.uk



No longer do you need a decked-out PC or premium smartphone to enjoy VR. The Oculus Go crams all the hardware you need into the headset itself, making virtual reality entertainment as immediate and accessible as it's ever been.



DISPLAY LCD • **RESOLUTION** 2,560x1,440 • **REFRESH RATE** 72Hz • **PROCESSOR** Octa-core 2.4GHz Qualcomm Snapdragon 821 • **RAM** 3GB • **WEIGHT** 467g • **DETAILS** www.oculus.com/go • **PART CODE** Go 32GB • **FULL REVIEW** Sep 2018

VR headset

NINTENDO Labo VR Kit

★★★★★

£70 • www.studio.co.uk



This addition to the cardboard-based Labo series turns your Nintendo Switch into a platform for a myriad of inventive VR minigames. Kids in particular will enjoy constructing the goggles and controllers themselves.



AVAILABLE FORMATS Nintendo Switch • **DISK SPACE** Not stated • **DETAILS** labo.nintendo.com • **PART CODE** Nintendo Labo VR Kit • **FULL REVIEW** Aug 2019

VR headset and games

SONY PS4 Slim

★★★★★

£250 • www.argos.co.uk



Sony has made the PlayStation 4 even better with a slimmer, neater chassis and superior power efficiency. It's as cheap as the PS4 has ever been as well.



PROCESSOR Octa-core 1.6GHz AMD Jaguar • **RAM** 8GB GDDR5 • **FRONT USB PORTS** 2x USB2 • **REAR USB PORTS** None • **STORAGE** 500GB/1TB/2TB • **WARRANTY** One year RTB • **DETAILS** www.playstation.com • **PART CODE** B01GVQVQH2 • **FULL REVIEW** Jan 2017

Games console

Free software guide

It's easy to access your free software. Just go to www.shopperdownload.co.uk/382 and register with the code from the card insert. Please be aware that you need to have bought the 'Free Software Edition' and not the '£4.50 Edition' to access the downloads

GETTING STARTED

The download instructions on the card insert (opposite) show you how to connect to the download site. Make sure you type in the web address exactly as shown. You'll need your coupon code the first time you log on to the site.

ANY PROBLEMS

If you need help with any of the software this month, please send an email to support@creativemark.co.uk. We check this inbox regularly. Please include the issue number of the magazine and your coupon code.

WHY DOWNLOADS

In order to provide us with free software, publishers now require us to offer the applications as a download and require online registration. You need to use the unique code printed in the box on the card insert to register and download the software in this issue. The unique code means we stop the deals leaking online, so only *Shopper* readers get the software.

NO CODE?

If you don't have the card insert with the unique code, you must buy the £4.99 'Free Software' print version of the magazine. If you have this edition and still don't have a card, please contact letters@computersshopper.co.uk.

**REGISTER YOUR SOFTWARE
BY 14th NOVEMBER 2019**

InPixio Photo Editor 9

YOUR CAMERA IS only as good as its software processing, and most cameras are limited by their ability to process your photos to a professional level. Indeed, it's usually best to turn off all camera-based processing and export Raw images, then simply load your photos into your favourite editor and spend time manually tweaking each shot.

InPixio Photo Editor is one of the more powerful post-processing editing tools. Simply load a photo (either a Raw file or one that's previously been processed) and Photo Editor will examine and offer a range of automatic enhancing filters. Better still, you're offered small previews of every single automatic filter, so you can quickly see how your photo will look. If you split your main window, using the split-view button, you can compare the original next to the altered image.

You can make manual adjustments, too, and there are plenty of options, from altering the temperature of the image to the clarity. You can also add texture and text overlays, a frame and much more.



Once you've finished editing your photo, you can simply export the image back to your hard drive. Alternatively, there are social media sharing options built into Photo Editor, or you can send your edited pictures by email.

If you need to process multiple photos, the Batch Processing tool enables you to select a number of photo and apply the same settings and adjustments to each on. They will be saved with those settings automatically.

REQUIREMENTS Windows 7, 8 or 10; 200MB hard disk space
WEBSITE www.avanquest.com
NOTES Get your registration code at npixio9.disc.computersshopper.co.uk

Auslogics Disk Defrag 9 Pro

DISK DEFRAG 9 Pro provides everything you'll need to keep your system running at peak performance.

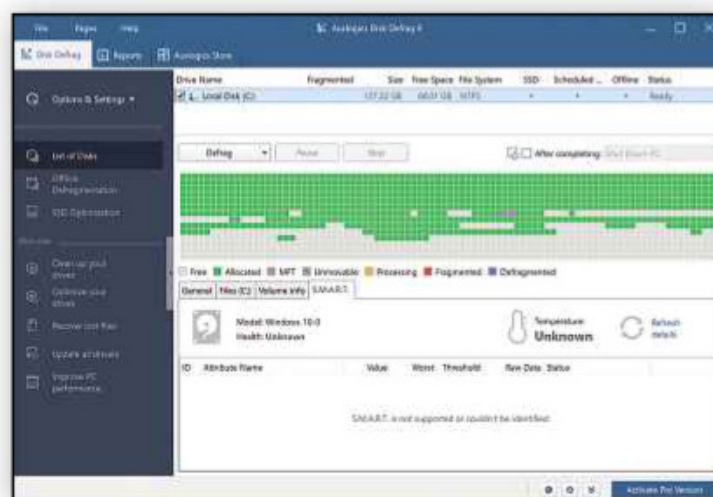
The program provides multiple defrag algorithms: it can optimise access according to file access time, modification time and Windows' own prefetch layout, or you can even manually define which files you'd like written to the fastest part of your drive. Leaving a little free space after specified files also helps to reduce future fragmentation.

There are even more ways to run a defrag job, too. You might choose to defragment an individual file, a folder or an entire partition; the program can run before Windows launches, enabling it to defrag system files that would

otherwise be locked; a scheduler can run unattended defrags whenever you like, or you can even leave the program running in the background, so it can detect and eliminate fragmentation as soon as it appears.

And if you're worried about the program slowing you down, don't: it's not going to be a problem. In just a few clicks you can limit the maximum use Disk

Defrag Professional will make of your CPU or hard drive, and you can tell it not to run at all when a particularly demanding application is running. This comes in handy when launching games or hardware-intensive productivity applications, as you can be sure they'll get their usual share of your system's resources.



REQUIREMENTS Windows XP, Vista, 7, 8 or 10; 75MB hard disk space
WEBSITE www.auslogics.com
NOTES To obtain your serial code, go to ddefrag9pro.disc.computersshopper.co.uk. To activate it, within Disk Defrag 9, go to the Help menu, select About and choose Enter License Key



Abelssoft KeyDepot 2019

KEYDEPOT 2019 IS an easy-to-use tool for creating secure passwords, storing them in an encrypted vault, and – optionally – syncing them across all your PCs.

A simple wizard walks you through the setup process. Create your starting vault, enter a master password, and you're ready to go within seconds.

Enter the logins for your favourite sites, and KeyDepot automatically checks them for security. If a password is too simple, you're asked to create another, but that's not difficult: a built-in password generator creates something highly secure with a single click.

Your websites are organised by categories – music, banking, news, whatever you like – so all you have to do is browse the list, click a button and the website launches right away.

KeyDepot won't autofill a logon page. Instead, you tap buttons to copy the username or password to the clipboard, then paste them into the logon form.

Normally your passwords are stored in a file on a local hard drive, but there are other options to try.



You can have the program store everything on a USB stick, allowing access to your credentials from any convenient PC. Alternatively, you can synchronise the password vault via KeyDepot's free Cloud Service, ensuring any changes you make on one PC are automatically available on your other computers.

In a thoughtful touch, KeyDepot will automatically clear the clipboard and close your safe if the program hasn't been used for a while, reducing the chance of snoopers gaining access. Again, the timeouts can be customised if the defaults don't work for you.

REQUIREMENTS Windows 7, 8 or 10;
40MB hard disk space
WEBSITE www.abelssoft.net
NOTES Get your registration code within the application

IObit Uninstaller 9 Pro

IOBIT UNINSTALLER IS a multitalented uninstall tool that can completely remove applications from your hard disk, with none of the usual Registry clutter and junk files that are often left behind.

The cleanup process has two stages. First, you launch the unwanted application's uninstaller and let it do its work. Second, IObit Uninstaller's Powerful Scan option checks your Registry and storage drive for remnants that the program might have left

behind. These are then displayed for your approval, and you're able to delete anything the program has discovered.

IObit Uninstaller additionally provides a Forced Uninstall option, which you can use to remove a program if the original uninstaller no longer works. It works reasonably well, although of course it can't be guaranteed to uninstall everything, so you should only try it as a last resort.

This program also doubles as an easy way to review and manage all your installed

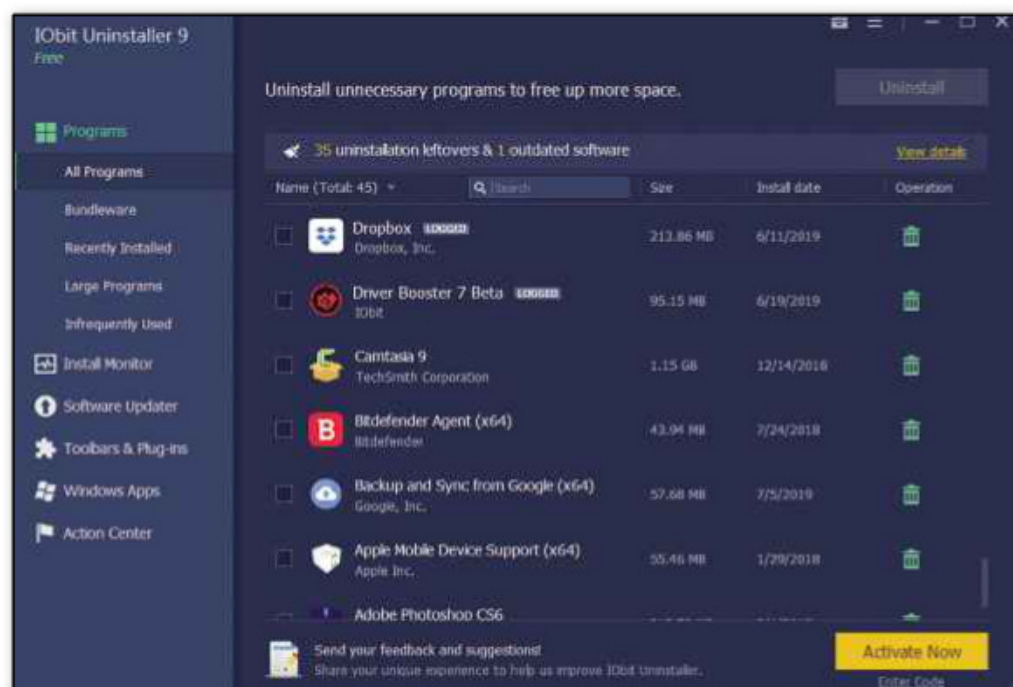
applications. It's faster than Windows' own Control Panel applet, for instance, and includes several useful views that will give you a quick look at particular installation types: Large Programs, Recently Installed, Infrequently Used and more.

It's just as easy to uninstall Windows 10 apps, even the default ones. Enable Batch Uninstall and you can remove them all with one click.

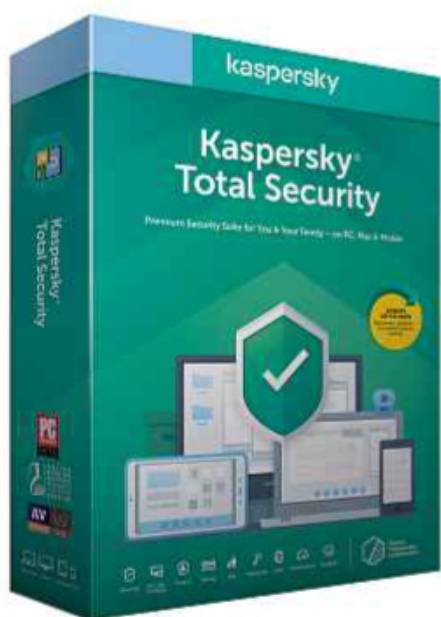
IObit Uninstaller extends the package with tools to control your Windows startup programs, manage running processes, and clean up assorted files left behind by other uninstallers.

There's also improved support for removing Chrome plugins – even if they've not been installed via the Chrome store – and Uninstaller now supports removing really stubborn applications, including antivirus programs.

Bonus extras include a secure file deletion tool and shortcuts for common Windows applications, and there's also a revamped interface with two new skins.



REQUIREMENTS Windows XP, Vista, 7, 8 or 10; 50MB hard disk space
WEBSITE www.iobit.com
NOTES Get your registration code at uninstall9.disc.computershopper.co.uk. Includes a six-month Pro version licence



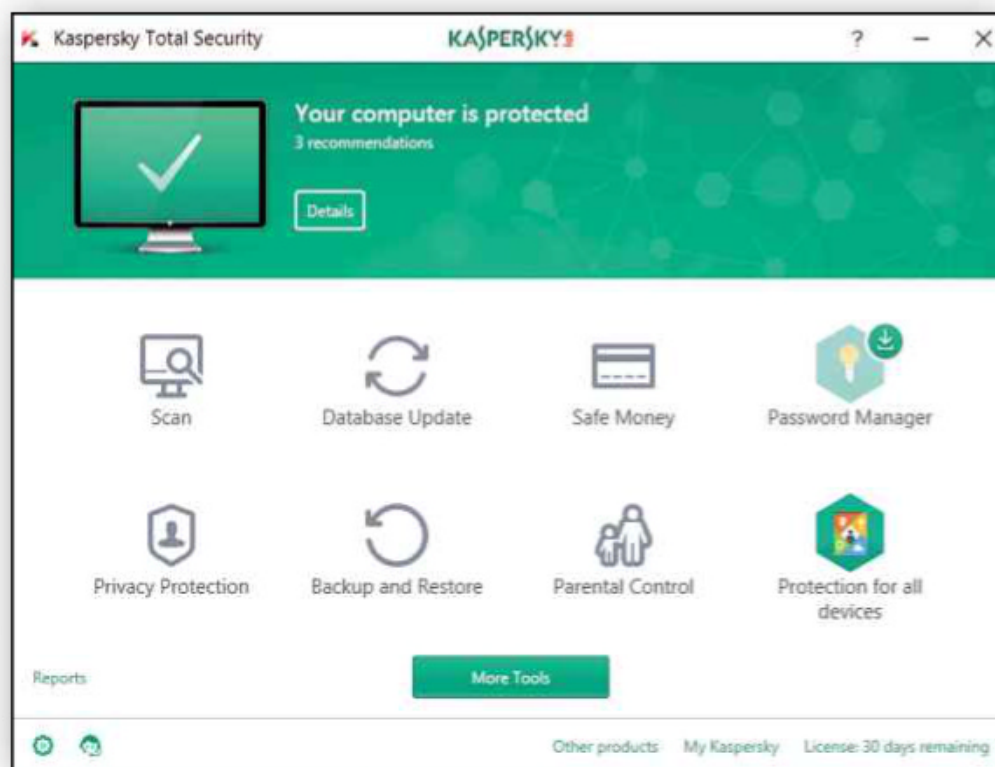
Kaspersky Total Security 2020

KASPERSKY TOTAL SECURITY 2020 is a powerful suite of malware-hunting, anti-hacker web safety tools.

As the name suggests, this is the complete package. There's antivirus, browsing protection, a firewall, exploit protection, a vulnerability scanner, parental controls, webcam and audio protection, online transaction protection and even more tools designed to keep both your privacy and personal information safe.

These features have real value, too. Independent testing labs such as AV-Comparatives typically rate Kaspersky as offering some of the best protection around; it's consistently been one of the highest-scoring anti-malware providers for several years now, and is quick to update its protections when new threats arise.

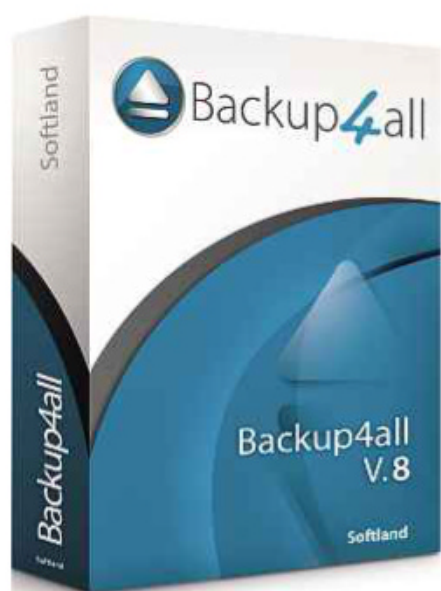
The Software Updater checks for updates to common applications (including Adobe Reader, Flash, Java, Chrome and Firefox, among others), and can optionally install them without you having to see or do anything at all.



In addition, the Secure Connection feature is essentially a privacy-oriented virtual private network (VPN), automatically kicking in to protect you when using Wi-Fi hotspots, internet banking sites and other potentially sensitive services.

The Installation Assistance tool also looks out for adware and other pests that can get silently installed with certain free software, while the Software Cleaner helps you decide what to remove.

REQUIREMENTS Windows 7, 8 or 10; 250MB hard disk space
WEBSITE www.kaspersky.co.uk
NOTES No need to activate. Includes a three-month licence



Softland Backup4all 8.1 Lite

BACKUP4ALL IS AN easy-to-use and capable backup tool, available in four different versions: Professional, Standard, Lite and Portable.

The Lite edition included here is aimed at home users, but still offers all the core functionality most PC owners will need. You can specify the files and folders you'd like to back up, and these can be saved to local, external or network drives. There are also options to compress your archives or

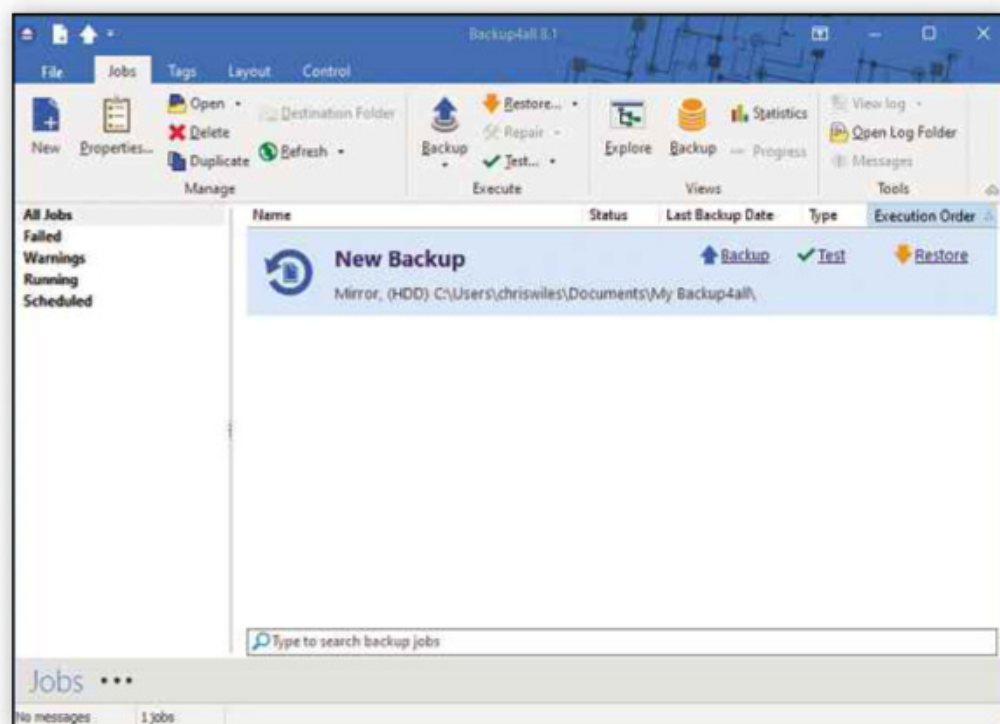
password-protect them for security, and a simple scheduler can automatically run your backup jobs every day, week or month.

Restoration is just as straightforward, because your backups are just mirrors of the original files and folders that are stored in regular Zip files. Simply open an Explorer folder and you'll be able to find and recover what you need in seconds.

Version 8.1 brings a lot of changes, some of

which we've mentioned already, and if you choose to upgrade to a paid version of the program you can get even more. The Professional version, for example, includes block level incremental backups, Azure and Amazon S3 support.

Every edition, including Lite, benefits from the revamped, more customisable and user-friendly interface. There are new tools both to test and repair your backups, and you can now suspend, cancel or stop all backup jobs as well. Backup4all can also run scheduled jobs it might have previously missed.



REQUIREMENTS Windows XP SP3, Vista, 7, 8 or 10; 150MB hard disk space
WEBSITE www.backup4all.com
NOTES Get your registration code at www.backup4all.com/creativemarkb192-promo.html

Chat and Communication

Evernote 6.20.2.8626 Store your notes, ideas and plans in the cloud, and synchronise them between computers.

UPDATED Mailbird 2.6.10.0

A free desktop email client for Windows.

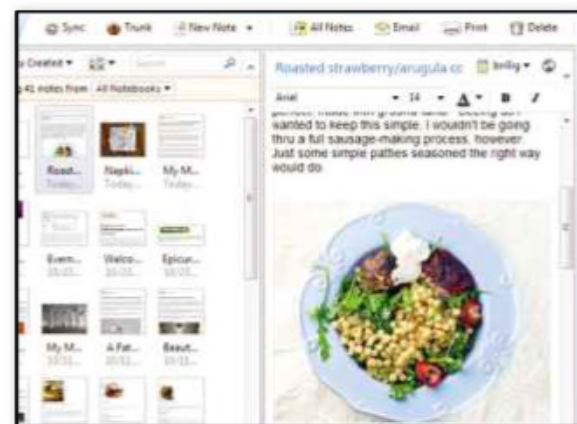
Miranda IM 0.10.80

Chat with friends across multiple messaging platforms, including AIM, Facebook, IRC and MSN, all from one simple interface.

UPDATED Skype for Windows 8.51.0.92 Make internet voice and video calls for free, and buy credit to make calls to mobiles and landlines.

UPDATED Telegram 1.8.4 This free IM app synchronises your conversations across multiple devices, and can spruce up chats with stickers and GIFs.

UPDATED WhatsApp Desktop 0.3.4479 A free PC and Mac version of the popular messaging app, letting you chat from your desktop.



Customisation

iolo System Mechanic Free 18.7.3.176

Speed up your system with iolo's PC optimisation suite.

Rainmeter 4.3

Customise the desktop with your choice of tools and shortcuts.

Windows 8 Transformation Pack 9.1

Emulate the look of Windows 8 on an earlier version of the operating system.

Windows 8 UX Pack 9.1

Get a glimpse of the Windows 10 UI without committing to a full OS upgrade.

Windows 10 Transformation Pack 7.0

Bring some of Windows 10's new features to your current operating system.

Winstep Xtreme 19.2

Freshen up your system with this suite of desktop and UI replacement applications.



General

Genie Timeline Free 2017 10.0.1.100

Protect your most valuable files with this easy-to-use backup tool.

Paragon Partition Manager 16 Free

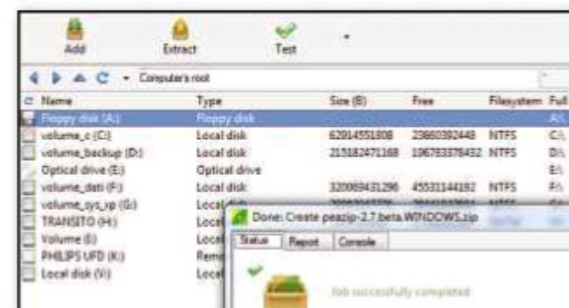
Create, format, split, merge and reorganise all your hard disk's partitions.

UPDATED PeaZip 6.9.2 A tremendously powerful archive-management tool.

Screenshot Captor 4.31.2 Create and manage screenshots the easy way.

UpdateScanner 2.2.0.0 Scan all the software on your PC, find out if an update is available, then install it immediately.

ZipGenius 6.3.2.3116 A flexible file-compression tool with support for a huge number of compressed file formats.



Internet and Network

CarotDAV 1.15.5

Manage all your online storage services with one simple application.

Cyberduck 7.0.2

A powerful but easy-to-use FTP client for uploading and downloading your files.

Glasswire 2.1.158

Keep tabs on your network usage with this simple monitor.

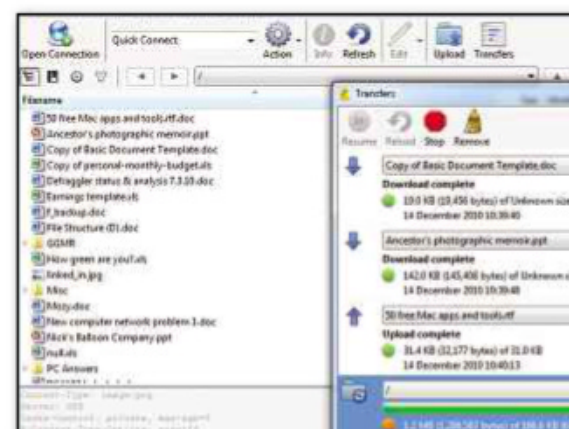
UPDATED FileZilla 3.44.2 A fast and reliable FTP client with lots of useful features.

UPDATED NetBalancer 9.13.2

Make the most of your internet connection by assigning download and upload priorities to web applications.

UPDATED TeamViewer 14.5.5819

Remotely control your computer from anywhere in the world.



Tweaking and Performance

UPDATED CCleaner 5.61 Remove unwanted information, temporary files, browsing history, huge log files and even the settings that uninstalled software leaves behind.

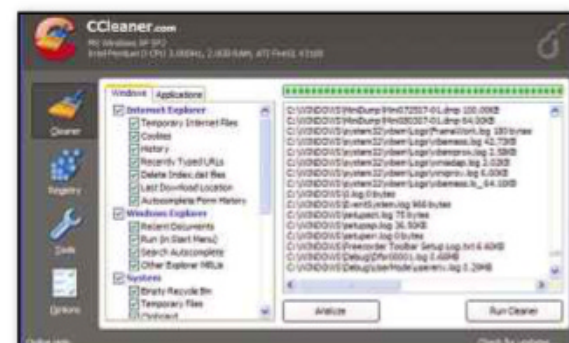
Defraggler 2.22 Ensure that your system is defragmented properly and improve its performance.

Finestra Virtual Desktops 2.5.4501 Set up four or more virtual desktops on your PC.

IObit Advanced SystemCare Free 12.5.0.354 A complete computer security, maintenance and optimisation suite.

Revo Uninstaller Free 2.1.0 Remove installed applications completely, including all their folders, system files and Registry entries.

Simple Performance Boost 1.0.5 Tweak the Windows Registry to give your PC a performance boost.





INKING ALOUD

Printers

CONTENT REVIEWS

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BROTHER MFC-J491DW

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BROTHER MFC-J5945DW

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CANON Pixma TS205

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CANON Pixma TS6250

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EPSON EcoTank ET-M2140

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EPSON EcoTank ET-M3180

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EPSON Expression Premium XP-6100

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HP LaserJet Pro M28w

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HP OfficeJet Pro 6970

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XEROX B215

From high-speed office lasers to affordable all-in-one inkjets, we've tested a plethora of printers to help you find the one that best suits your imaging needs

PRINTERS, IN GENERAL, can seem to be moving forward and standing still at the same time. While there have been advances in how ink is replenished and how you can connect via devices besides a PC, printers aren't particularly faster, cheaper or more compact than they were a few years ago.

Yet new models appear on a regular basis, and so without any truly innovative standouts to lead the way, buying a new one is as complicated as it's ever been. Hopefully, this guide will make things simpler: we've tested 10 of the latest models, encompassing everything from simple entry-level units to premium multifunctional peripherals (MFPs), which can also include scanning and fax capabilities.

You can find these starting on page 72, but if you want further insight into the sometimes

overwhelmingly jargon-filled world of printers and MFPs, keep reading for our buying guide.

SPRAYED IN FULL

One of the few recent developments in printer orthodoxy is the increasing versatility of inkjet printers compared to laser printers. It was once the case that lasers were almost guaranteed to be faster and cheaper to run than inkjets, making them the superior choice for the kind of bulk printing work that might take place in a home office or small business. High printing speeds and low toner costs are still a strength of mono laser printers, but these days you can get competitive performance, and often much lower running costs, from an inkjet, especially those that specifically prioritise efficiency, such as Epson's EcoTank range.

Does this mean you should always favour inkjets? Not necessarily. Inkjets that can match a laser printer's speeds tend to be expensive to buy, making efficiency savings over time less meaningful. That said, we recommend inkjets for colour-sensitive jobs such as photos and posters, as opposed to lasers, which are better for rapidly blasting out text documents.

DRUM ROLL PLEASE

Laser printers are also more complex in how they actually put text and images on to a page. Essentially, a laser traces the image of the printed documents on to a positively charged internal drum, leaving the image with a negative charge. This then attracts positively charged toner particles, which transfer to the paper – which is given an even stronger negative charge – when the drum rolls over it. Finally, heated rollers fuse the toner on to the paper, creating the final image.

Inkjet printers are much simpler: they spray liquid ink from a nozzle directly on to paper. This helps inkjets fit in more compact chassis designs, making them better for home use.

There are a couple of sub-types of inkjet systems, but they don't vary much in terms of results. Thermal inkjets force droplets out of the nozzle by boiling the ink and producing air bubbles, while piezo (or piezoelectric) inkjets electrically charge a crystal or ceramic piece, which flexes until it applies enough pressure to push ink out of the nozzle.

PAPER RACE

We're mainly interested in testing out printing performance – both speed and quality – but since most of the printers here are MFPs, we'll be looking at scanning performance, too.

Our tests aim to imitate a range of typical high-demand printing and scanning tasks. For example, our first test involves printing 25 copies of the same text-only letter, to see how efficiently a printer can churn out long documents. We also run a similar test using pages of mixed graphics, as well as printing and scanning some large images.

We'll describe general print quality in each review, as well as how long each test took to complete in either pages per minute (ppm) or images per minute (ipm). Manufacturers will sometimes give their official ppm figures, but the results given in each review (and in the specs table on page 82) are what you can more realistically expect.

FLIPPING GOOD

If you're expecting to print or scan in large quantities, there are two features to watch out for. One is duplex, or double-sided, printing. This allows a printer or MFP to print on both sides of a single sheet of paper, which slows down the process compared to simplex (single-sided) printing but can significantly save on the amount of a paper you need to go through for multipage documents. Some MFPs can even offer duplex scanning, which – as you can probably guess – means both sides of a sheet are scanned in a single job.

For even greater ease of use, some models have an automatic document feeder (ADF). This is rarer and more expensive to attain than duplex printing capability, but can be very helpful: it's a tray into which you can place a handful of documents or images, which will automatically be sucked in for scanning or copying. It's far less cumbersome than having to stand over a single-tray scanner, going through each page one by one.

REDUCE, REUSE, REFILL

We've already touched on running costs, the amount you'll have to pay for replacement ink cartridges or bottles. The golden rule is that the more often you print, the more importance you should place on finding a printer with low ink or toner replacement costs.

This sounds self-evident, but consider the reverse scenario. If you only print, say, a couple of pages a month, it's more economical to buy a cheap printer with high running costs than an expensive printer with low running costs. Otherwise, it could take decades – long beyond the device's feasible lifespan – for the savings to make up for the initial outlay.

Conversely, say you work in a home office and print 500 pages a month: if you bought the Epson EcoTank ET-M3180, which costs £406 but only 0.2p per page to print, you'd spend a mere £12 per year on ink. If, however, you bought the Xerox B215 – which is cheaper at £199 but costs 2.5p per page to print – you'd spend £150 per year. The money you'd have saved on the B215's initial purchase would be wiped out in less than two years.

THE DIRECT APPROACH

Most printers will offer a variety of connection interfaces, which can be useful even if you're going to position it close to your PC. Wi-Fi connectivity allows you to print from anywhere, which is especially handy for laptop users. Wi-Fi, Bluetooth and NFC also enable printing from a phone or tablet, while USB ports and SD card slots make it quicker to print images and documents from external storage without the need to plug them into a PC.

Just be wary that printing over networks can be slower than the trusty USB cable route, especially if you're using Bluetooth or if your Wi-Fi simply isn't very good.

THE BEST PRINTERS FOR...

HOME INKJET

CANON Pixma TS205

The Canon Pixma TS205 is slow, loud, lacking a scanner and not particularly cheap to run. This doesn't sound like a recipe for a successful printer, but for just £29, the normal rules don't quite apply.

Even if it does trundle along at a relaxed pace, print quality exceeds expectations set by this rock-bottom price, and because it's quite frugal with its ink usage, you won't have to buy replacement cartridges so often. If you only need something to print the occasional document, it's an attractive alternative to more fully loaded MFPs.



CREATIVE INKJET

CANON Pixma TS6250

Further up the range is the Canon Pixma TS6250, which is much better for printing and scanning photos and artwork. It cleverly uses different types of black ink according to whether you're using plain or photo paper, and colour and contrast are generally high quality.

It's missing one or two premium features, such as an ADF for its scanner, but nevertheless this is a very capable MFP for its price.



OFFICE MONO

EPSON EcoTank ET-M3180

There are a couple of decent laser MFPs in competition, but the inkjet Epson EcoTank ET-M3180 beats them at their own game. Fast and almost unbelievably cheap to run, the EcoTank ET-M3180 is the new mono MFP to beat.

A big part of its appeal is the EcoTank system itself. Instead of replaceable cartridges, ink is contained within large tanks that can print thousands of pages before needing a top-up from bottled refills. For high-volume work, it's perfect.



BROTHER

MFC-J491DW



£91 • From www.printerbase.co.uk

VERDICT

If you're after an inkjet MFP for the home office, Brother's MFC-J491DW doesn't quite hit the mark

BROTHER'S MFC-J491DW IS an inkjet MFP primarily aimed at home office use, so there's Wi-Fi, duplex printing, a fax modem, and a 20-sheet automatic document feeder for unattended faxes, scans and copies. As a fairly lowly model, the MFC-J491DW is keenly priced. It does without a touchscreen, but its button-controlled menu is straightforward.

Brother appears to have cut down on the orange plastic that once protected its ink cartridges, but it's yet to introduce physical keying to prevent you inserting them in the wrong slot. There's a seven-minute thumb twiddle while the printer primes its ink system; you can't join a wireless network first, so you can't use that time to install software. During the installation there's a 360MB download of the Brother iPrint&Scan software utility, but you can defer it.

SLOW AND UNSTEADY

The MFC-J491DW suffers from the same clattery paper tray we've seen on other



Although this MFP has some strengths, it's not great, and it's not helped by running costs of about 10.3p per A4 page of text and graphics

Brother inkjets, but otherwise it sounds quiet and refined. In part, that's down to its modest print speeds: we timed black text at a gentle 10.9ppm. This is a very slow printer in colour, with our graphics test inching out at just 2.6ppm, and each borderless 6x4in photo needing more than three-and-a-half minutes. At 1.8 colour images per minute, duplex printing was also glacial, but at least it's good to have the feature.

Unfortunately, the MFC-J491DW isn't spending the extra time on high print quality. Black text was perfectly fine, but colour graphics looked washed out on plain paper, and photos tended to look a little drab, although skin tones were a welcome exception. It's a similar story for photocopies: a mono print took 17 seconds and preserved plenty of detail from the original, whereas a colour page needed 32 seconds and looked rather murky. Duplex prints were fainter than single-sided ones, yet there was still a little bit of image bleed through our thin test paper.

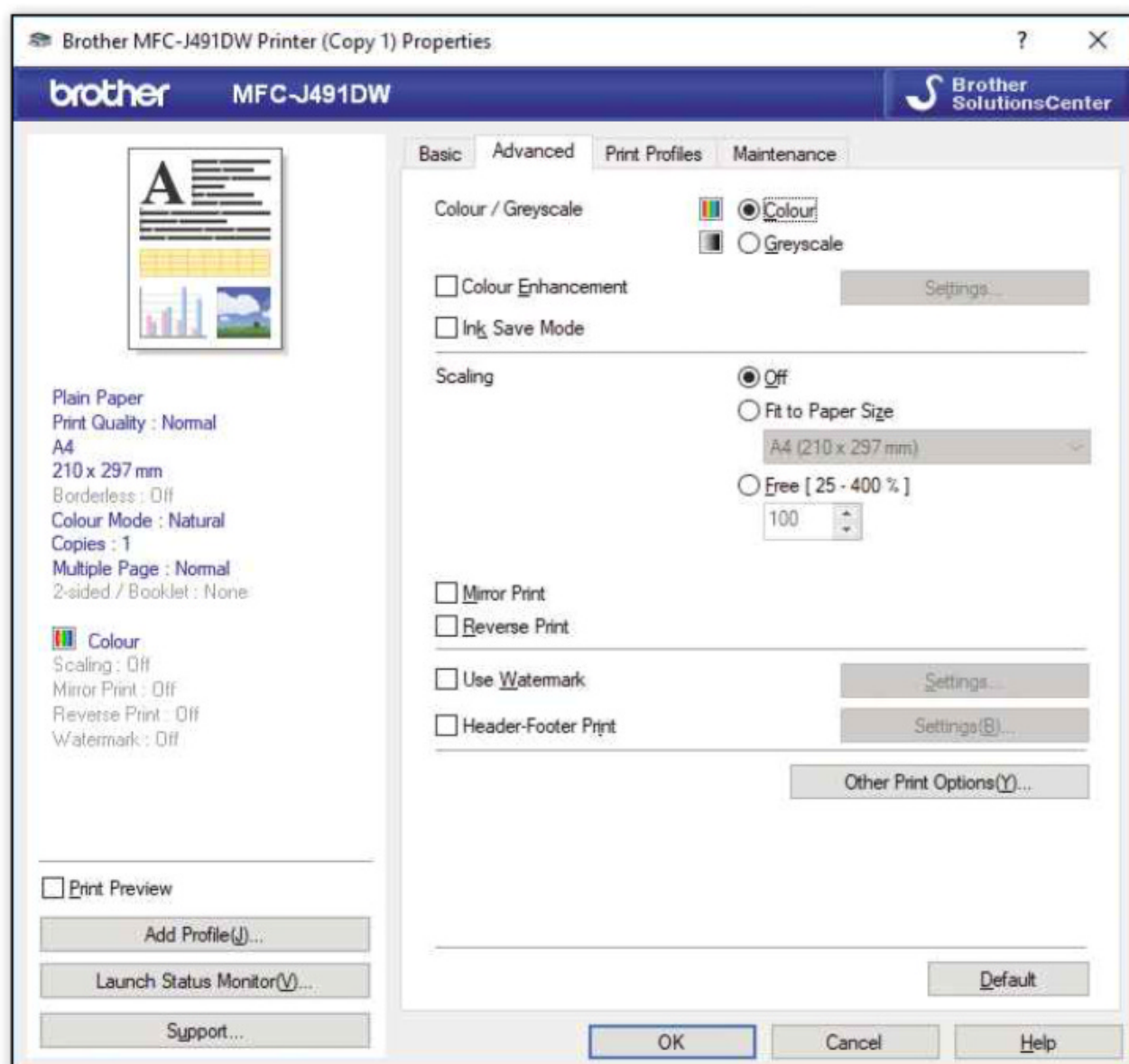
COLOUR BLIND

The MFC-J491DW does get a shift on when it comes to scanning. With a line-of-sight connection to our router, it managed to preview an A4 document in just eight seconds, and capture it at 150dpi in nine seconds. Scanning a 6x4in photo at 600dpi took just 19 seconds, and even at 1,200dpi it was under a minute.

Again, however, the results weren't great. Focus was fine, but our test photo picked up a slight aqua tint, while the scanner struggled to preserve differences among the darkest shades in various originals. The end result was adequate for archiving, but not up to more creative needs.

Although this MFP has some strengths – it's notably easy to use, both directly and from a PC – it's not great, and it's not helped by running costs of about 10.3p per A4 page of text and graphics. The MFC-J491DW joins something of a trend for high black ink costs of late: the black ink alone accounts for 3.6p of the above figure.

For a capable MFP around the £100 mark, the Canon Pixma TS6250 is a much better bet. There's no automatic document feeder, but it's both faster than the MFC-J491DW and cheaper to run.



↑ It may be slow and expensive to run, but at least the MFC-J491DW is easy to use

BROTHER
MFC-J5945DW



£277 • From www.printerland.co.uk

VERDICT

Brother's MFC-J5945DW is a fast and economical choice for A3 printing

IT'S NO SECRET that inkjets have been slowly replacing laser printers in small and home offices, and Brother's MFC-J5945DW shows why. This MFP can print, scan, copy or fax one- or two-sided A4 pages. It can also print single-sided A3 pages, though not A3+. It has two 250-sheet input trays in the base and a 100-sheet multipurpose feed at the back, all of which support A3. There's also a 50-sheet A4 automatic document feeder on top.

The MFC-J5945DW supports wired and wireless networks, and is controlled via a colour touchscreen. It's an easy printer to install and use, but setting up involves a nine-minute wait for ink priming, and a 300MB download of the iPrint&Scan software.

MESSY BUSINESS

The MFC-J5945DW's A3 capability is welcome, but it's not perfectly executed. The main paper trays need to be extended to accept A3, but if you only expand the bottom one then its paper becomes partially exposed to dust. You need to extend the output tray fully to



receive A3 pages, but leave it there and A4 prints get untidy, and can occasionally overrun the stop. Having two output positions, manually selected, partially undermines the benefit of such flexible paper inputs.

On the plus side, this is an impressively fast inkjet, printing black text at 20ppm, colour graphics at 10.2ppm, and managing a heady 5.0ipm when duplex-printing colour graphics. Each A3 page of black text took about 10

seconds, and a page of rich colour graphics completed in 16 seconds. Connected via Ethernet, all but one of our scan tests took 10 seconds or less, and even scanning our postcard photo at 1,200dpi took just 25 seconds. This MFP can multitask, too, scanning to one PC while printing from another.

We've seen better scan results than those from the MFC-J5945DW, but while photos were too dark and suffered a slight aqua tint – similarly to the Brother MFC-J491DW – documents were more than adequate for office purposes. The ADF can scan both sides in a single pass, so duplex scans and copies are fast, and come with less chance of a paper jam; this is a good device for archiving lots of paperwork. Print quality is generally good, with impressive black text in particular. Photocopies were a little dingy, but acceptable for most uses, while photos aren't really this printer's forte.

The MFC-J5945DW's results may be closer to decent than spectacular, but running costs are impressively low: we calculated that an A4 page of mixed colour images and text will set you back 3.7p, which is relatively cheap.

SHEET CRED

None of the other nine printers here has the same combination of A3 functionality, speed and affordability, but unfortunately for the MFC-J5945DW it's not lacking for competition in the grander scheme. Epson's WorkForce WF-7710DWF (*Shopper 369*) generally has it matched or beaten for quality: it also supports A3+ prints, A3 scans, and duplex A3 prints and copies, yet it costs nearly £140 less.

For quality and flexibility, we'd choose either the WorkForce WF-7710DWF or its two-tray variant, the WF-7720DTWF. Brother's MFC-J5945DW is a good effort, but we'd really only prefer it where its high speed and low running costs are more important.



▲ The MFC-J5945DW is an easy printer to use, once you've downloaded Brother's iPrint & Scan software

CANON Pixma TS205

COMPUTER SHOPPER **RECOMMENDED** ★★★★★ **£29 • From www.ebuyer.com**

VERDICT

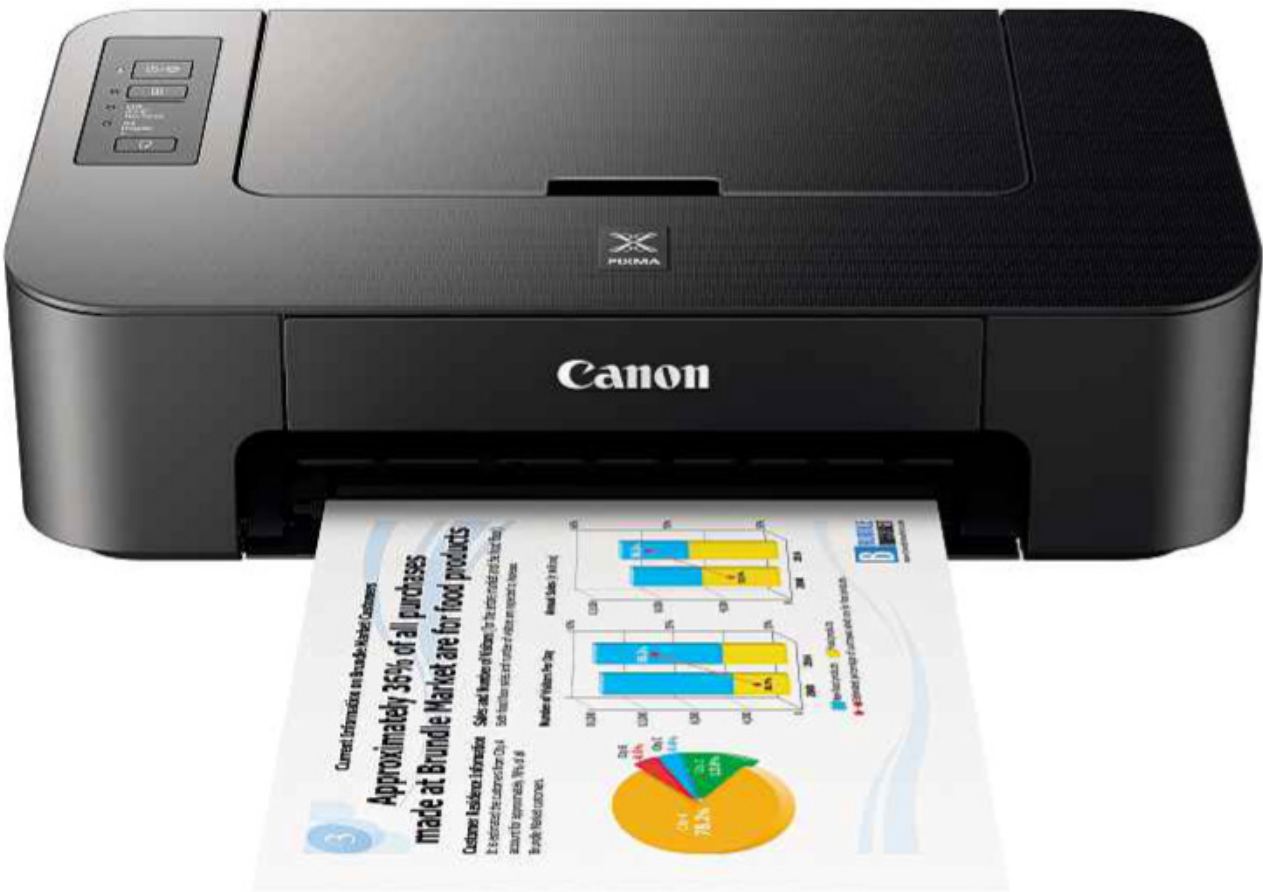
It may be basic and slow, but if you're after a cheap printer, the Pixma TS205 is a bargain

YOU MIGHT NOT expect much from an inkjet printer that costs less than some cartridges, but don't be too quick to write off Canon's Pixma TS205. There's no denying it's basic; it's easier to mention that it has a USB port than to detail the lack of networking, scanner, display, duplex printing or other features.

Still, it's under £30, and if you're realistic with your expectations the TS205 is unlikely to disappoint. It's very light, and there's a flexible and approximate feel both to its trays and covers and the way the print cartridges slot into place. The paper input and output trays are basic, and there's no lip at the end of the latter, so pages can begin to overspill by the end of longer print jobs. Without network access, there's no scope for cloud services or printing from a mobile device. There's also no memory card slot, so if you want to print photos, you'll need to do it via a PC.

DIN FOR A PENNY

Start printing and you're struck by two simultaneous realisations: that the TS205 is a slow printer, and that despite this, it's



Print quality is quite good. On plain paper it's a match for most mid-range inkjets, with sharp text and bold graphics

rather noisy. Its paper feed mechanism clatters away, while the print heads move across the page with wheezy monotony. It managed a peak of 7.5ppm on our 25-page mono letter test, and dropped to just 1.6ppm when printing complex colour graphics. On 6x4in photo paper, each print took around two-and-a-half minutes.

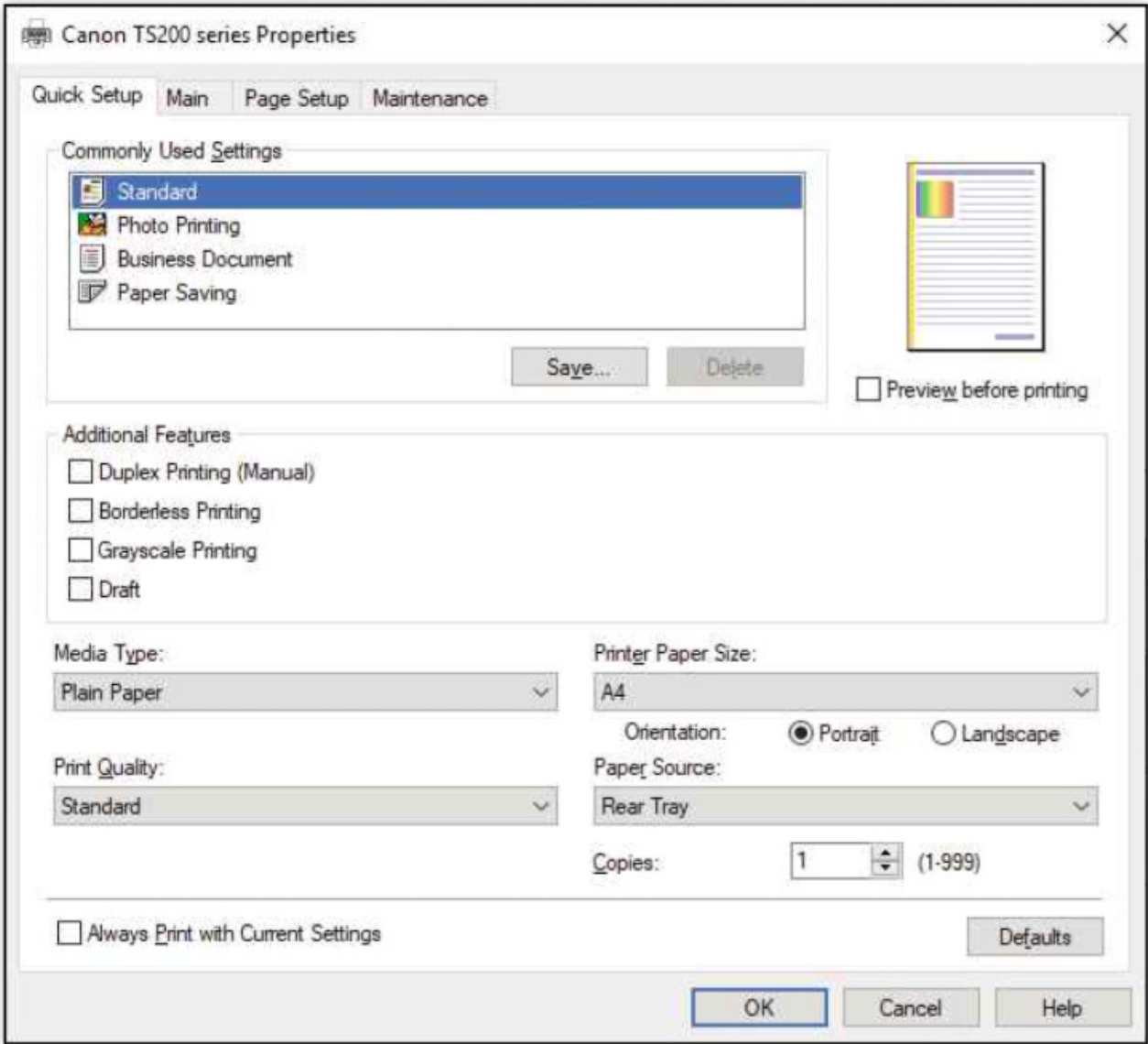
Print quality is quite good, however. On plain paper it's a match for most mid-range inkjets, with sharp black text, and bold, streak-free graphics. Photo prints had a warm colour bias, which can work well on skin tones but won't be to everyone's taste. Although photos didn't match the detail levels of the best printers, they were more than good enough for occasional prints.

The TS205 comes with standard cartridges good for 180 pages in black or colour. To Canon's credit, the printer wasn't even running low on ink after our standard tests, which on a single-function printer amount to about 80 pages of text and graphics plus six borderless 6x4in photos; we've seen more expensive printers exhaust their ink before we've finished. That said, usually our tests also include at least three A4 photos, but the TS205 doesn't support printing on A4 photo paper. Annoyingly, it will nonetheless let you configure and send the job, which then produces an error.

EXTRA, EXTRA

After the supplied cartridges are exhausted, you can buy XL black cartridges rated at 400 pages, and XL colour items rated at 300. Using these, running costs are 9.2p per mixed black and colour page – hardly cheap, but surprisingly reasonable given the low cost of the printer. Less reasonable is the fact that the black component is 3.9p per page, which is about as high as it gets.

The Pixma TS205 is strictly frill-free, but for less than £30 it can turn out great results without ridiculous running costs. If you won't print lots of black text, don't mind a bit of noise, and can live with slow results, it's easy to recommend.



▲ The TS205's print options are limited, but that's hardly a surprise given the printer's rock-bottom price

CANON Pixma TS6250

COMPUTER SHOPPER ★★★★★
BEST BUY £100 • From www.printernet.co.uk

VERDICT
A smart yet straightforward MFP for home use – and it’s not too expensive, either

THE PIXMA TS6250 is a mid-range model from Canon’s latest line-up of home inkjet multifunction peripherals. Like the rest of the range, it’s compact and smart, and wouldn’t look out of place next to a stack of considerably more expensive audio-visual kit. It comes in two colours: the black TS6250 pictured here, and the white TS6251.

This MFP is aimed at home users, with a bias towards creative tasks. While there’s no fax modem or automatic document feeder for multipage copies, you can connect and share it over a wireless network, working easily from PCs and mobile devices, and even printing from or scanning to the cloud. In the base, plain paper is stored in a 100-sheet cassette, while you can keep photo paper and other media stocked in a second tray at the rear; just remember to push the guide rollers down after you’ve loaded it.

SCRATCH THAT
The TS6250 isn’t the quietest inkjet in use, with printing characterised by a slight scraping noise as the heads move over the



This is a strong MFP for the home, particularly if you’re mostly interested in creative work

page. At 12.7ppm, its text printing is fast enough, but lags slightly behind the best in class. It’s a similar story for colour graphical prints, which worked out to 3.9ppm, and for our two 10x8in photos, which took nearly 11 minutes. However, at only around 40 seconds each, borderless 6x4in photos were very fast.

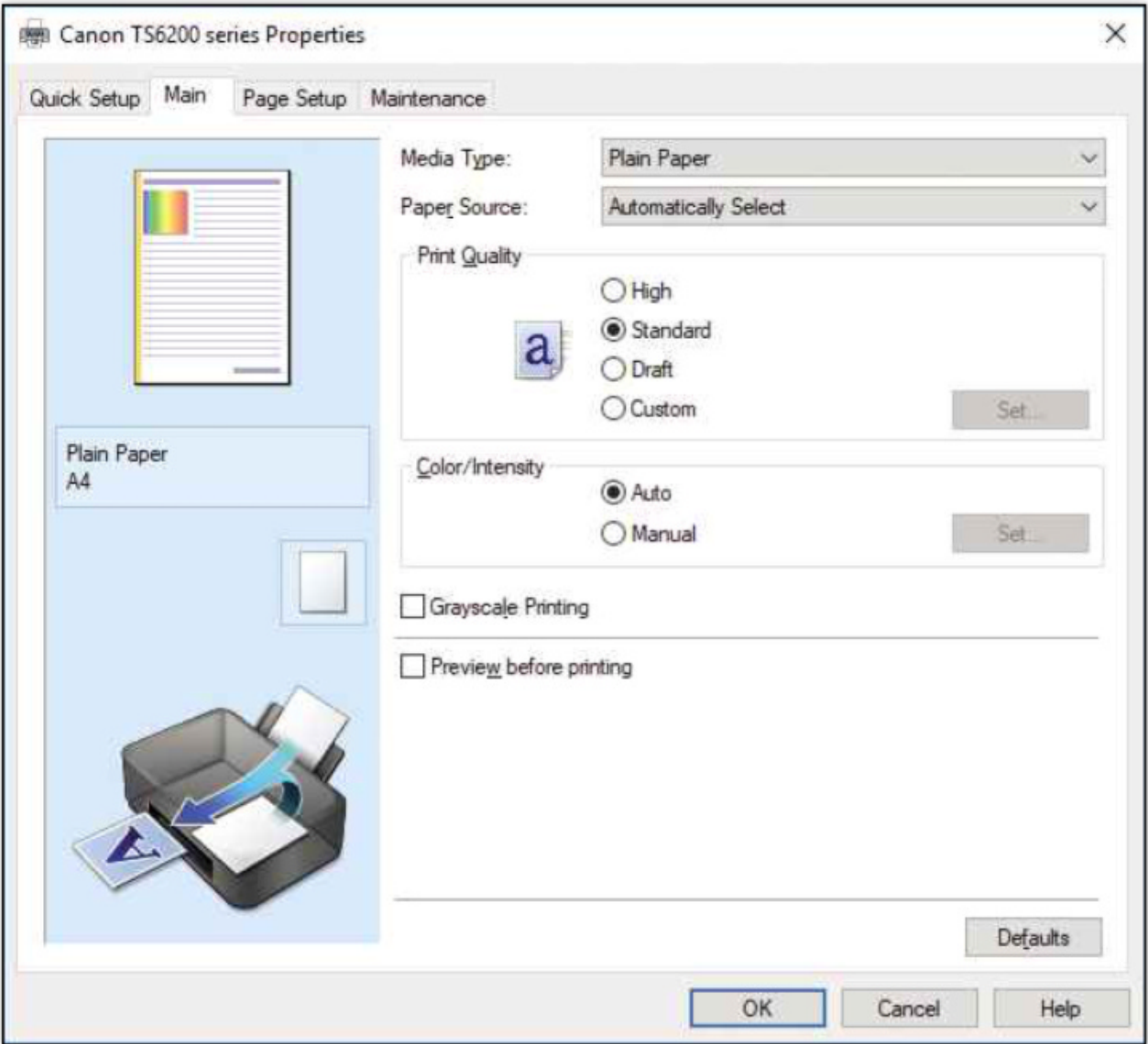
Tested over a short range, line-of-sight wireless connection, scans were swift at slow

resolutions, but slower at 600dpi and above. Our 1,200dpi 6x4in photo scan took 1m 40s, around twice the time of some competitors. Photocopies were quick enough, a single A4 page needing 12 seconds in black and white, and 22 seconds in colour.

As we’ve come to expect from most Pixma devices, the results were very good. Scans preserved the full range of detail in light and dark areas, and were sharply focused with accurate colours. On plain paper, text was bold and crisp, and graphics were punchy with strong colours. As with many inkjets, this was less the case with duplex prints, where the TS6250 uses less ink to reduce bleed-through, and to prevent ink smearing as the paper is flipped over and re-fed. On coated paper, photos were generally impressive, but we noted a little grain and some subtle blotchiness in the blue sky of one test subject.

DOUBLE DARK
The TS6250 uses a five-colour setup, combining dye-based black, cyan, magenta and yellow inks with an additional pigment black. The latter is used only on plain paper, while the dye black is used only for photos. Calculated for the largest XXL size ink tanks, running costs are perhaps slightly higher than ideal, at 8.7p per colour A4 page of text and graphics. The black component of this is a considerable 2.9p.

Overall, this is a strong MFP for the home, particularly if you’re mostly interested in creative work such as scanning and printing photos. It’s fairly well specified, costs only a few pounds more than the similar Brother MFC-J491DW, and produces strong results. With the caveat that it’s a little pricey to run and isn’t especially fast, we’re still happy to recommend it.



▲ The Pixma TS6250 lacks an ADF for scanning, but duplex printing helps with multipage documents

EPSON EcoTank ET-M2140

★★★★☆

£310 • From www.printerbase.co.uk

VERDICT

Epson has built an inkjet to beat cheap mono laser MFPs, but it's lacking some key features

EPSON'S ECOTANK INKJET printers ditch cartridges in favour of refillable ink tanks, reducing hassle and plastic waste while dramatically cutting running costs. Until recently the range included only home devices, but the ET-M2140 is one of three models introduced earlier this year that target small businesses and home offices. Mono only, it's ready to pick a fight with entry-level mono laser MFPs, while the ET-M1100 (USB-only) and ET-M1120 (USB and Wi-Fi) are gunning for single-function mono laser printers.

At this price you might expect a few bells and whistles, but the ET-M2140 is surprisingly basic. There's a 250-sheet paper input tray, and it can duplex-print on both sides of a page, but there's no automatic document feeder, so multipage copies can be a pain. There's no fax modem or network connection, just USB, and there's no port at the front for walk-up prints or scans. The basic control panel comprises a colour screen and clicky membrane buttons. This is smart and uncluttered, but at first the menu functions take some second guessing.

GOT THE BOTTLE

Even allowing for the initial 10-minute priming, Epson says the supplied ink will last around 11,000 pages; you'd be lucky to get 2,000 in the box with an equivalent laser. Replacement ink bottles are rated for 6,000 pages and cost just £12, so ongoing costs are a paltry 0.2p per page, which is roughly a quarter of what we'd expect from the best mono lasers, and more than 15 times cheaper than the worst.

The ET-M2140 is an adequate scanner, capturing an A4 page in 11 seconds at 150dpi, or 26 seconds at 300dpi. It reached 20ppm when printing our 25-page text test, and 15.2ppm with complex greyscale graphics – more than a match for cheap mono lasers. Its duplex speed of 7.5ipm isn't



stellar, but it's good to have the feature regardless. Unfortunately, we found it tricky to retrieve printed pages from this MFP's back-to-front output tray.

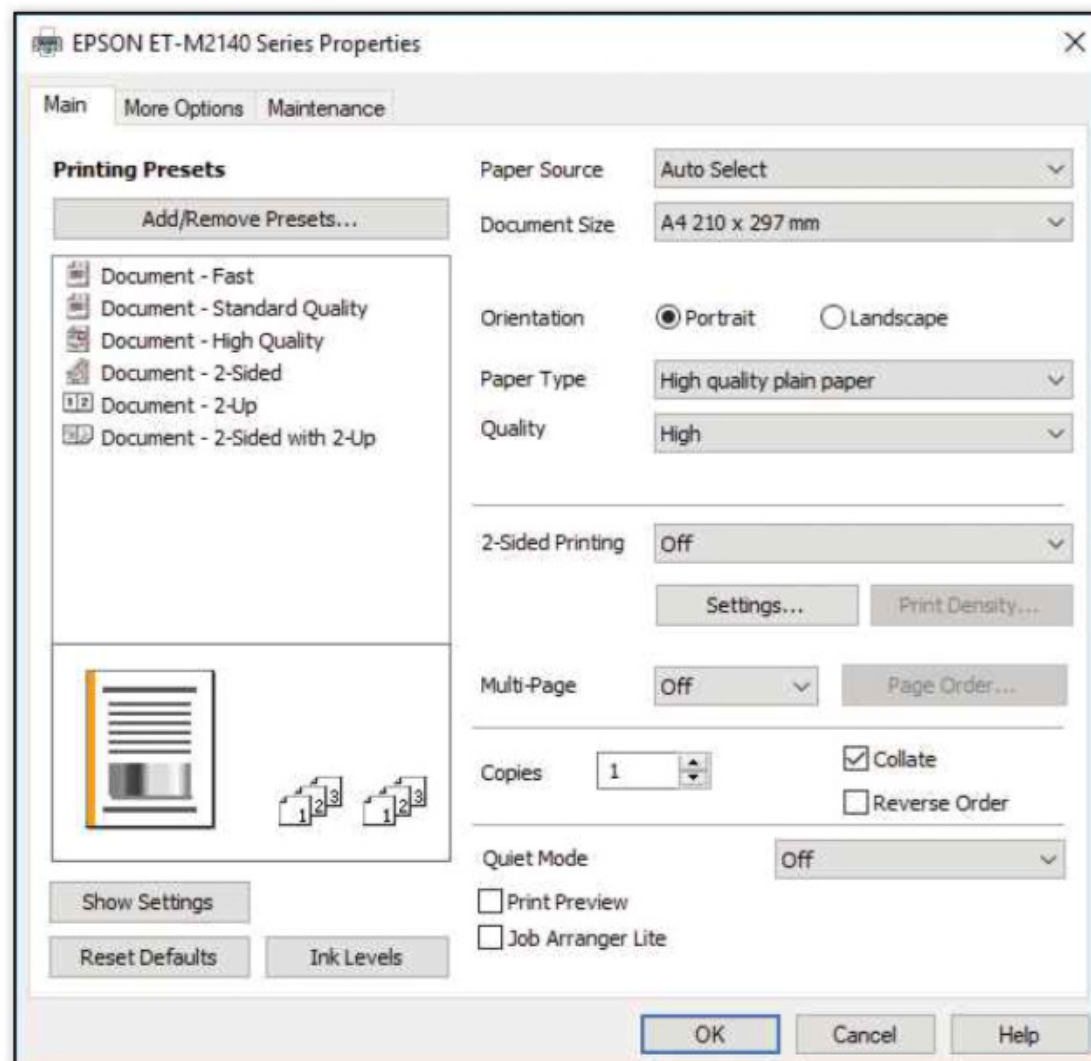
Other than black text, mono laser printers don't usually set a high bar for print quality. The ET-M2140 arguably produced better graphics and photos; certainly they were free of banding and other artefacts.

Black text is crisp right down to tiny font sizes, but most laser printers would win here. Scans and photocopies are more than good enough for office work.

FAMILY FEUD

All in all, the EcoTank ET-M2140 genuinely competes with cheap mono laser printers for speed and quality, and it trounces any laser when it comes to running costs. Many might blanch at its huge premium over true competitors such as HP's LaserJet Pro M28w, but if you bought that particular MFP and spent the change from Epson's asking price on toner, you'd still run out at around 10,000 pages. The ET-M2140, remember, has the capacity for 11,000 already in the box.

However, we still think the ET-M2140 is too basic to be a truly great professional printer. For this, it really needs a network interface, an automatic document feeder, and ideally a fax modem too; all three can be found in the EcoTank ET-M3180, which also launched earlier in 2019. This is more expensive, by £96, but is worth the additional expense thanks to its productivity-minded features, and it's still about as fast and cheap to run as the ET-M2140.



↑ Even with a straightforward interface, the EcoTank ET-M2140 would blast through copies much quicker if it had an ADF

EPSON EcoTank
ET-M3180

COMPUTER SHOPPER
RECOMMENDED ★★★★★
£406 • From www.printerland.co.uk

VERDICT

If you want the benefits of a mono laser MFP, Epson's EcoTank ET-M3180 is a good pick

THE EPSON ECOTANK ET-M3180 is the latest model in a range of inkjet devices designed to compete with entry-level mono lasers in small and home offices: a range that also includes the EcoTank ET-M2140. As we've just seen, that MFP's strengths were diluted by the lack of essential office features, such as an automatic document feeder, network interface and fax modem. The ET-M3180 has them all, so does that make it strong all round?

EFFICIENCY SAVINGS

While a competing laser device might cost less than a third as much to buy as the ET-M3180, its higher running costs would soon leave you worse off overall. This MFP's sole ink tank is refilled without fuss from high-capacity bottles of black ink. There are two 120ml bottles included, which Epson says will last for about 11,000 pages – at least four times as many as you'd get from the startup toner of a competing mono laser. Once the bundled ink is gone, replacement bottles work out at less than 0.2p per page, far cheaper than the 2-3p per page typical of cheap lasers.

Like most inkjets, you can't set up the M3180's wireless network connection until it's finished priming its ink system – a frustrating waste of 10 minutes that could otherwise be spent installing software. The same problem doesn't apply to USB and wired Ethernet connections, at least.

Once installed, it's clear that this is a serious alternative to entry-level mono lasers. It could produce a first page of black text from standby in just nine seconds, before going on to hit almost 20ppm over our 25-page text test. Mono graphics printing was also quite speedy, reaching 14.8ppm over 24 pages, but at 7.3ipm, duplex graphical prints were slower than most lasers. The same could be said for multipage photocopies, with a 10-page copy taking nearly two-and-a-half minutes. Sadly, the ADF doesn't support duplex scanning, so automatic double-sided photocopies and faxes aren't possible.



While the quality of scans is up to Epson's usual high standards, scan speeds are comparatively slow. There's not much wrong with a preview time of 11 seconds, but taking nearly 30 seconds to scan an A4 page at low or medium resolutions isn't particularly impressive. We wondered if the 100Mbit/s network interface was acting as a bottleneck, but scan times were unchanged over a USB connection. The speeds were all the more odd

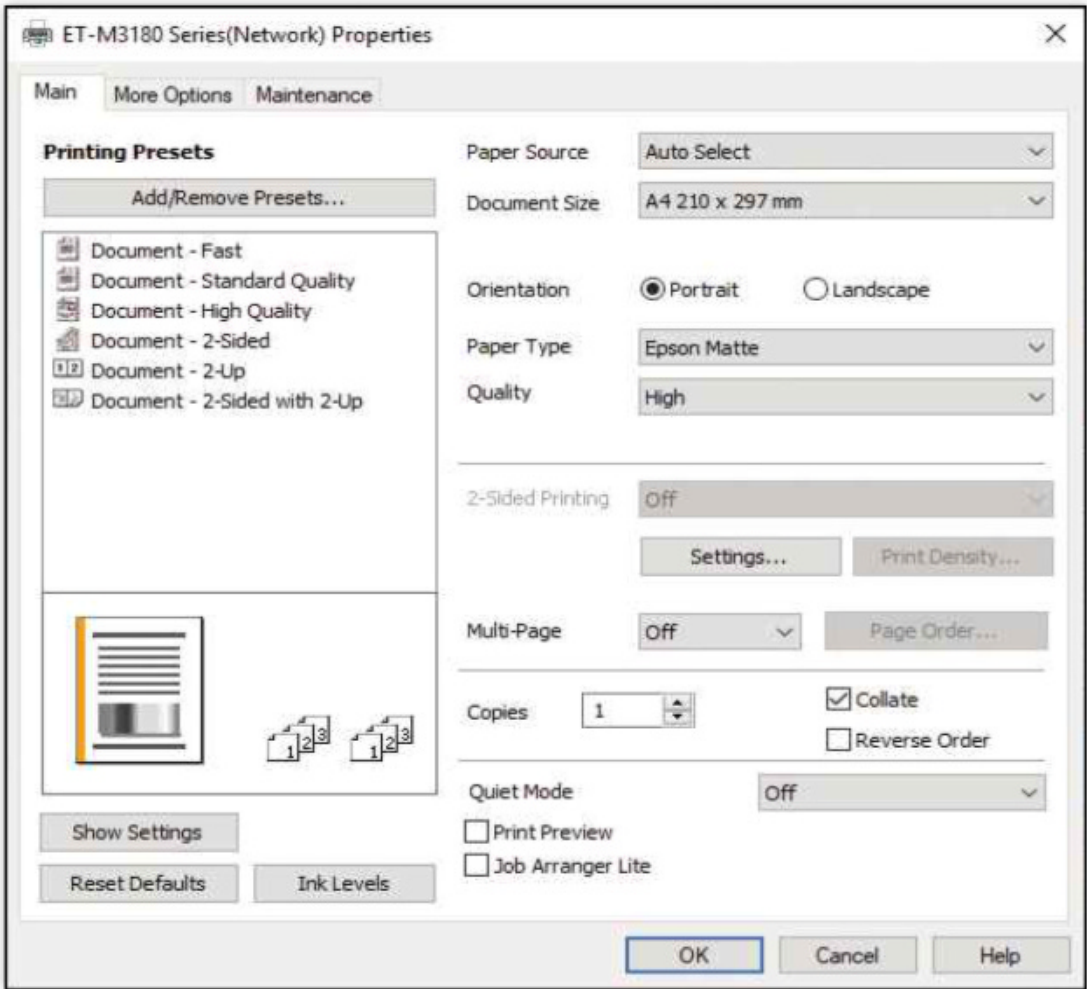
given that the cheaper ET-M2140 was fractionally faster across our print tests, and significantly more so when scanning.

FEEDING TIME

Even so, this is arguably the better printer overall, and definitely the better-featured. The addition of an ADF is particularly valuable, as this will allow you to make copies of long documents much more easily.

It doesn't have duplex printing capability, but there's still much more here than the ET-M2140.

As such, the ET-M3180 is a more sensible buy even with its higher price. It's as fast when printing as a typical entry-level mono laser, its print quality is a match in most ways, and its scans are better than we would expect from a typical laser MFP. Despite its high purchase price, it destroys competing mono laser printers when it comes to running costs, with the added bonuses of less plastic waste and lower electricity consumption. Apart from faster scanning and a duplexing ADF, the ET-M3180 has everything a home office or micro business needs from a mono MFP, and we'd choose it over any entry-level laser equivalent.



↑ You can set up single-sided prints to get going quickly, while duplexing slows things down

EPSON Expression Premium XP-6100

COMPUTER SHOPPER
RECOMMENDED

★★★★★

£100 • www.amazon.co.uk

VERDICT

Epson's XP-6100 is a brilliant MFP for creative home use, but it could be cheaper to run

THE EXPRESSION PREMIUM XP-6100 is a mid-range inkjet MFP, designed for everyday and creative use at home. It can print, scan and copy, and you can share it among users on a wireless network. There's support for automatic duplex printing, although if you want to fax you'll have to look elsewhere.

While Canon's rival Pixma TS6250 uses a touchscreen, this MFP partners a colour screen with a small group of buttons. It works well enough, and the XP-6100 has plenty of other neat features. In the base there are two trays for up to 100 pages of A4, and 20 sheets of 6x4in or 5x7in photo paper. Tidied away behind the front panels are an SD slot and a USB port for direct scans and printing.

PLAYING FROM THE BACK

The XP-6100 is rather compact. Its slight width is achieved by mounting the five ink tanks behind, rather than alongside, each other. As with the TS6250, Epson's system



Print quality was impressive across the board, with crisp black text and strong graphics

pairs a pigment black ink for plain paper work with a dye-based black for photos. Dye-based cyan, magenta and yellow are used for both. Epson sells replacements in standard or XL sizes, but even calculated for the latter, a colour A4 page costs a steep 11.2p, of which the black component is a dizzying 3.7p. Photo black isn't used on plain paper so isn't included in this figure: Epson says a £17 XL cartridge should last for 800 6x4in photos.

Expensive ink aside, it's hard to criticise the XP-6100. It's surprisingly quick, delivering black text at a nimble 15.6ppm in our test. Colour graphics reached a swift 4.4ppm, but they would have been quicker still without some pauses during the most complex pages. At less than a minute each, 6x4in photos were quick, while two 10x8in photos completed in just under 10 minutes.

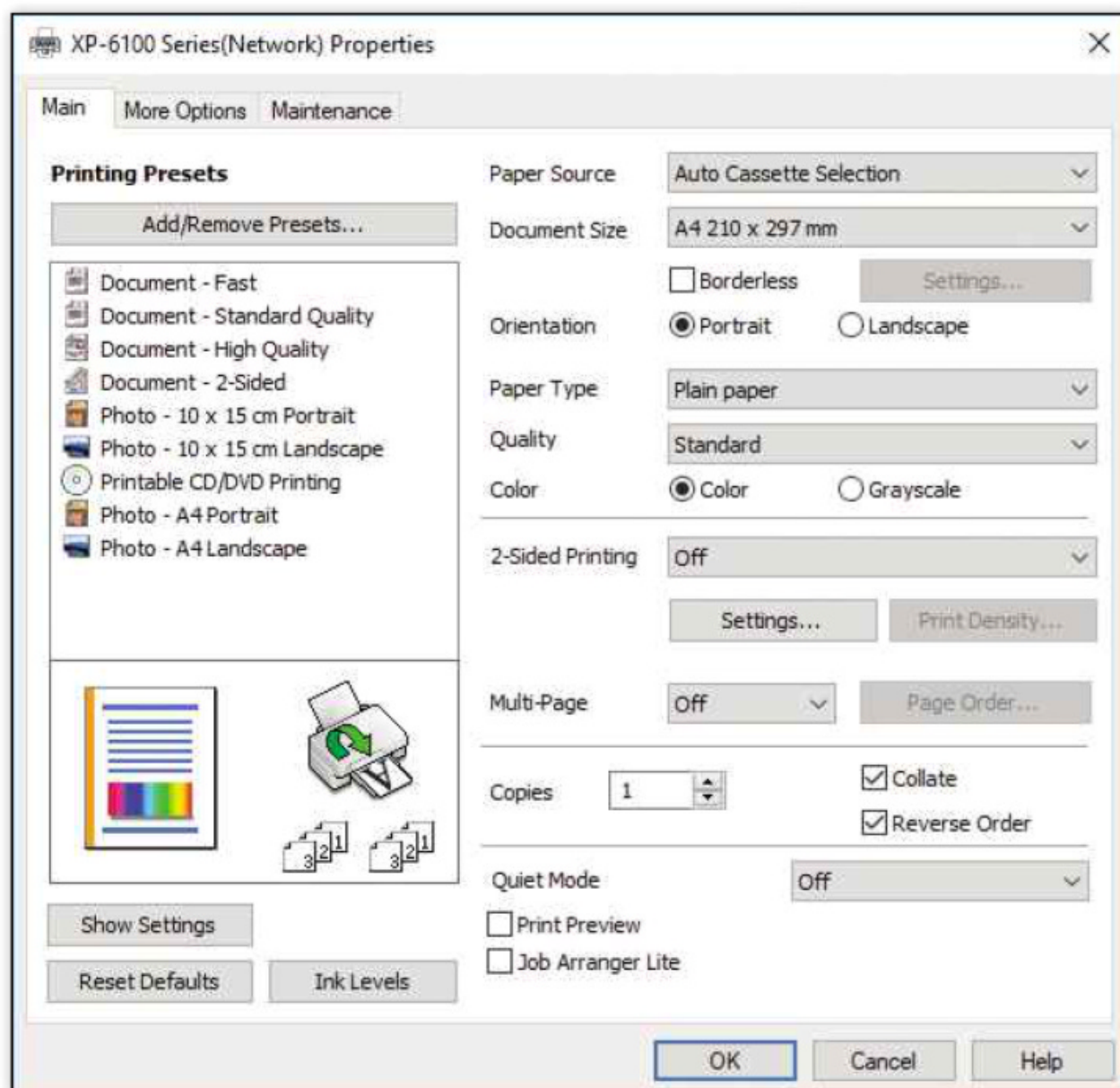
Despite testing over a wireless connection – which is often a bottleneck – scans were very fast, too. An A4, 150dpi scan completed in just seven seconds, and even our 1,200dpi 6x4in photo was done in 45 seconds. Although Epson's scan interface feels a bit businesslike, it combines a good set of features with reasonable ease of use, and produces great results.

Print quality was impressive across the board, with crisp black text and strong graphics. Duplex prints looked as bold as single-sided ones, although there was some visible bleeding through the page. This can be avoided by adjusting the ink density in the driver, or by using thicker paper than we did.

HOT COPY

Photocopies were fast, at nine seconds in black only or 19 seconds in colour, and their exposure was well judged. Photos were extremely good, with accurate colour reproduction and a wealth of detail, particularly in mid and light regions. The one disappointment was a dull, grey/brown livestock photo, which looked to have been enhanced with too much contrast, making it look far too exciting.

This is a great MFP, with all the features the typical home needs, but it's a very tight choice between it and Canon's Pixma TS6250. We'd narrowly favour the XP-6100 for its speed and quality, but the Pixma is cheaper to run and almost as good.



↑ You don't need a fancy user interface to get great-quality prints and scans

HP LaserJet Pro M28w

★★★★☆

£98 • From www.amazon.co.uk

VERDICT

HP's LaserJet Pro M28w is small and simple, but limited. We'd rather have an inkjet

IF YOUR IDEA of a laser printer is something too big, hot and noisy to share a desk with, HP's LaserJet Pro M28w might be a pleasant surprise. It's a multifunction peripheral built around a basic mono laser printer, and the end result is about as compact as a typical home office inkjet MFP. With no vents to spew hot air, and a slow-ish 18ppm print engine keeping the noise down, it's as easy to live with as laser devices get.

Politely, we'd suggest that 'Pro' is something of a misnomer for this strictly no-frills device. It has no automatic document feeder for multipage copies, no automatic double-sided printing, no fax modem, and just a basic, uncovered paper input tray. There's also no front panel USB slot for walk-up printing or scanning with a USB drive, and no fancy control panel: just a set of buttons and indicators with a rudimentary LCD screen.

GONE DOTTY

What you do get is a small mono MFP you can share via a wireless network, and with that in mind the LaserJet Pro M28w isn't bad at all.



It's fairly easy to set up, although we found that the installed print driver wouldn't process any jobs; we used the version automatically installed by Windows 10. HP's TWAIN scan interface, which we've criticised before for being oversimplified, is fine for this MFP's target market. However, while HP's website lists the maximum scan resolution as 1,200dpi – which the scanner is technically capable of – the software limits it to 600dpi. An HP rep told us the marketing materials would be

updated to reflect this, although it's still pretty strange that the scanner wouldn't be allowed to operate at its highest capabilities.

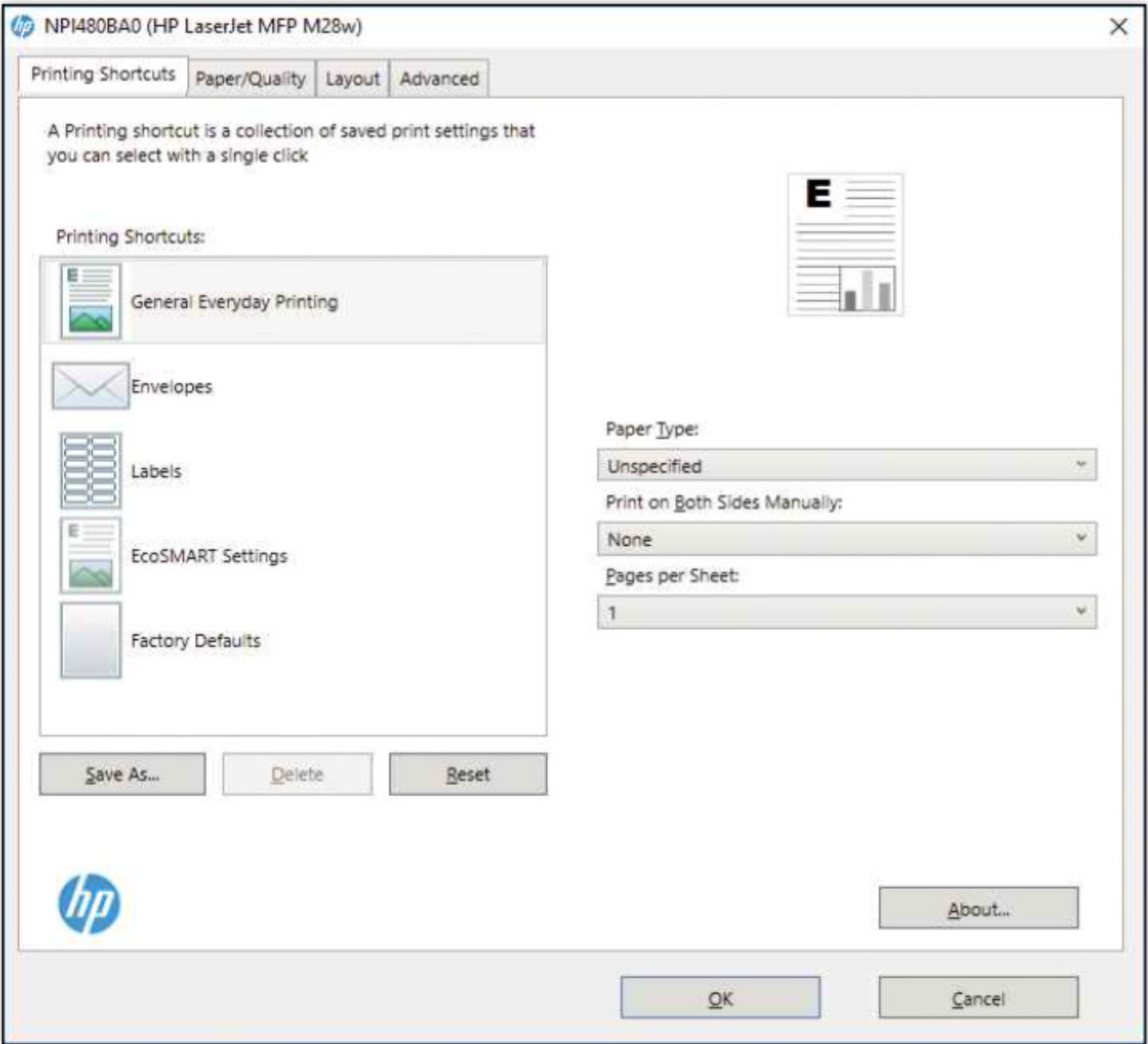
The M28w has no discernible warm-up time, so whether it's been unused for a minute or a week it can chuck out a first page of text in nine seconds. It produced 25 pages of black text at 16.7ppm, and delivered our graphics test at 7.1ppm; both quite leisurely results by laser standards. Over a wireless connection, two 10x8in images completed in 42 seconds, and three pages containing six 6x4in photos needed nearly a minute; both very slow, but acceptable for a budget device. At 11 seconds, single-page photocopies were quick.

HP's scan software only offers 200, 300 and 600dpi resolutions, so we couldn't complete all of our standard tests, but scanning an A4 page at 300dpi over Wi-Fi took a reasonable 22 seconds. At 55 seconds, scanning a 6x4in photo at 600dpi was on the slow side.

BEYOND WORDS

Quality-wise, we were generally happy with our test results. Black text was excellent, while graphics and photos were entirely free of the banding typical of a cheap laser printer. We did notice evidence of sharpening – artificially strengthening the boundaries between shades – which made photos in particular look slightly artificial. We've often applied a similar criticism to scan results from HP devices: here our photo scan seemed less artificial than others, but also not especially crisply focused.

The LaserJet Pro M28w is only equipped with a 500-page print cartridge, and replacement consumables last for only twice that. With running costs of 3.9p per page, it's hard to suggest buying this MFP, particularly given that an equivalent inkjet would be almost as fast, and would doubtless offer more features.



HP's TWAIN interface remains as simple as ever

HP OfficeJet Pro 6970



£111 • From www.amazon.co.uk

VERDICT

A mostly good home office MFP, albeit one that comes with frustrations

THE HP OFFICEJET Pro 6970 is an inkjet MFP all-in-one that prints, scans and copies. It comes with a number of smart features designed to make life in a busy home office a little bit easier.

Its home office bias is reflected in sensible features, such as a 225-sheet paper tray in the base, a 35-sheet, duplexing automatic document feeder on top, and ink supplies rated for up to 1,500 black pages, or 825 in colour. At the front is a USB port for direct printing, although this is less well suited to the demands of an office. You can only print photos from an inserted USB drive, not PDFs or other documents, which might be an acceptable compromise on a general home MFP but is a strange limitation on something more professionally focused.

STRAY TRAY

The OfficeJet Pro 6970 also seems much wider than necessary, and it's not the most user-friendly MFP. Its large paper tray is tricky to load unless you release the two blue catches near the rear and pull it free. Its lid doubles as the output tray and latches up nicely to help you reload.



This is a fast printer for the price, reaching 4.7ppm in our colour graphics test, and churning out black text at an impressive 18.5ppm

However, its two telescoping parts felt too loose and tended to stick momentarily as we extended or retracted the tray.

Still, it's not all bad news; far from it. This is a fast printer for the price, reaching 4.7ppm in our colour graphics test, and churning out black text at an impressive 18.5ppm. Copies were swift in black, with a 10-page mono job

needing just 89 seconds, but a colour version took twice as long, and a duplex colour copy inched out at 2.1ppm.

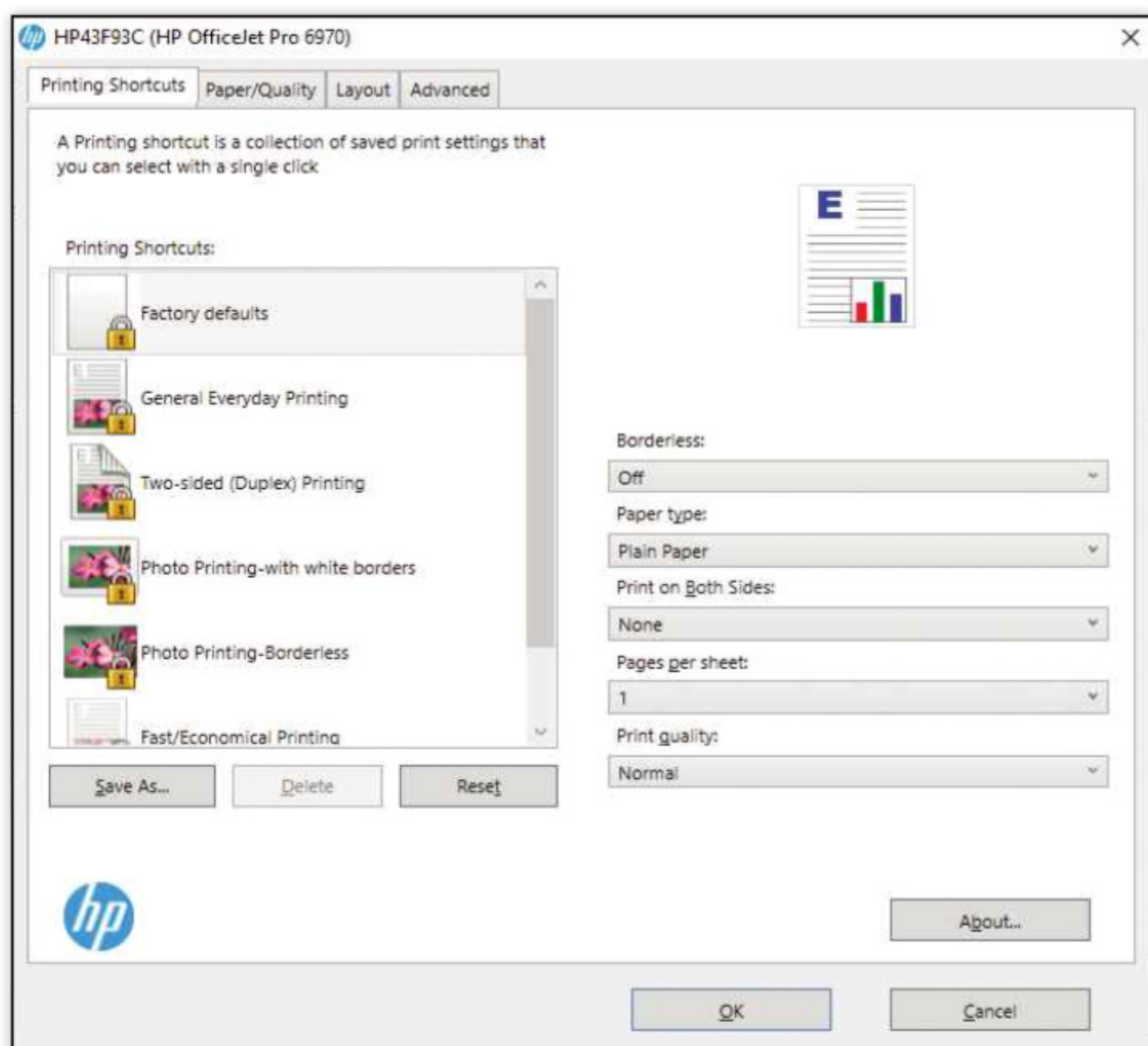
The software needs work, however. HP's scan interface is over-reliant on shortcuts and is too proscriptive, allowing only a limited set of pre-defined resolution choices. The 6970 spent nearly five minutes working on our 1,200dpi photo scan before giving up and returning no image. We reset the host PC, reinstalled HP's drivers and retried over a wired Ethernet connection, but the issue remained.

At least once we got it working, scan quality was generally good, although our 600dpi photo scan looked as though it had been overly sharpened and seemed artificial when viewed at 100%. We were also disappointed by the faint bands that appeared in some graphical prints on plain paper.

JETTING AHEAD

Colour photos were good for a non-specialist device, but our black-and-white print had a distinct green tint. Using the highest-capacity supplies, it should cost the 6970 around 6.8p to print a page of mixed text and colour graphics – a couple of pence cheaper than the Pixma TS6250, a similarly priced inkjet. The OfficeJet Pro 6970 is also a faster printer than Canon's MFP, both for black text and colour graphics.

Nevertheless, of the two we'd rather have the Pixma TS6250. It's not that the OfficeJet Pro 6970 is bad overall – it's a good-value MFP that would suit and serve generally well in a home office – but with its frustrating scan software and a design that's clunky in places, the Pixma TS6250 is just that little bit easier to live with.



↑ HP's software provides only a limited set of pre-defined resolution choices

XEROX B215



£199 • From www.printerbase.co.uk

VERDICT

The Xerox B215 is a decent mono MFP, if you don't mind its hefty running costs

THE B215 IS part of Xerox's new B200 series of mono devices for home offices and small businesses. This is the top MFP model of the bunch, distinguished by a sleek colour touchscreen and duplex printing capability. The cheaper B205 MFP has no screen and makes do with simplex (single-sided) prints, while the B210 single-function printer has duplex printing, but no scanner or display. The B215 has most of the features a small office could need. In its base there's a 250-sheet paper input with a single-sheet manual feed slot. On top there's a 40-sheet automatic document feeder for the scanner, although this can only scan one side of original documents; duplexing is only for printing. Connectivity is particularly good: you can use it with a PC via USB, wired Ethernet or Wi-Fi. As with the Epson EcoTank ET-M3180, there's also a fax modem, although the B215 goes even further by including a front-panel USB port for direct printing or scanning.

CHECK ONLINE

This MFP's uncluttered control panel and touchscreen lend it a touch of class, but the system isn't quite perfect. While there are apps to manage the main features, you can't install more as you can with some more expensive Xerox devices. There's also a surprisingly narrow range of configuration options available, mostly limited to simple network and time-out settings. For the

B215's more advanced options you'll need to delve into its web admin interface. That's also the only place where you can disable the banner pages – designed to separate multiple jobs in a busy office – which print before each job. This is the only printer we've tested where they're on by default. Banners banished, the B215 turned out to be a fast printer. Xerox claims a printing pace of up to 30ppm, and it reached 26.3ppm on our test, which includes job preparation. This

took longer on our 24-page mixed graphics job, but the printer still reached a creditable 21.8ppm. Duplex speeds were impressive, the B215 printing 10 sides on to five pages in one minute. Print quality was generally very good, with just a couple of subtle artefacts in our test presentation slides and some mild banding. Text printed with the PostScript driver was consistently perfect, but on some documents printed with the default PCL driver it wasn't fully black, making it appear jagged under magnification.

HIGH RISK

The B215 uses a simple scan interface that's easy to operate. Scanning was quick, with A4 scans at either 150 or 300dpi, each completing in just 11 seconds. We encountered problems when attempting our higher-resolution scans of a photo, however, with the TWAIN interface crashing at 600 and 1,200dpi. We switched to the supplied Easy Document Creator software, which worked fine at 600dpi but doesn't support the maximum 1,200dpi optical resolution. While a couple of scans seemed a touch overexposed, generally their quality was more than good enough for office work. Overall, the B215 is a fast MFP, producing decent results, but it's let down by high running costs of 2.5p per page. While we've seen worse, the Epson EcoTank ET-M3180 inkjet prints a page for just 0.2p, while still having comparable office credentials. The B215 is a better MFP for low and medium-volume use, but if you're likely to print more than 14,000 or so pages, the ET-M3180 will prove better value over time.



Neither the desktop software nor onboard UI are as fleshed-out as the web interface

PRINTERS



Award			RECOMMENDED	BEST BUY		
Manufacturer	BROTHER	BROTHER	CANON	CANON	EPSON	
Model	MFC-J491DW	MFC-J5945DW	Pixma TS205	Pixma TS6250	EcoTank ET-M2140	
Rating	★★★★☆	★★★★☆	★★★★★	★★★★★	★★★★☆	
HARDWARE						
Technology	Piezo inkjet	Piezo inkjet	Thermal inkjet	Thermal inkjet	Mono piezo inkjet	
Maximum print resolution	6,000x1,200dpi	4,800x1,200dpi	4,800x1,200dpi	4,800x1,200dpi	2,400x1,200dpi	
Maximum optical scan resolution (output bit depth)	1,200x2,400dpi (24-bit)	1,200x1,200dpi (24-bit)	N/A	1,200x2,400dpi (24-bit)	1,200x2,400dpi (24-bit)	
Mono print speed	10.9ppm	20.0ppm	7.5ppm	12.7ppm	20.0ppm	
Mixed colour print speed	2.6ppm	10.2ppm	1.6ppm	3.9ppm	N/A	
Number of colours (cartridges/tanks)	4 (cartridges)	4 (cartridges)	2 (cartridges)	4 (cartridges)	1 (tank)	
Maximum colours (cartridges/tanks)	4 (cartridges)	4 (cartridges)	2 (cartridges)	4 (cartridges)	1 (tank)	
Interfaces	USB, USB host, Ethernet, Wi-Fi, NFC, SD card	USB, USB host, Ethernet, Wi-Fi, NFC	USB, USB host	USB, USB host, Ethernet, Wi-Fi, Bluetooth	USB, USB host	
Dimensions	172x400x341mm	376x545x436mm	131x426x255mm	139x372x372mm	302x375x347mm	
Weight	8.3kg	20.9kg	2.5kg	6.2kg	6.2kg	
Duty cycle (maximum pages per month)	2,500	30,000	Not stated	Not stated	20,000	
PAPER HANDLING						
Maximum paper size	A4/legal	A3	A4/legal	A4/legal	A4/legal	
Maximum paper weight	80gsm	80gsm	105gsm	105gsm	256gsm	
Input trays (capacity)	2 (100 + 20)	3 (250 + 250 + 100)	1 (60)	2 (100 + 100)	1 (250)	
Automatic duplex printing	Yes	Yes	No	Yes	Yes	
FEATURES						
Borderless printing	Yes	Yes	Yes	Yes	Yes	
Direct (PC-less) printing	USB, mobile	USB, mobile	No	Mobile	No	
Memory card support	SD/SDHC/SDXC	None	None	None	None	
Supported operating systems	Windows, macOS	Windows, macOS	Windows, macOS	Windows, macOS	Windows	
Display	Colour LCD	Colour LCD touchscreen	None	Colour LCD touchscreen	Colour LCD	
BUYING INFORMATION						
Warranty	One year RTB	One year RTB	One year RTB	One year RTB	Three year RTB	
Price	£91	£277	£29	£100	£310	
Mono page cost	3.6p	0.9p	3.2p	2.9p	0.2p	
Colour page cost	6.7p	2.8p	5.2p	5.8p	N/A	
Supplier	www.printerbase.co.uk	www.printerland.co.uk	www.ebuyer.com	www.printernet.co.uk	www.printerbase.co.uk	
Details	www.brother.co.uk	www.brother.co.uk	www.canon.co.uk	www.canon.co.uk	www.epson.co.uk	
Part code	MFCJ491DWZU	MFCJ5945DWZU1	2319C008	2986C008	C11CG27402BY	

Prices correct at time of going to press

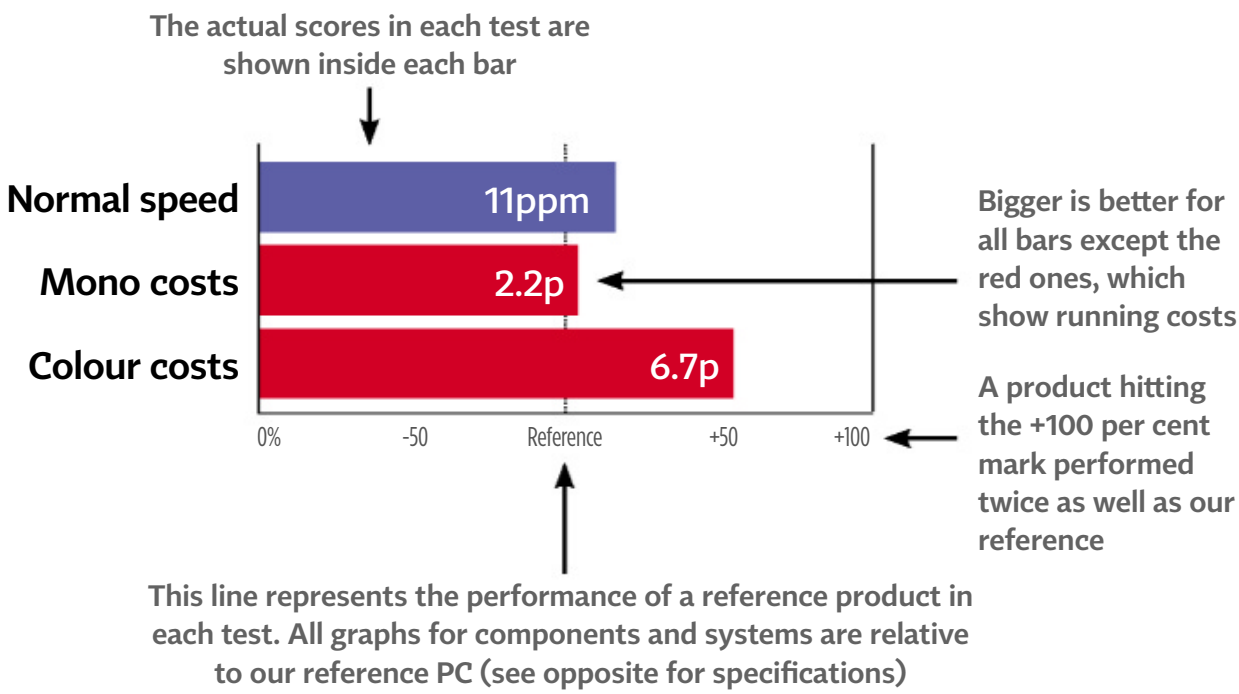
				
RECOMMENDED	RECOMMENDED			
EPSON	EPSON	HP	HP	XEROX
EcoTank ET-M3180	Expression Premium XP-6100	LaserJet Pro M28w	OfficeJet Pro 6970	B215
★★★★★★	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Mono piezo inkjet	Piezo inkjet	Mono laser	Piezo inkjet	Mono laser
2,400x1,200dpi	5,760x1,440dpi	600x600dpi	1,200x600dpi	600x600dpi
1,200x2,400dpi (24-bit)	1,200x4,800dpi (24-bit)	1,200x1,200dpi (24-bit)	1,200x1,200dpi (24-bit)	1,200x1,200dpi (24-bit)
19.7ppm	15.6ppm	16.7ppm	18.5ppm	26.3ppm
N/A	4.4ppm	N/A	4.7ppm	N/A
1 (tank)	5 (tanks)	1 (cartridge)	4 (cartridges)	1 (cartridge)
1 (tank)	5 (tanks)	1 (cartridge)	4 (cartridges)	1 (cartridge)
USB, USB host, Ethernet, Wi-Fi, Bluetooth	USB, USB host, Wi-Fi, SD card	USB, USB host, Wi-Fi	USB, USB host, Ethernet, Wi-Fi	USB, USB host, Ethernet, Wi-Fi
375x347x346mm	142x349x340mm	197x360x264mm	390x464x229mm	365x401x387mm
7.2kg	6.6kg	5.4kg	8.1kg	11.5kg
20,000	Not stated	8,000	20,000	30,000
A4/legal	A4/legal	A4/legal	A4/legal	A4/legal
256gsm	75gsm	120gsm	280gsm	215gsm
1 (250)	2 (100 + 20)	1 (150)	1 (225)	1 (250)
Yes	Yes	No	Yes	Yes
Yes	Yes	No	Yes	Yes
Mobile	USB, mobile	USB, mobile	USB, mobile	USB, mobile
None	SD/SDHC/SDXC	None	None	None
Windows, macOS	Windows, macOS	Windows, macOS	Windows, macOS	Windows, macOS, Linux, Ubuntu, Debian, Fedora
Colour LCD touchscreen	Colour LCD	Mono LCD	Colour LCD touchscreen	Colour LCD touchscreen
Three years onsite	One year RTB	One year RTB	One year RTB	One year replacement
£406	£100	£98	£111	£199
0.2p	3.7p	3.9p	2.2p	2.5p
N/A	7.5p	N/A	4.6p	N/A
www.printerland.co.uk	www.amazon.co.uk	www.amazon.co.uk	www.amazon.co.uk	www.printerbase.co.uk
www.epson.co.uk	www.epson.co.uk	www.hp.co.uk	www.hp.co.uk	www.xerox.co.uk
C11CG93402BY	C11CG97401	W2G55A#B19	T0F33A#BHC	B215V_DNI

How we test

Find out how well products perform with the help of *Computer Shopper's* comprehensive tests

COMPUTER SHOPPER'S REVIEWS use some of the most exhaustive testing procedures you'll find in any PC magazine. Every product is subjected to qualitative and quantitative tests that show how it performs in practical use. Graphs for performance, battery-life scores and costs are used in the *Reviews* section, as shown on the right. Look in the 'Summary of tests' table (below) for details of each test we run.

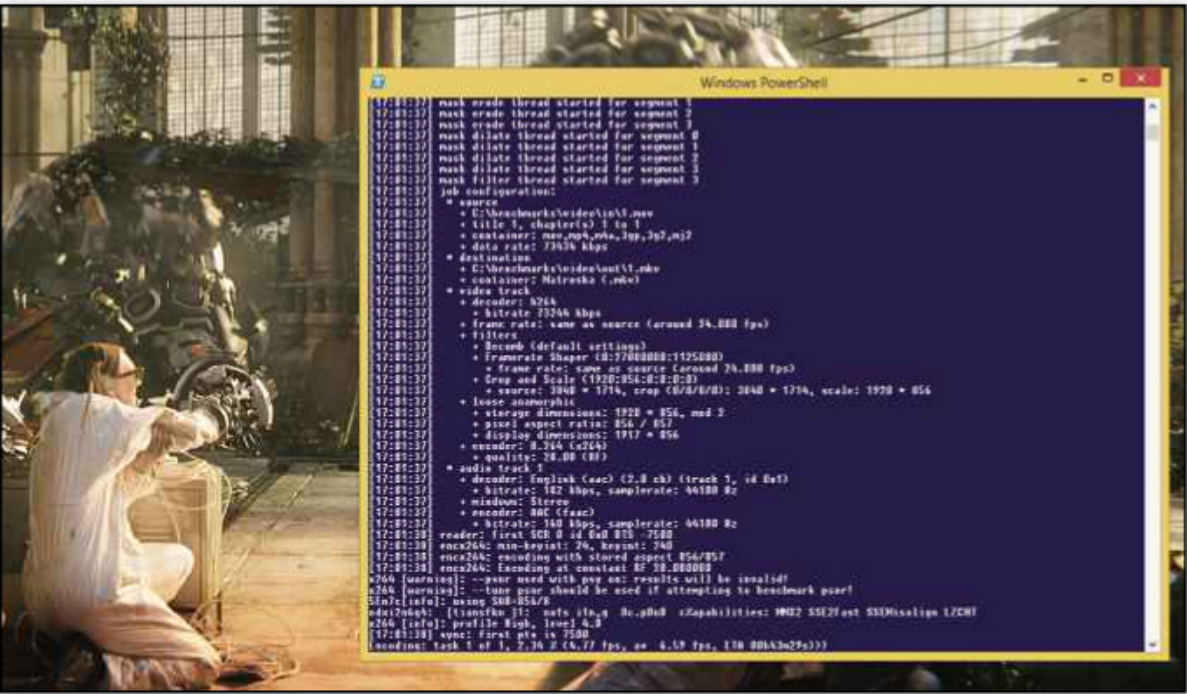
For PCs and laptops, we evaluate performance using our own custom benchmarking suite. See opposite for a description of our benchmarking software and game tests.



SUMMARY OF TESTS

PC SYSTEMS & GAMING LAPTOPS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAA, Ultra detail
Metro: Last Light Redux (1080p)	Frames per second at 1,920x1,080, SSAA, Very High detail
LAPTOPS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Processor-intensive multitasking test
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
Battery life	Run time in minutes for continuous video playback
SMARTPHONES/TABLETS	
Battery life	Run time in minutes for continuous video playback
PRINTERS AND MFPs	
Mono text speed	Pages per minute for correspondence-quality text
Mixed colour speed	Pages per minute for presentable text and graphics
Mono page cost	Running costs expressed as pence per page
Colour page cost	Running costs expressed as pence per page
DIGITAL CAMERAS	
Battery life	Number of shots from full charge
CAMCORDERS	
Battery life	Run time in minutes for recording
ROUTERS	
Laptop 2.4GHz 5m	Mbit/s at 5m with 802.11ac laptop on 2.4GHz band
Laptop 2.4GHz 1 floor	Mbit/s 1 floor up with 802.11ac laptop on 2.4GHz band
Laptop 2.4GHz 2 floors	Mbit/s 2 floors up with 802.11ac laptop on 2.4GHz band
Laptop 5GHz 5m	Mbit/s at 5m with 802.11ac laptop on 5GHz band
Laptop 5GHz 1 floor	Mbit/s 1 floor up with 802.11ac laptop on 5GHz band
Laptop 5GHz 2 floors	Mbit/s 2 floors up with 802.11ac laptop on 5GHz band
NETWORK-ATTACHED STORAGE	
Large files	Average MB/s for read/write of 100MB large files
Small files	Average MB/s for read/write of 100MB small files
HARD DISKS	
Huge files	Average MB/s for read/write of a single 2.5GB file
Large files	Average MB/s for read/write of 2.5GB of large files
Small files	Average MB/s for read/write of 2.5GB of small files
PROCESSORS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
MOTHERBOARDS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAA, Ultra detail
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAA, High detail
GRAPHICS CARDS	
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4x MSAA, Ultra detail
Tomb Raider	Frames per second at 1,920x1,080, SSAA, Ultra detail
Metro: Last Light Redux	Frames per second at 1,920x1,080, SSAA, Very High detail

BENCHMARKS



SHOPPER BENCHMARKS

Our benchmark suite uses open-source software that runs on Windows, macOS and Linux systems. This lets us use objective results to compare PCs and laptops, no matter which operating system they run. It's designed to test each computer to its limit, using a combination of intensive image-editing, video-encoding and multitasking tests.

We ran the tests on our reference PC, which has an Intel Core i5-4670K processor, 8GB of DDR3 RAM and an AMD Radeon R7 260X graphics card. We normalised our results so this PC had a score of 100. This makes it easy to draw comparisons between test systems.

The resulting overall score is shown at the bottom of every PC and laptop review. As we use the same tests in our standalone and group test reviews, you can compare the performance of any computer, whether it's a hybrid, laptop or desktop, from both sections of the magazine.

3D BENCHMARKS

DIRT SHOWDOWN

Dirt Showdown is a cracking racing game that makes good use of DirectX 11's fancy graphical effects. You'll want at least 30fps for smooth racing.



TOMB RAIDER

With the ultra-demanding Super-Sampling Anti-Aliasing (SSAA) enabled, 2013's Tomb Raider reboot is a great indicator of mid-range performance.

METRO: LAST LIGHT REDUX

Our most demanding graphics test uses tessellation, SSAA and massive textures to give even high-end cards a thorough workout.



RATINGS & AWARDS

Computer Shopper rates products out of five:

★★★★★
Excellent

★★★★☆
Very good

★★★☆☆
Good

★★☆☆☆
Below average

★☆☆☆☆
Avoid!

The best products can win the following awards:

BEST BUY

Products with outstanding quality and performance for the money win our Best Buy award.



RECOMMENDED

Products that don't quite qualify for a Best Buy award but are still highly rated by our reviewers.



BUSINESS BUY

The very best products for work win our Business Buy award.



Product Reviews

Our guide to all the products reviewed in this month's *Computer Shopper*

137
reviews

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Laptops

Dell Latitude 5500 23

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Kingston A2000

Networks

D-Link DCS-8515LH

Pan & Tilt 32

Displays

Acer Nitro VG270UP 34

Video

DJI Osmo Action 35

Audio

Pure DiscovR 36

AKG N700NC M2 37

Handhelds

Samsung Galaxy Note 10+ 38

Samsung Galaxy A50 42

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100% would recommend!

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SHANNON

Pleased with service

The process of getting the car was very easy and secure.



DANIEL

Easy Peasy!

No trawling garage showrooms! Already recommending to friends & family.



KAREN

Purchased VW Golf

I was nervous about buying on the internet. Needn't have worried.



SIMON

READ MORE REVIEWS ON TRUSTPILOT

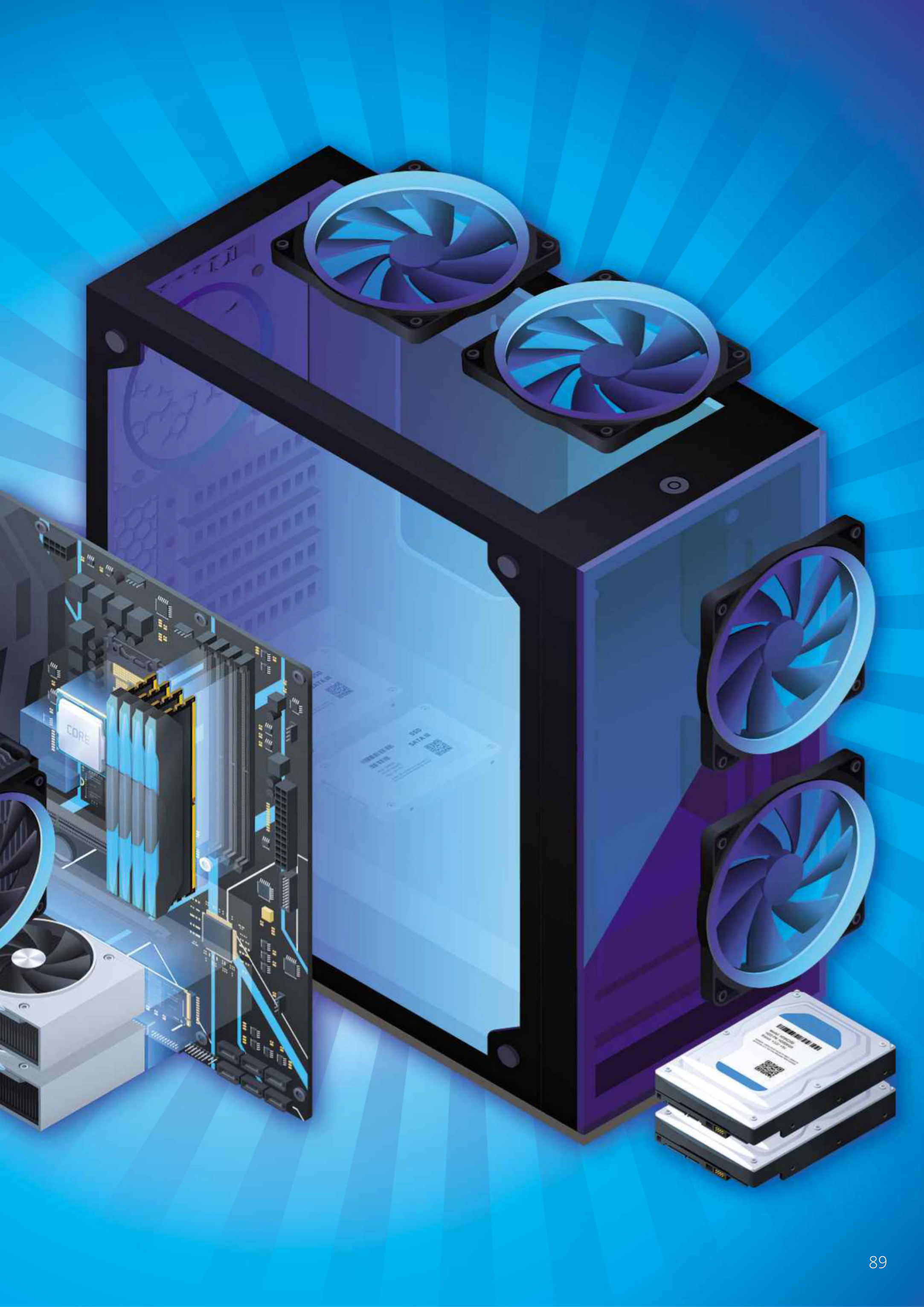
BUILD YOUR DREAM PC FROM SCRATCH

Building your own PC gets you the exact specs and build you want, with a completely custom finish. In this guide, **David Ludlow** shows you how to build a computer for any purpose

Given that most things we buy, from smartphones and soundbars to TVs, come pre-made and can't be serviced, the humble desktop PC is rather refreshing. Standing the test of time, the PC is as modular and easy to build and service today as when the first model came out. That's brilliant news for all of us that want a computer that's completely customised.

As good as off-the-shelf computers are, when you build your own, you get to pick everything that goes into it, getting the exact components you want for your specific needs. Building a PC is a valuable skill, too, as you get to see exactly how it works, and how it can be updated and fixed.





CHOOSE YOUR OWN PC

The benefit of building your own computer is that you get to pick the exact specifications that you want. To make things easier, Computer Shopper has tested all the top components to help you make the right choices. Just check out our Best Buys section on pages 48 to 65 to see our top-rated storage devices, graphics cards, and our recommended specs for budget, mid-range and premium PCs.

The budget model specification is ideal for basic web and email use, and some low-intensity office work. Look for the mid-range PC if you use your computer a lot for work and you want to do some video or photo editing, while if you edit a lot of photos or video, the premium PC core spec is a great choice, and it's ideal for a gaming rig.

Each spec can be tweaked for different uses, and you'll also need to add a few components. In addition to those core specs, you'll need a power supply unit (PSU). We recommend the Corsair TX550M for budget PCs, Corsair RM750i for mid-range PCs, and the Be Quiet! Dark Power Pro 11 850W for premium PCs.



ABOVE: Corsair's RM750i is a great power supply unit for mid-range PCs

While these specs will get you started, there are some tweaks and adjustments that you should make based on the type of PC you want.

RAM

Memory is used to store any information the CPU might need, from applications to data. When your computer runs short on memory, virtual memory is used, storing some data on your hard disk or SSD. This is far slower than using RAM, which can make your computer start to feel sluggish.

Installing more RAM can make your computer feel faster and make it easier to run multiple applications at once. So how much RAM should you have?

We recommend a minimum of 8GB for budget computers, where email, web browsing and some productivity software is used. Go for 16GB of RAM if you edit a lot of photos or tend to run a lot of demanding applications or games. Even 32GB wouldn't be excessive for a workstation PC or dedicated multimedia rig, although this is where memory starts to get really expensive. One of the best things about RAM is that it's easy to upgrade in the future, especially if you have a motherboard with spare slots.

If you buy a new PC, you'll need to use DDR4 memory. Buy your RAM in dual-channel kits, with two identical sticks of half the total capacity (so a total of 16GB of RAM would come as two 8GB sticks). By splitting the available memory between two channels, the data on them can be accessed more efficiently than with a single stick in a single channel, similar to how having more CPU threads can improve your PC's performance.

Lastly, there's the issue of clock speed. Also just like a CPU, RAM is rated at a certain operation speed, which can be overclocked if desired. This particular spec isn't as important as the total RAM pool size, however; 3,000MHz kits won't be significantly faster than 2,400MHz kits for most uses, so buy the cheapest, fastest memory that you can.

GRAPHICS CARDS

Do you really need a graphics card and, if so, how much should you spend on it? The answer to those questions depends on what you want to do. If you're building a budget PC and are using an Intel CPU, you get integrated graphics, so there's no need to buy an additional graphics card. If you're building a Ryzen system, then you don't get integrated graphics, so you'll have to add a separate graphics card. The budget Sapphire Radeon HD 6450 (£35, www.ebuyer.com) serves the job of feeding a monitor, although it lacks a DisplayPort output, and has only DVI Dual-Link and HDMI 1.4 outputs, so you can run a display with a maximum resolution of 2,560x1,600.

Buying a better graphics card, such as those featured in our Best Buys section, can have several advantages. First, if you want to run a higher-resolution monitor, such as for viewing two documents side by side or for high-resolution video and photo editing, it's worth spending a bit more. Second, if you want to do a lot of productivity work, a graphics card can accelerate the work in video editing and photo editing with applications such as Adobe Photoshop. Finally, if you want to play games, then you'll need to install a graphics card.

STORAGE

If there's one thing that we recommend for any PC of any budget, it's a solid-state drive

RAM RECOMMENDATIONS					
PRODUCT NAME	PART CODE	SPEED	CAPACITY	PRICE	SUPPLIER
Corsair Vengeance LPX 8GB	CMK8GX4M2A2666C16	2,666MHz	8GB (2x 4GB)	£45	www.amazon.co.uk
HyperX Fury 8GB	HX424C15FBK2/8	2,400MHz	8GB (2x 4GB)	£55	www.ebuyer.com
Corsair Vengeance LPX 16GB	CMK16GX4M2A2400C16	2,400MHz	16GB (2x 8GB)	£73	www.amazon.co.uk
HyperX Fury 16GB	HX424C16FB2K2/16	2,666MHz	16GB (2x 8GB)	£71	www.amazon.co.uk
Corsair Vengeance LPX 32GB	CMK32GX4M2A2400C16	2,400MHz	32GB (2x 16GB)	£145	www.amazon.co.uk



LEFT: An M.2 NVMe drive saves space and delivers the best performance

(SSD) for storage. Far faster than a hard disk, SSDs will make your computer boot faster and feel more responsive. If your computer supports an M.2 NVMe drive, then buy this type. A minimum of 256GB as a boot drive is recommended, but buy as big a drive as you can afford.

Mechanical hard disks are useful if you want to have a load of cheap storage, say for files, but they are a lot slower. If you can

go all-flash, you'll appreciate the speed increase and reduced noise that you get; however, go where your budget will allow and get the right amount of storage.

MINI-ITX

Finally, should you build a mini PC with Mini-ITX components? If you do, you can get a much smaller computer, not much bigger than a games console. However, the build tends to be tougher as you'll have less room to work in, and you may need to buy more expensive low-profile components such as power supply units and CPU coolers. With this kind of build, opting for an M.2 SSD makes a lot of sense to save space.

Ultimately, Mini-ITX computers are a great way to save space, but you have to make compromises elsewhere. In this guide, we've focused on putting together a traditional PC (ATX and microATX), although many of the tips apply to building a Mini-ITX computer, too.



ABOVE: A Mini-ITX PC is console-sized, but you may need to compromise on components

PREPARE THE CASE

Your PC's case will hold everything that you've built, so it makes sense to start here, preparing it to house your computer. At this point, it's worth talking about static and the danger it poses to your computer. Static electricity can fry delicate components. Although this isn't common, it's something to watch out for and protect against. At the minimum, make sure that you discharge any static by touching the metal part of your case before you touch any components. An anti-static wristband is a good, and cheap, way of protecting your components, too.

TAKE THE SIDE PANELS OFF

You should remove both of the side panels: one gives you access to where the main components go, the other is for cable routing and may be used to house a drive bay or two.



Most cases will have thumbscrews at the back. However, some models have screws hidden behind the front panel, so you may need to remove that first. Once the screws are out, the panels slide back and can be lifted out of the way. You should store these somewhere safe while you work on the inside of your computer, and you won't need these again until the end. **1**

ORGANISE DRIVE BAYS

Inside the case, look at how many drive bays you have. You should have 5.25in bays for optical drives, 3.5in bays for regular hard disks and 2.5in bays for SSDs. The latter will be available in a modern case but could be provided for by adaptors that fit into 3.5in bays if you're using an old case. There may be drive bays, often 2.5in ones, around the back of the case, too.



TOP TIP

Look out for the box of accessories, which is often slotted into one of the 5.25in drive bays.

You'll need this, as it will contain all the screws, blanking plates and the like that you'll need to complete your build.

These are handy for keeping SSDs out of the way and maximising airflow through the main part of the case.

Some drive bays may be removable, usually by undoing a thumbscrew – check your case's manual first. If removing optional bays leaves you with enough bays for your drives, then it's worth taking out the extra ones. This gives you more room to work inside the case and helps improve airflow.

REMOVE BLANKING PLATES

If you want to install an optical drive, now's a good time to remove the blanking plate. Locate the topmost 5.25in drive bay and push from the inside of the case outwards until the plastic blanking plate drops out; you may need to squeeze the retaining clips slightly. A fair bit of force is usually required to get the blanking plate to pop out.

LAY THE CASE DOWN

For the next bit of work, you'll need to have the case lying flat on its side. Make sure that the larger cavity is facing upwards. The other side of the case, pointing downwards now, won't need to be accessed for a while. **2**



PREPARE THE MOTHERBOARD FOR FITTING

Before you can do anything else, you need to have your motherboard ready. You should remove the board from its packaging, but it's worth keeping the anti-static bag that it shipped with. You can use this to stand the motherboard on while you get on with the initial job of preparing it. We often stand the motherboard on the anti-static bag, on top of the motherboard box, just so that the more delicate solder joints on the underside aren't on a hard surface.

As far as possible, it's worth working on the motherboard before you put it in the case, as this will give you a bit more room.

LINE UP THE REAR I/O SHIELD

In the box of accessories, you'll find the rear I/O shield (a metal plate with holes cut out to fit around the motherboard's rear ports). This shield fits into the rectangular hole at the rear of your case, provided you've inserted it the right way round.

To do this, line up the blanking plate with the ports on the rear of your motherboard. The descriptive information and any symbols should be pointing away from the board so you can see them from outside the case.

FIT THE I/O SHIELD

When you know which way around the shield should go, you can fit it into the case. You



INSTALL THE MAIN COMPONENTS

Once you have the place for the motherboard, you can fit the most fiddly components, giving you more room to work and cutting down on the chances that you'll make a mistake.

INSTALL RAM

RAM is straightforward to fit, although you need to make sure that you install your memory in the correct slots.

Most motherboards support dual-channel memory, where RAM is installed in pairs. For dual-channel to work properly, you need to use matching slots. Some motherboards have colour-coded slots, while others just number them. Check your motherboard's manual to see which slots you should use. Of course, if you're filling all your slots, you can just skip this and install all your RAM.

Once you know which RAM slots you're going to use, open up the retaining catches at the end of the slots. Some motherboards will have two slots (one at each end), some just have a single one. Now, take a stick of RAM and line it up with the slot, making sure that the cutout in the RAM lines up with the nodule in the slot.

Once done, push firmly (but not too hard) down on the RAM, placing your thumbs on either end. When the retaining clips click into place, your RAM is inserted correctly. A second push just to make sure that your RAM is in place makes sense. Repeat until you've used up all your RAM. **1**



INSTALL AN INTEL PROCESSOR

If you have an Intel processor, the installation procedure is the same for all types. First, you need to carefully remove the plastic protector on top of the CPU slot. Now take the handle on the slot, and push it away from the slot and lift. The processor cage will lift up. Take it carefully and fold the cage all the way back. Do not touch the processor socket itself, as you risk damaging the delicate pins inside.

Intel processors can only be inserted one way. To work out the correct position for the CPU, look at the processor, and you'll see it has two notches in the side. These should line up with the nodules sticking out in the socket. Second, every CPU has an arrow on it, which should line up with the part of the socket that has a diagonal row of pins.

Carefully lower the CPU into place, but don't use any force: the CPU should just gently sit on the rows of springy pins.

With the CPU lined up correctly, fold over the CPU cage and pull down the handle, clipping it back into its retainer. This will take a bit of pressure, so don't worry; if it feels as if there's too much resistance, make sure the CPU is sitting cleanly in its socket. **2**

INSTALL AN AMD PROCESSOR

AMD processors are all installed in the same way, regardless of type. The difference from Intel processors is that AMD CPUs all have pins that stick out from the processor. First, flip open the handle next to the CPU socket: you'll see the socket move.

Line up the processor with the socket, making sure that the arrow on the CPU matches the arrow on the socket. When it



TOP TIP

The rear I/O shield can be fiddly to fit, so make sure that it's clipped in all

the way by pressing hard around the edges until it's level.

need a bit of brute force to get it in. Starting from inside the case, line up the shield with the hole and then give a firm push on the sides so that you don't bend the metal. You should hear a click when the shield goes in, but it's worth pushing all around the edges to make sure it's in all the way. **1**

FIT THE MOTHERBOARD STANDOFFS

Your motherboard can't just be dropped into the case. Instead, it sits on standoffs, which

keep the motherboard raised so that its solder joints don't touch the metal case and cause a short. They take a retaining screw to hold your motherboard firmly in place.

Modern cases will often have pre-fitted standoffs, so you can skip this part if that's the case. If you have an older case or a cheaper one, you'll need to fix the standoffs into place. Look in the bag of accessories that came with your case; you're looking for tall screws that have a hex head.

To work out where you should put the standoffs, gently lower your motherboard into position and make a note of where the screw holes are. These are the places where the standoffs need to be fitted, so



remove the motherboard and place it back on the anti-static bag.

Now, you can screw the standoffs into place. To do this, use your fingers to screw the standoffs into the places that you noted earlier. Just tighten them by hand until they feel secure. **2**

2



does, carefully line up the CPU's pins with the socket's holes and then gently lower the CPU into place. It should drop down, but a gentle push on top to make sure that it's seated doesn't go amiss.

Now pull down the processor handle and click it into place. This requires a fair amount of pressure: if it feels as though you have to use too much force, then stop and check that the CPU is correctly inserted. **3**

INSTALL AN M.2 SSD

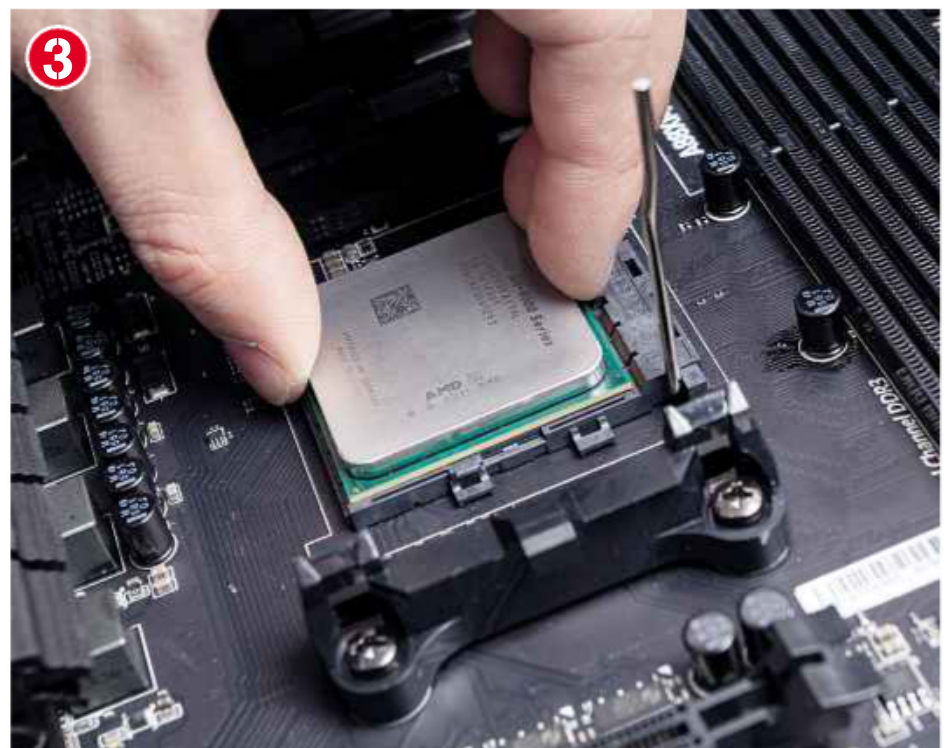
An M.2 SSD is a great way to save on space in your PC, using a single memory stick-like device that plugs into a slot directly on your computer. There are two types of M.2 SSDs: SATA or the faster NVMe. You need to install the SSD in the right type of M.2 slot.

If your motherboard has a single M.2 slot, it will usually support SATA and NVMe drives;

a motherboard with two slots will often have one (typically, the one on the rear of the board) that only supports NVMe drives.

If your motherboard does have two slots, try to use the rear one if possible, as that gives you the option to add a

3



second M.2 drive in the future without having to dismantle your PC.

M.2 SSDs come in different lengths, so motherboards have adjustable retaining standoffs. Line up your SSD with the M.2 slot and note down which hole in the motherboard the screw hole in the SSD lines up with. Depending on your board, you can either unscrew the standoff from a different hole, screw it back in the right place, or you can find the standoffs in the motherboard's bag of accessories.

With the standoff in the right position, line up the M.2 SSD at a slight angle with the M.2 slot and push it gently into place until the connector disappears into the slot. If you let go of the SSD, it will stick up at a slight angle. Gently push the end of the SSD down and then put a retaining screw into the standoff, carefully tightening the screw by hand.



TOP TIP

Processors and their sockets are very delicate, and bending

a pin is typically fatal. To avoid problems, be gentle, and carefully line up your CPU with the socket. If you feel any resistance, start over again to avoid any damage.

HOW TO FIT THE MOTHERBOARD AND CPU COOLER

With the core components in the motherboard, it's time to fit everything into the case and then fit the CPU cooler. While you could fit the CPU cooler at this point, we don't recommend it. Coolers tend to make a tempting place to grab as a handle, which can cause damage to the motherboard.

The one exception is if you have a custom cooler that requires a rear mounting plate (stock coolers that ship with your processor don't need one). Have a look at your case. If there's a large cutout behind where the processor will be on the motherboard, you can fit the mounting plate later. If there isn't, you need to do this step now. Check your cooler's instructions carefully, but in most cases, you press the rear plate up against the rear of the motherboard and screw in the fan brackets from the front side. **1**



ADD YOUR MOTHERBOARD

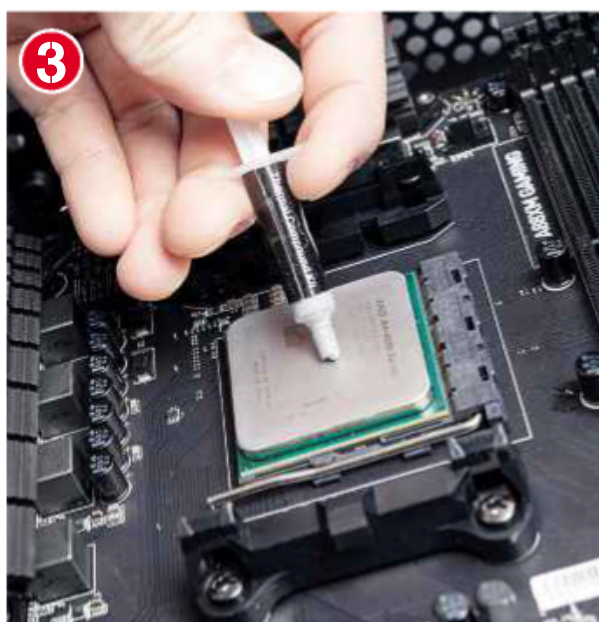
To put the motherboard in the case, slowly lower it down so that the ports line up with the I/O shield. When the ports are aligned, push the motherboard towards the rear of the case until the screw holes line up with the standoffs. You may need to gently lift up a couple of springs on the I/O shield to get the motherboard lined up.

While maintaining pressure on the motherboard, insert a screw and tighten by hand. You want enough pressure on the screw to know that it's in place, but don't overtighten it. This first screw will keep the motherboard in place while you add the remaining screws. Add as many screws as there are screw holes, otherwise your motherboard may not sit straight, which can make adding expansion cards tricky. **2**



ADD THERMAL PASTE TO YOUR CPU

If you have a brand-new cooler, there's a good chance that it is already pre-loaded with thermal paste. If not, or if you're reusing an older one, you'll need to add your own. Take the tube of thermal paste and gently squeeze a pea-sized dollop on the middle of your CPU. Don't spread the paste: it will naturally expand and cover the surface of the CPU when you put the cooler on. **3**



ATTACH AN INTEL COOLER

If you're using a stock Intel cooler or a third-party model with push-pin connectors, now's the time to fit yours.

Take a flathead screwdriver and insert it into the cooler's screw slot. Turn in the opposite direction of the arrow until you can't turn the foot any more. This sets the feet up to lock into place; turning the foot in the direction of the arrow unlocks the foot

for removal. Repeat for all four feet.

Look at the cooler and see which side the power connector sticks out of. Make sure that this side of the cooler points towards the CPU fan cooler header on your motherboard. Now lower the cooler into place so that the feet line up with the holes around the processor socket. Start with one foot and push down on top until it clicks into position. Now go

diagonally opposite and push down on the connector until it locks into position. Repeat for the remaining two feet.

When the cooler is locked into place, it will feel firm; if it wobbles, it means at least one foot is not pushed through the retaining hole in the motherboard. Undo any loose feet (turn against the arrow) and pull up to remove, then turn the foot to the lock position and push down. **4**



ATTACH AN AMD COOLER

Official AMD coolers clip on to the retention frame surrounding the CPU. Line up the cooler so that the fan cable is closest to the CPU header on the motherboard. Open the cooler's handle, then gently lower the entire unit on to the CPU.

Fit the metal clip without the handle over the retention frame anchors on one side of the processor. Now, push the remaining



TOP TIP

If your cooler isn't fitted tightly enough, your PC can overheat and even crash. Make sure that there's a tight fit with no wobble before you continue.



cooler clip over the remaining retention frame anchors and pull the handle closed. You'll need some force to do this properly, but the cooler will lock into position when the handle is all the way down. **5**

ATTACH A THIRD-PARTY COOLER

Third-party coolers are all a little different, so you'll need to follow the bundled instructions. Typically, you lower the cooler down on to the CPU and then use the supplied screws to secure the unit into the backplate you fitted before you inserted the motherboard. You can read more about custom coolers in *Advanced Projects* (page 124).

PLUG IN THE FAN

Look for the CPU fan header on your motherboard, and then plug in the fan connector from your CPU cooler to power it. Your motherboard will most likely have a four-pin PWM connector, which gives finer control over fan speeds. If your CPU cooler has only three pins, this will still connect to a four-pin header. To make the connection, line up the ridges in the CPU cooler's fan connector with the plastic stand-up on the motherboard header. Push gently down until the connector is securely in place.

FITTING TRADITIONAL STORAGE

Unless you've gone fully M.2, chances are that you'll need to fit traditional storage: hard disks, SSDs and maybe even a DVD drive. Here, we'll show you how to fit traditional storage devices.

FIT A 2.5in SSD

If you're using a 2.5in SSD, you should find that modern cases will have bays especially for this type of storage. Look at the rear of the case to see if there are vertical mounts; these keep the SSD out of the way for a neater finish.

For vertical mounts, you'll have to remove the mount (typically with a thumbscrew), screw the SSD into place underneath and then reattach the mount on the rear of the case.

If you have traditional 2.5in drive bays, slide the SSD into place, with the connectors pointing outwards. Secure the SSD using the method your case provides: this could be screwless connectors, thumbscrews or old-fashioned real screws. **1**



FIT A HARD DISK

Find a 3.5in drive bay and slide your hard disk in, so that the ports stick out the back, either facing you or towards the motherboard, depending on the orientation of your drive bays. Secure the disk in place using the method your case provides: screwless connectors, thumbscrews or real screws.

FIT AN OPTICAL DRIVE

Use the 5.25in bay where you removed the panel at the start of this guide and slide the drive in so that it sits flush with the front panel. Secure using the screwless mounts, thumbscrews or actual screws, depending on your case. **2**



FIT SATA CABLES

All traditional storage connects via SATA cables to the motherboard. Modern boards will have all SATA3 connectors; if yours is a little older or a budget model and you have a mix of SATA3 and SATA2 ports (check your motherboard's manual), then you need to connect your storage devices to the right ports. SSDs and newer hard disks are best suited to SATA3 ports, while optical drives operate fine with SATA2.

Finally, if you fitted a SATA M.2 drive, then your motherboard has probably disabled a SATA3 port. Check the manual to see which one(s) have been disabled, and then don't use them. All SATA ports will be clearly numbered to help you make the right decision.

Take the SATA cables from your motherboard's box. If your cables have a right-angle connector on them, that end is for the storage device; the straight end is for your motherboard. If you've only got straight connectors, the cable can be connected either way round.

SATA connectors can only be fitted one way, so plug one end into your drive, and the other end into the SATA ports you identified earlier on your motherboard. For neatness, you may want to route the cables through the back of your case, using the cutouts provided.



TOP TIP

Make sure that your drives, particularly hard disks, are firmly in place. Mechanical hard disks

vibrate in operation and a loose disk will make a lot of noise.

HOW TO FIT INTERNAL CABLES

With the bulk of the peripherals in your case, it's now time to start connecting everything up. In this guide, we'll show you how to run all the case cables that you need. If you can, route cables to the back of the case and bring them through to the front using the cutouts provided. This will give you a neater build.

FIT INTERNAL FAN HEADERS

Most cases will ship with some internal fans pre-installed, but you have to hook up the power cables to the fan headers on your motherboard. Your motherboard's manual will tell you where the fan headers are located.

Fan headers usually have four-pin PWM connectors for advanced control; they'll work with three-pin connectors from fans, too. To insert a connector, line up the ridges on the fan's power connector with the plastic plate on the fan header and insert downwards. Repeat for all the fans you have. **1**

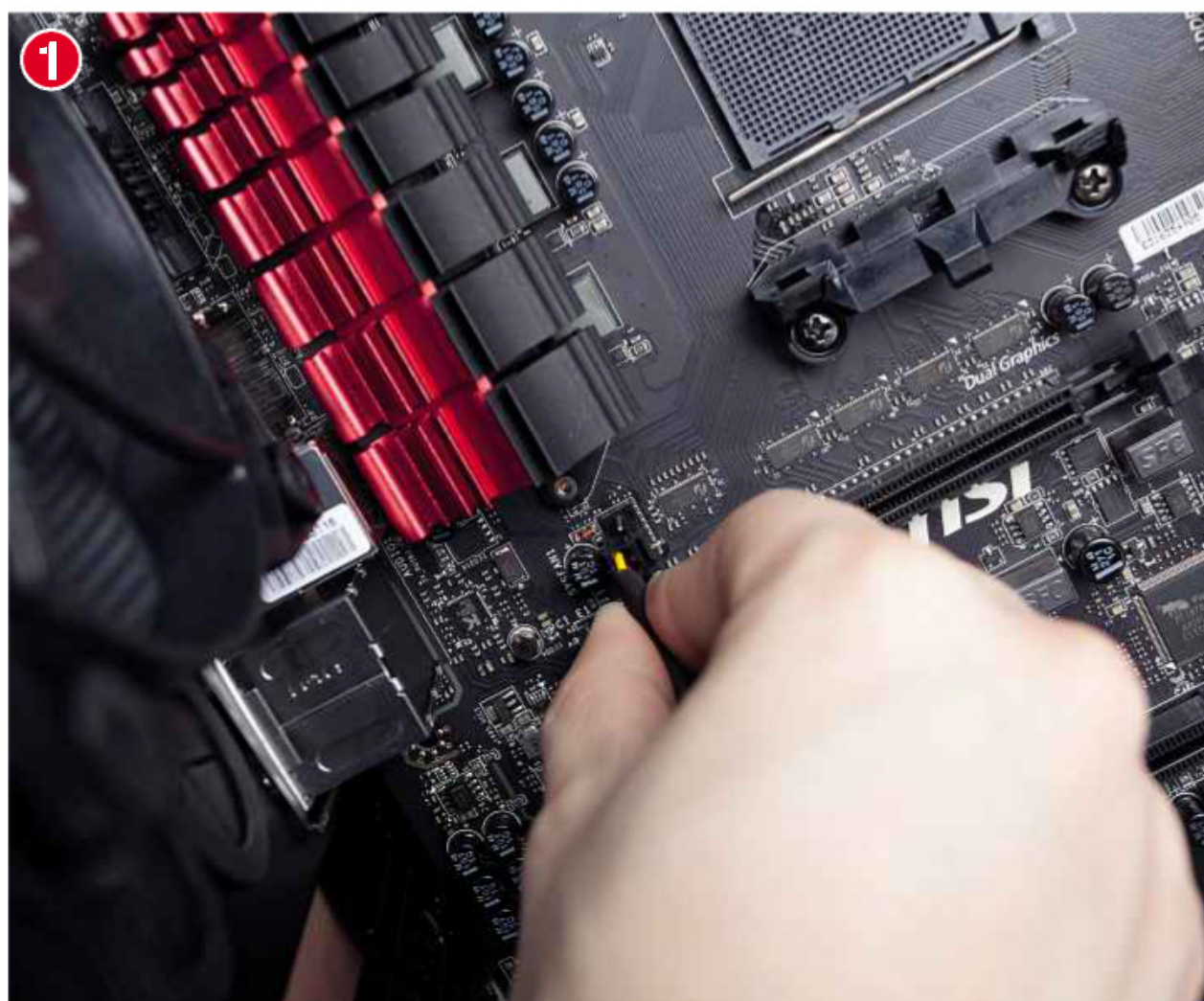
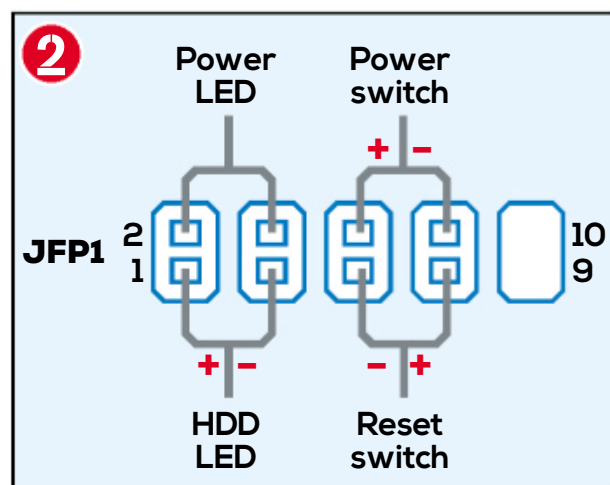
FIT THE POWER SWITCH

To turn on your computer, you need to route the power switch from the case (it will probably have Power SW written on it). Plug this into the jumper marked in your motherboard's manual. The cable will slide down easily, and it doesn't matter which way round it goes.

FIT THE POWER, RESET AND LED CABLES

To turn on and reset your computer and get the hard drive activity lights working, you need to hook up the cables from your case, which should be labelled, to the connectors on the motherboard. These will be clearly labelled in your motherboard's manual (see the diagram below for an example **2**).

For the power and reset switches, it doesn't matter which way round the cables go. For the power and HDD cables, make sure that you get the cable with the '+' on it connected to the '+' terminal on the motherboard or it won't work, and you



TOP TIP

Missing a pin on the front panel connectors is easily done, and may mean that lights don't work or your PC won't turn on. If you get this situation, carefully check the front-panel connectors.

could end up damaging the LEDs. The cables should slide into place.

FIT THE USB HEADERS

If you have front USB ports, you need to plug these in. Your motherboard will likely have USB2 and USB3 headers. USB2 cables can only be plugged in one way: look at the pin layout on the connector and line this up with the motherboard. With USB3 headers, the job's easier: line up the notch on the connector with the cutout on the motherboard and you're good to go. **3**

FIT THE AUDIO CONNECTORS

Front-mounted audio makes it easier to plug in a headset or headphones. The connector looks similar to a USB one, but will be marked HD Audio. Find the matching header on your motherboard and connect the cable; it can only go in one way round. **4**





HOW TO FIT THE PSU AND CABLES

With everything in place, the final steps are to get power to everything. Remember, if you can route cables through the rear of your case, do so, as this will keep your computer looking less cluttered. If you're using a modular PSU, only connect the cables that you'll need to further reduce clutter.

FIT THE PSU

With most cases, PSUs are fitted at the bottom of the case, sometimes in a separate caged-off area. Turn the PSU so that its fan is facing downwards towards the bottom of the case: you may find it easier to stand your case up the normal way for this step.

Slide the PSU in and push it backwards, so that the power connector is facing out the back of your case. From the rear of your case, screw in the power supply. The mounts will be clearly visible, and you should need four screws to hold the PSU in place. Screw the PSU in quite tightly so that it's pulled into the rear of the case. **1**



to go in, try turning it around and trying again. A little bit of force, followed by a click, shows you have it right. **2**

CONNECT THE SECONDARY POWER CONNECTOR

Motherboards have a secondary power connector (the ATX auxiliary connector). This can be a four-pin or an eight-pin connector. If it's the latter, you'll need to squeeze together the two four-pin connectors from your PSU. If it's the former, look at the PIN layout on the motherboard and line this up with the correct four-pin connector.

In all cases, the secondary power connector can only plug in one way, with



the clip designed to grab the ridge on the motherboard's connector. A firm push and an audible click show you've done the job.

CONNECT SATA POWER CABLES

Any 2.5in SSDs, hard drives and optical drives need to have SATA power connectors plugged in. These can only plug in one way, and should connect with a slight click, letting you know that they're firmly in the right place. **3**



TOP TIP

Make sure you have the secondary power connector in place; it's easy to miss and means that your computer won't start up.



HOW TO FIT A GRAPHICS CARD

If you want to play games or you have a CPU that doesn't have integrated graphics, you'll need to fit a graphics card. If you stood your case up to fit your PSU, you should lay it flat again to fit a graphics card.

REMOVE BLANKING PLATES

Locate the top-most PCI-E x16 slot (the long one), and unscrew and remove the rear blanking plates, remembering to keep the screws. If you have a single-height card, you need only remove the one blanking plate that's in line with the slot. If you have a dual-height card, you'll also need to remove the blanking plate below. **1**

INSERT CARD INTO THE SLOT

Line up the PCI-E x16 connector on your graphics card with the slot on your motherboard. Providing equal pressure along the length of the card, firmly push the card into place until it clicks into position. A correct fit should see the retaining clip at the end of the PCI-E x16 slot click into place. If you can still see some of the graphics card's connector, push down again.

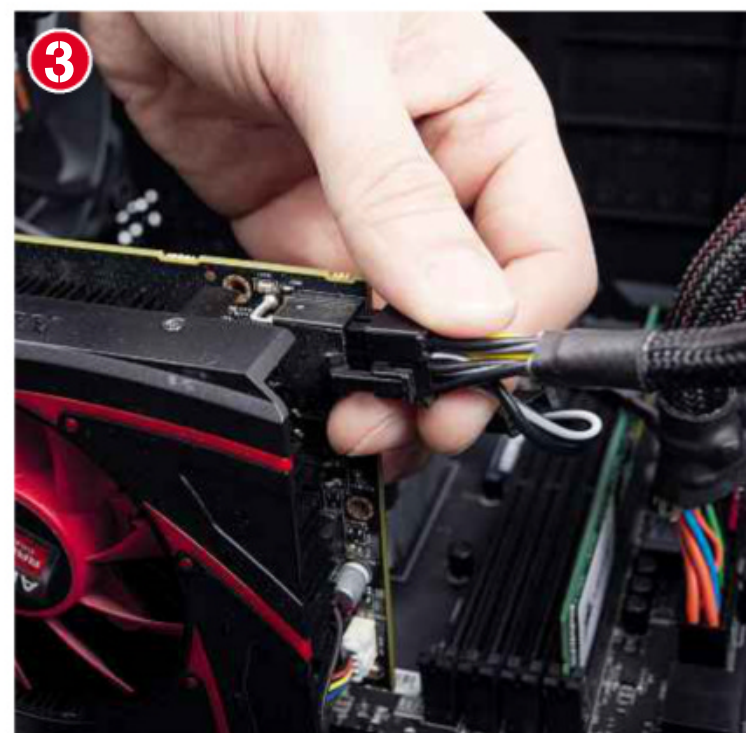
Take the screws that you kept from before and put them through the graphics card's retaining bracket and back into the case. You may have to push the graphics card up and towards the case slightly to do this. Once the screws are in place, the card should not wobble and the



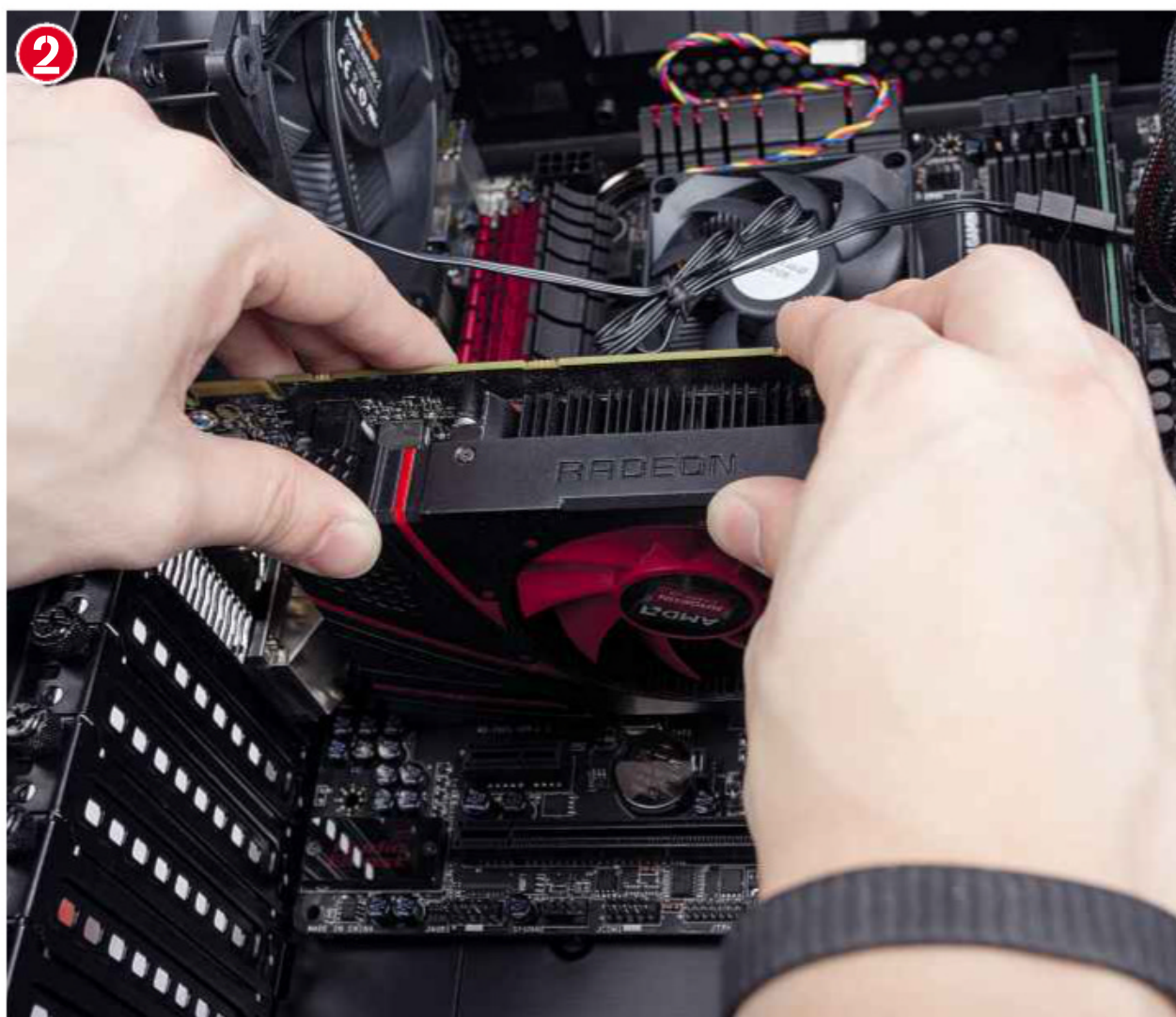
graphics card outputs should be clearly visible at the rear of the case. **2**

CONNECT PCI-E POWER

From your PSU, you need to connect the power to the graphics card, although a minority of budget cards don't need this. Check the number of power adaptors on the back of the card. There are two types of PCI-E connector: six-pin and eight-pin. Most PSU six-pin PCI power connectors can



be converted to eight-pin by pushing in the spare, dangling two-pin connector. PCI-E connectors can only go in one way and have a retaining clip to hold them in place. When this clip clicks into place, you know you've done the job properly. **3**



TOP TIP

Not quite lining up the card properly is the biggest problem to avoid as your PC will turn on, but you won't get a picture. Some cards are fiddly to fit, but some extra pressure along their length can push them into place.



PUT YOUR CASE BACK TOGETHER AND POWER ON YOUR PC

Now, your computer is built. To make it ready for installing Windows, you'll need to put it together and sort out the crucial BIOS settings.

FIT THE SIDES OF THE CASE

Stand your PC up and grab the case sides. Slide them back in, lining up the catch on the sides with the mounts inside the case. Once they've slid into position, lock them in place with the screws that you removed.

You'll need your Windows 10 installation USB drive. You should have had installation instructions when you purchased a Windows 10 licence, and you can create a Windows 10 installation USB drive by going to tinyurl.com/382buildpc. Connect this USB drive to your computer. You can now connect the power, keyboard, mouse and your monitor, and turn on your computer.

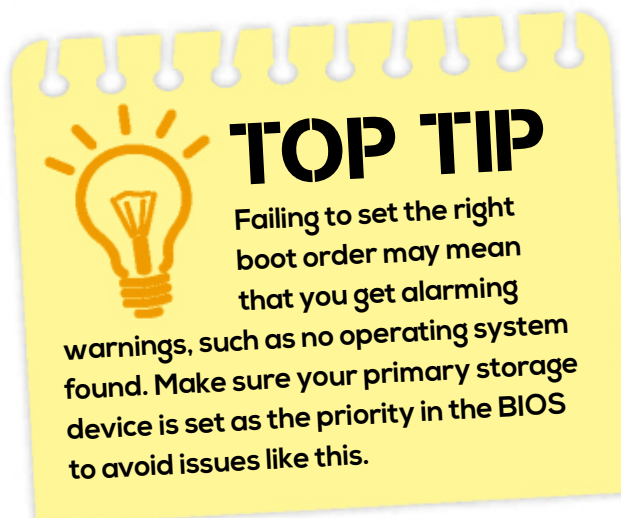
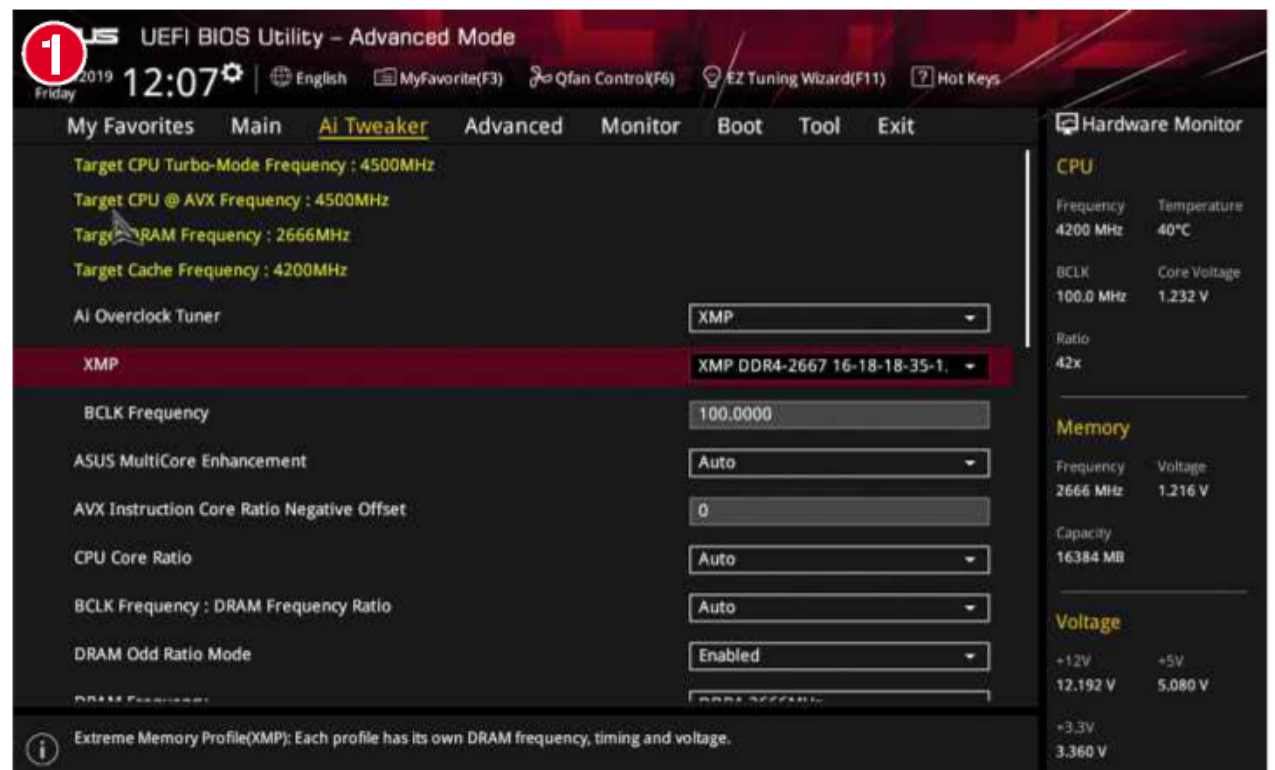
CONFIGURE RAM

When your PC boots for the first time, go into the BIOS by hitting the appropriate key. Usually, it's Delete, but we've seen F2 and F10 used before: the on-screen message should tell you which key to press.

You now need to configure your RAM, as it will have been set to run at the slowest, most compatible speeds. Using the XMP profile will make your memory run at full speed. XMP settings can typically be found in the Advanced settings mode, and may be located in a memory menu, overclocking section or hardware section. In other words, you may have to hunt around a bit. When you find it, enable XMP and select the first profile. This will make your RAM run at its fastest speeds. **1**

CHOOSE BOOT DEVICES

Next, you need to find the option for boot devices. If you have a new hard disk or SSD



that hasn't been used first, this should be set as the priority. If you have a drive that has had Windows on it, you need to set your USB drive as the first boot device.

Depending on the UEFI, this can be done in two ways. With some models, every storage device is listed in order. Select the first entry and choose your main hard disk or SSD. For some UEFI BIOSes, you first have to go into the hard disk priority menu,

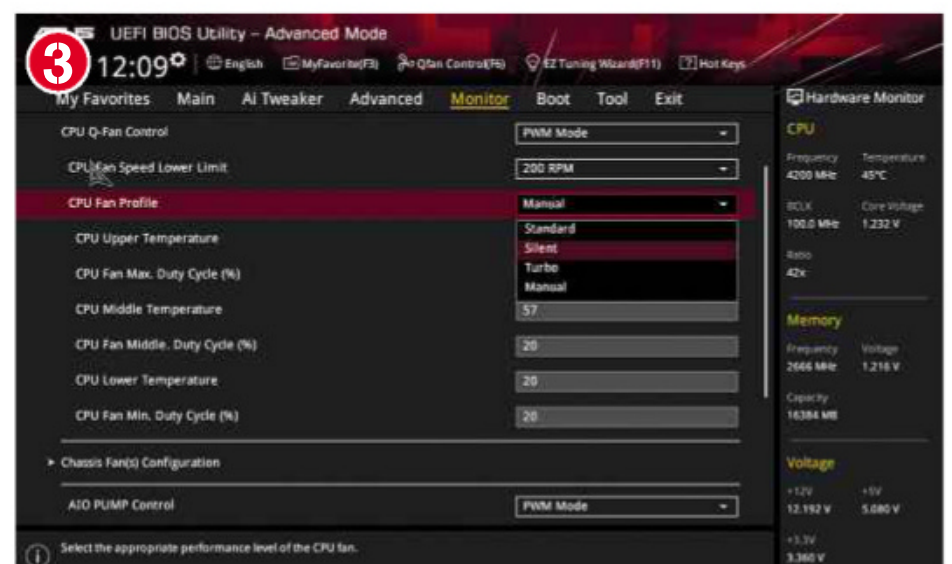
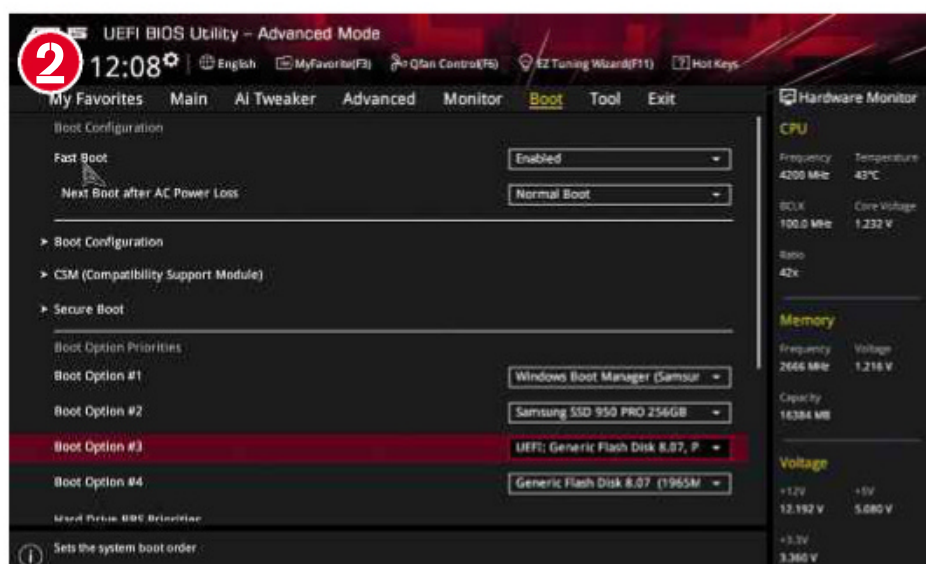
and set your main drive to be first in that list. Then, go back to the boot priority menu and you'll see your main drive listed; set this as the first boot device. **2**

CONFIGURE FAN SETTINGS

Modern UEFI BIOSes are very intelligent and can control fan speeds based on heat. Typically, in the fan settings menu, you'll find multiple profiles. We find that the Silent or Quiet options are the best: your computer will only run its fans when there's a fair amount of heat, helping to keep your computer virtually silent otherwise. You'll also find custom options, but try using the profiles first. **3**

SAVE SETTINGS AND REBOOT

Save your new settings and choose to reboot, and your computer will restart, ready to go. You'll now need to install Windows 10 so that you can use your brand new computer. **4**



IFA 2019



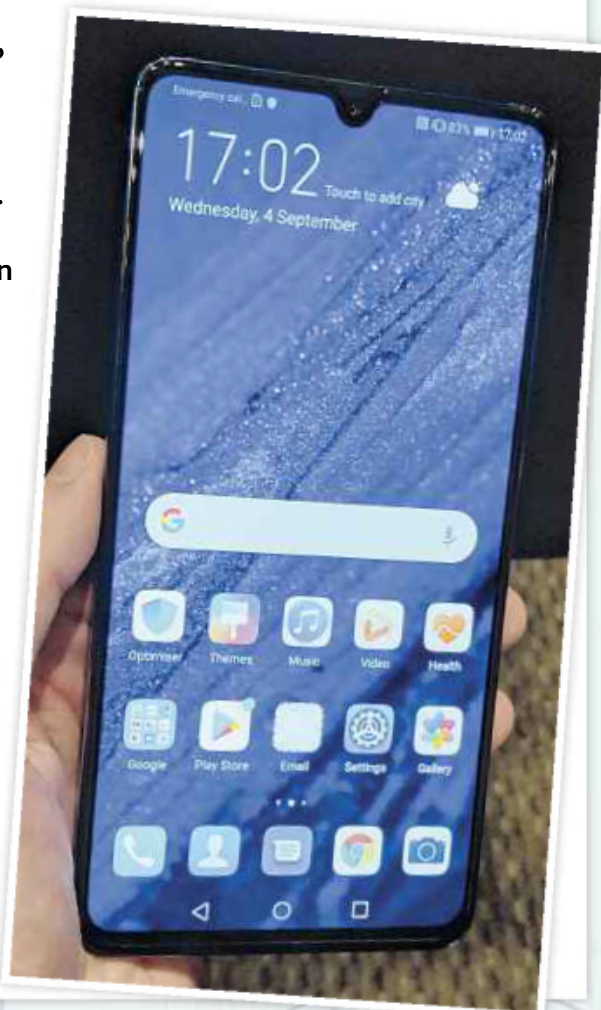
Europe's biggest technology show returned to Berlin this year. **James Archer** and **Roland Moore-Colyer** were on the ground to find the best new and upcoming products

HUAWEI

5G was the theme of Huawei's IFA 2019 plans. Unusually, these began with something that's already available in the UK, with the Chinese firm giving us another look at the Mate 20 X 5G (right). This is likely to become obsolete soon, however, as Huawei's main event was the reveal of its Kirin 990 smartphone processor.

This is the first 5G-capable 7nm SoC on the planet and, unlike on the Mate 20 X 5G's Kirin 980, the 5G modem is fully integrated: it's not a conventional SoC with an added-on modem. This helps it stay smaller and more power-efficient.

The Kirin 990 will first find a home in the Mate 30 series, which will have been revealed at a separate event in Munich by the time you read this.



ACER

Two very different products caught the eye at Acer's booth, which mainly contained updates to its Swift laptops and Predator gaming systems. One was the C250i (right), a portable projector designed for quickly blowing up your smartphone screen. It connects wirelessly, projects at 1080p, and can automatically switch between landscape and portrait modes, just like your phone. It launches in January in the UK at €539 (£480).

The other was the Swift 5, which we've looked at in more depth on page 14. While not as highly specced as the Swift 7, it is Acer's lightest laptop yet, weighing a mere 990g. Despite this, there's still room on the chassis for a couple of full-size USB3 ports and an HDMI output, and processors come in a choice of Intel's latest 10th-gen Ice Lake Core i5 and Core i7 chips. Prices will range from €899 (£799) to €1,399 (£1,240) when the Swift 5 is released later this year.



NETGEAR

Wi-Fi 6, also known as 802.11ax, was the big networking trend at IFA this year. Netgear won the race to announce a mesh router system that uses this new, higher-bandwidth standard, unveiling the tri-band Orbi WiFi 6 System AX6000 (right), alongside a range of traditional standalone Wi-Fi 6 routers, such as the Nighthawk AX8 (below) and Nighthawk AX12.

The AX6000 should look familiar, as physically it's based on the excellent current generation of Orbi mesh systems. However, it has two more internal



antennas than the 802.11ac RBK50 system (Shopper 375), a much faster 2.2GHz quad-core processor and greatly improved throughput speeds of

1,200Mbit/s on the 2.4GHz band and 2,400Mbit/s on the two 5GHz bands.

None of this comes cheap: when the Orbi WiFi 6 System AX6000 launches it will cost \$700 (£565) for one router and one satellite. That's more than three times as much as an equivalent RBK50 set.

WESTERN DIGITAL

Following on from an internal NVMe launch earlier in 2019, Western Digital has expanded its WD Black series into a new range of external SSDs and hard disks.

These are, like the original WD Black SN750 SSD, targeting gaming use specifically. The line-up includes two drives certified for Xbox One consoles: the WD Black P10 Game Drive for Xbox One (right), a 2.5in hard disk with capacities of 1TB, 3TB or 5TB; and the WD Black D10 Game Drive for Xbox One, which comes in a single 12GB version. Both of these also have standard PC equivalents (with the same names, minus the 'for Xbox One'), although the WD Black P10 Game Drive is significantly slimmer than its Xbox counterpart.

For the more performance-minded, there's also the WD Black P50 Game Drive, which uses a 20GB/s USB Type-C connection and promises read speeds of up to 2,000GB/s. We'll aim to have a review soon, as this and the rest of the WD Black range are already on sale.



XYZPRINTING

Having spent several years as the first name in affordable, home-friendly 3D printers, the Netherlands-based XYZPrinting is changing course and focusing more on industrial printing. It's not done yet with desktop printers, however, and was at IFA showing off two interesting new models.

The da Vinci Color 5D (far right) is a bit too big to fit on most desks, but it's unique in being both a full colour 3D printer and a 2D inkjet printer at once. That's not all, either: it's equipped with a laser engraver, too.

Also on show was the da Vinci Color Mini (right), a smaller version of the da Vinci Color 5D. This also has colour 3D printing and laser engraving capabilities, and while the build area has shrunk from 150x200x200mm on the 5D model to 130x130x130mm here, its tighter footprint could make it even better for home use.



ASUS

Asus's press conference was an eclectic one, announcing everything from the VivoWatch SP fitness smartwatch to a range of ProArt systems for the creative industry, such as the ProArt StudioBook One (right) and StudioBook Pro X laptops, the ProArt Display PA32UCG monitor and the ProArt Station D940MX compact desktop. We also had our first reasonably convincing hands-on time with the dual-screened ZenBook Pro Duo.

Perhaps the most notable new product is the ProArt StudioBook One, the first-ever laptop to use the mobile version of Nvidia's high-end Quadro RTX 6000 GPU. Both the graphics chip and the CPU, an Intel Core i9-9980HK, are also positioned behind the screen, something Asus says will make the base cooler and more comfortable to use on your lap. There's no pricing or UK availability details yet, but expect a hefty cost.



LENOVO

Lenovo took a similar 'kitchen sink' approach to Asus, announcing no fewer than seven laptops and a host of other products ranging from smart displays to phones. There was even an AR game based on Marvel's superhero characters, Marvel: Dimension of Heroes.

Some of the laptops were merely refreshes of recent models – the Yoga 940, for instance, is the Yoga C930 (Shopper 377) with Intel's 10th-gen CPUs – but there were some highlights. The Motorola Zoom One smartphone brings quad-sensor rear cameras to the mid-range, offering a 48-megapixel main sensor, a 10x zoom lens, a depth sensor and an ultrawide angle unit for £379.

Three different smart displays were also unveiled (right), all of which are powered by Google Assistant. One of these is pretty conventional – the Lenovo Smart Display 7 – but the others, the Smart Tab M8 and Yoga Smart Tab, are distinct in that they can also be removed from the base and used as regular Android tablets.

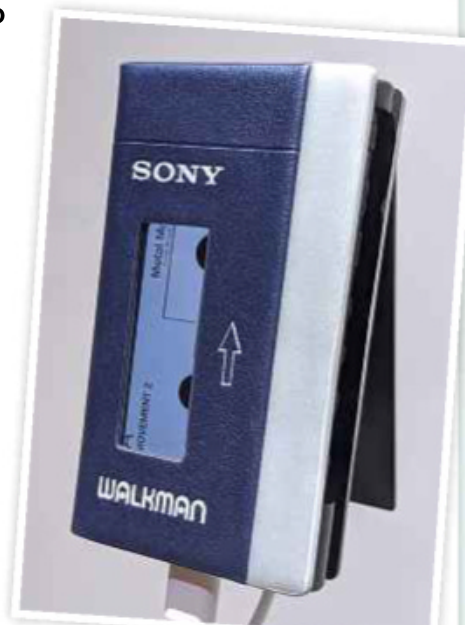


SONY



The big reveal for Sony was the Xperia 5, its latest flagship smartphone (left). It borrows a trick from the recent Xperia 1, itself an ultra-premium handset, by including a long, 21:9 aspect ratio OLED screen. It's smaller than the Xperia 1's display, at 6.1in, but this – combined with some extremely thin bezels – makes for a smaller, lighter device that's easier to handle. No UK pricing is available yet, but it will be on sale by the time you read this, and will cost €799 in the rest of Europe. That's about £709, £140 less than the Xperia 1.

Sony also announced a limited edition Walkman (right) to mark the legendary music player's 40th anniversary. It's £400, which is a lot for nostalgia's sake, but the design is cute: the MP3 player itself comes in a case designed to mimic the original cassette players, and the 3.6in display plays a little tape graphic as the music plays.



SAMSUNG

Qualcomm Snapdragon laptops never really caught on after a brief burst of excitement in 2017, but Samsung is giving them another go with the Galaxy Book S (right) and its purpose-built Snapdragon 8cx processor.

Performance is yet to be determined, but according to Samsung it helps deliver an incredible-sounding 23 hours of battery life. 4G connectivity will be available, too, provided UK carriers pick it up. Right now, only US carriers are confirmed, as is US pricing of \$999 (£800) and upwards.

We'll be keeping an eye on it regardless, partly to see how the 8cx holds up running Windows 10, and partly because it's so beautifully thin and light. At just 11.8mm thick and weighing 960g, it joins a growing number of sub-1kg ultraportables to be revealed at the event.

Samsung also detailed improvements to its flexible Galaxy Fold smartphone, including a reinforced hinge and redesigned screen that no longer leaves the top screen surface looking as though it needs to be peeled off.



NOKIA

One big company making its first-ever IFA appearance was Nokia: this was a surprise, considering how long both Nokia and IFA have been around. The Finnish firm didn't waste the opportunity, either, showing off five new smartphones.

Another surprise was that only two of these, the Nokia 6.2 and 7.2, fit the modern smartphone mould. Nokia's presentation also included the Nokia 110, essentially a remake of the 2012 feature phone of the same name, and the Nokia 2720, a 4G flip phone. There was also the Nokia 800 Tough, a fully ruggedised Android handset that meets both the IP68 and milspec 810G specifications.

The Nokia 7.2 (below) overshadowed them all, however. It will cost £299 when it's released later this year, but it looks and feels like a real high-end handset, with a massive 6.3in screen, 48-megapixel rear camera, and a stylish glass and metal frame.



SONOS



Multiroom audio specialist Sonos announced three new products at IFA: the Sonos One SL, which is basically a Sonos One speaker without the voice control microphones; the Sonos Port, which can turn analogue music players (such as turntables) into multiroom sources; and the Sonos Move (above), a battery-powered smart speaker you can take anywhere.


Perhaps not anywhere, as it's still moderately bulky, and will need Wi-Fi for Alexa and Google Assistant (both are supported) to function. With Bluetooth connectivity and IP56 weatherproofing, however, it's the first Sonos speaker you can comfortably take outside in the garden.

Back indoors, it can tune its frequency response to best suit the size of the room it's in, and best of all can do this automatically by using motion sensors to detect its surroundings. The Apple HomePod can do the same, but it needs manual setup. The Move is an excitingly complete speaker, and is available right now for £399.

GARMIN

The Vivoactive series of Garmin fitness watches has been consistently brilliant, and it looks like the newly revealed Vivoactive 4 (right) and its smaller variant, the Vivoactive 4S, will only improve things.

The 1.3in display is larger than that of the Vivoactive 3 (Shopper 363), but it's not overly bulky and the narrower bezel helps make it look better overall. GPS is also included, as is built-in music playback, something the Vivoactive 3 lacked until a special edition model was launched earlier this year.

There's also now a Pulse Ox sensor, which can provide insights into your blood pressure, and besides the usual step counting, sleep tracking and heart-rate monitoring, the Vivoactive 4 has been upgraded with menstrual cycle tracking, hydration tracking and respiration tracking. Fitness fans will have no shortage of data to sift through when the Vivoactive 4 launches later this autumn at £239. 



ARE WE ALONE?

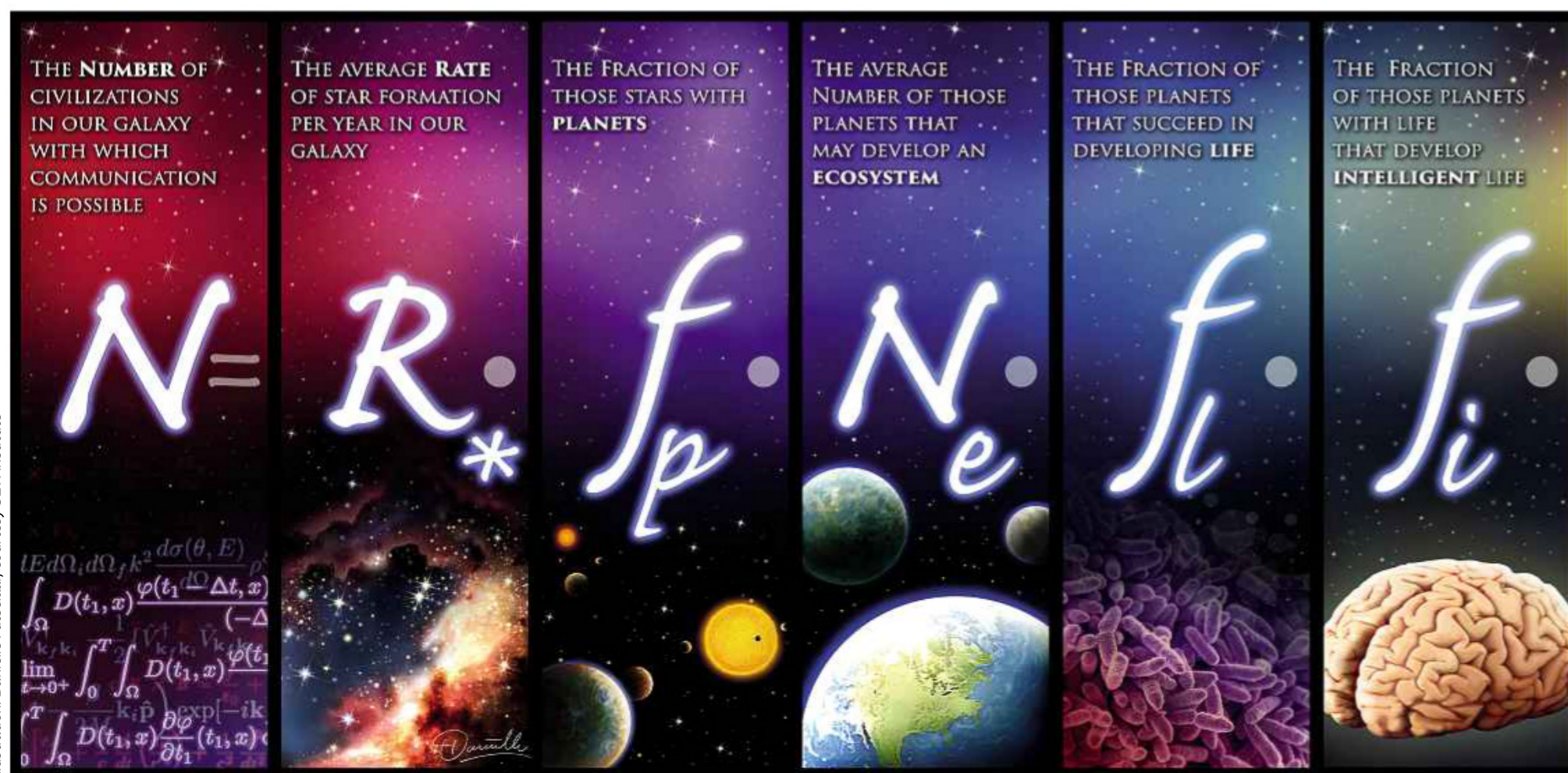
**MIKE BEDFORD
TACKLES ONE OF THE
MOST PERPLEXING
QUESTIONS OF ALL TIME
AS HE DELVES INTO THE
TECHNOLOGY INVOLVED
IN THE SEARCH FOR
EXTRATERRESTRIAL
INTELLIGENCE**

T

here can't be many more quoted people from the 20th century, even though his question 'Are we alone in the universe?' isn't one of his most well known. For while this individual is regarded as one of the world's foremost statesmen, his role as a scientific thinker is less well appreciated. This was the title of a recently discovered and unpublished essay that was written on the eve of World War II. Its author was Winston Churchill.

Speculation about intelligent life elsewhere in the universe can be traced back centuries and millennia. But while much of the early debate was philosophical or theological in nature, Churchill's paper was written at the time when the subject was just starting to be addressed by the scientific community. It would be several more decades before technology that might answer that question would become available, but such technology is now driving SETI, the Search for Extraterrestrial Intelligence. Here we take a look at the computer and communications technologies that are fuelling the search, and try to come to a conclusion on whether it might succeed. ➔





THE ARGUMENTS

Churchill's conclusion to that age old question sounds a convincing argument. "With hundreds of thousands of nebulae, each containing thousands of millions of suns, the odds are enormous that there must be immense numbers which possess planets whose circumstances would not render life impossible," he said, a sentiment that has been oft repeated.

However, making such an assumption raises another question. In 1950, physicist Enrico Fermi asked a group of other eminent scientists, "Don't you ever wonder where everybody is?". The question, now generally referred to as the Fermi Paradox, can be expressed like this. If the numbers suggest the galaxy ought to be teeming with intelligent life and, even at the speed of our present-day space vehicles, it would take only five million to 500 million years for any one of them to colonise the galaxy – a short period in cosmological time frames – why is there no evidence for their existence?

The somewhat qualitative assertion – that with so many potentially habitable planets, there must be countless extraterrestrial civilisations – was brought under more mathematical scrutiny by Frank Drake, just 11 years after Fermi raised his thought-provoking question. The equation that bears his name is the one shown above.

Drake's aim was profound: to provide a method by which the number of intelligent civilisations in

▲ The Drake equation has allowed scientists to calculate the number of intelligent, communicative civilisations in our galaxy

▼ Given the vast number of stars in the galaxy, many experts maintain that it's barely conceivable that we could be alone

the galaxy could be calculated. What's more, he succeeded. It's not hard to see that the equation is surely correct; after all, it seems to be common sense.

If only things were that simple. For while the equation is undoubtedly correct, give or take the odd slight amendment here and there, assigning values to its variables is considerably trickier. For example, estimates for the fraction of habitable planets on which life comes into being have varied from virtually zero – which would imply that the Earth is about the only planet where it's ever happened – to one, suggesting it's a certainty. His results would have been vastly more diverse had he thought that this fraction could be anything other than one, but by plugging in his best guesses to the other variables, Drake concluded

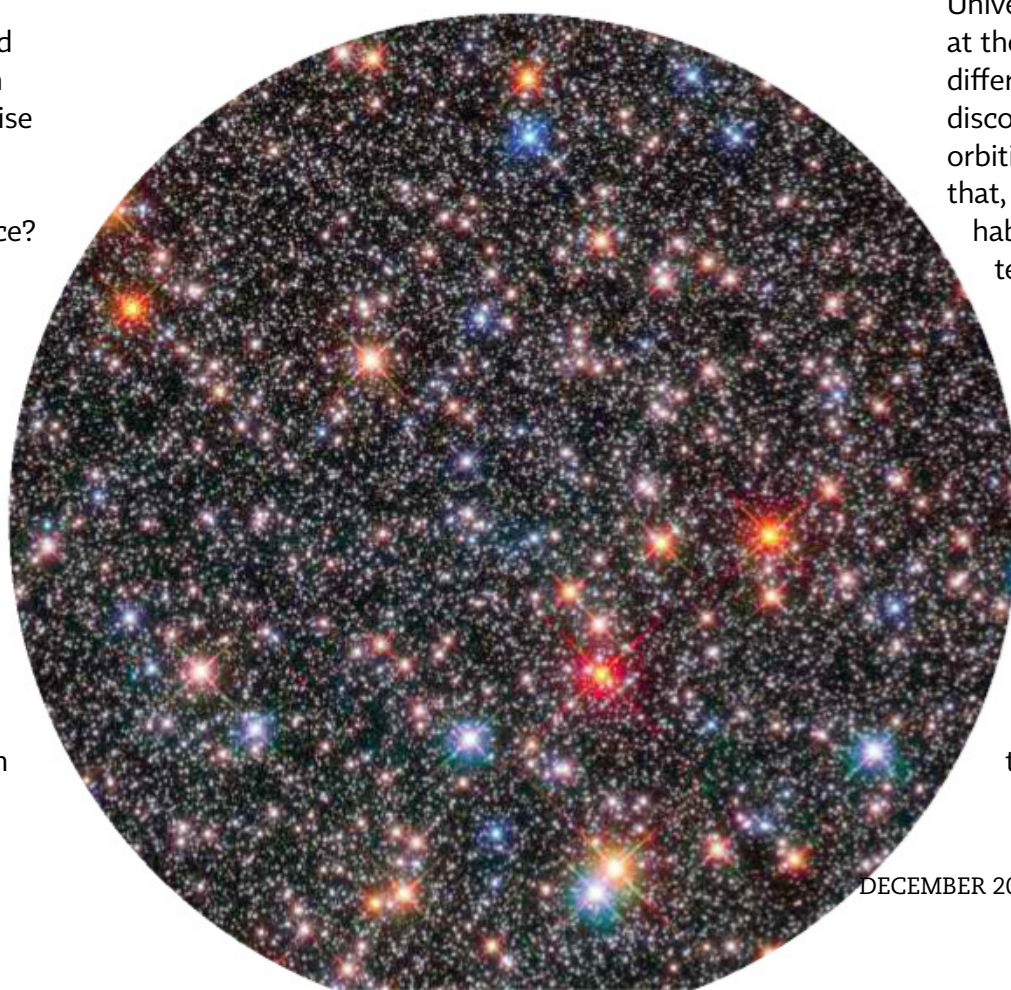
that the galaxy contains anywhere between 1,000 and 100 million communicative civilisations.

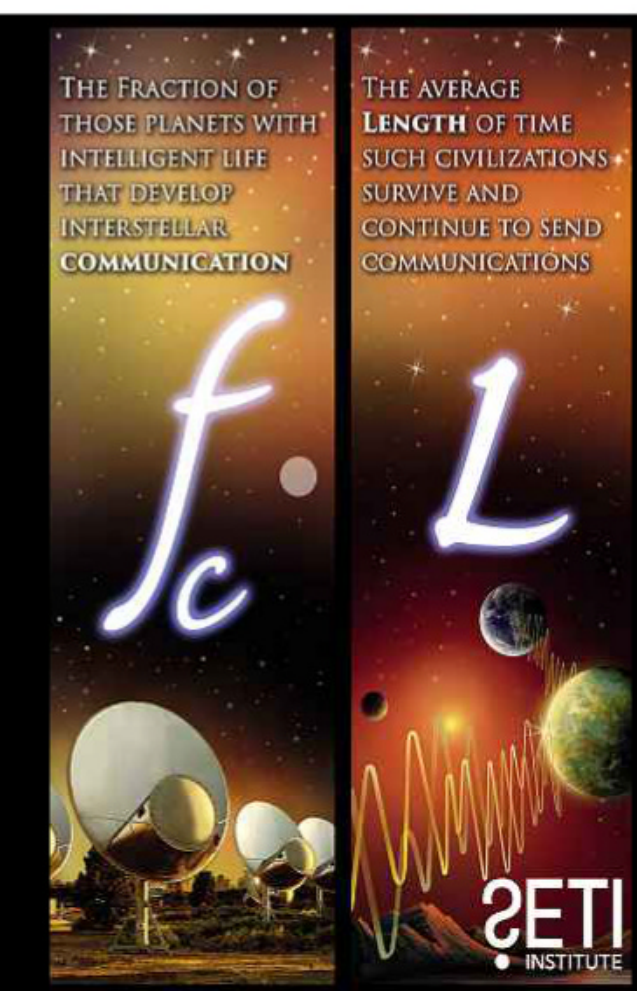
We're really no closer to coming up with a definitive figure today, and two recent studies bring this into sharp focus. A study by Anders Sandberg, Eric Drexler and Toby Ord of the Future of Humanity Institute at Oxford University has taken a fresh look at the Drake equation. They consider that the difficulty in drawing any meaningful conclusions is due to the uncertainties in some variables that span multiple orders of magnitude. When they use realistic distributions of uncertainty for the variables, they conclude that there's a substantial probability that there's no other intelligent life in our observable universe.

Astrophysicist Adam Frank at the University of Rochester has also looked at the Drake equation, but takes a different view. Using data on the recent discovery of exoplanets – planets orbiting other stars – he concludes that, "As long as the probability that a habitable zone planet develops a technological species is larger than about 10^{-24} , humanity is not the only time technological intelligence has evolved."

Effectively, therefore, he's saying that if the chance of intelligent life appearing on a habitable planet is greater than the probability of you being hit by lightning twice in a year, then intelligent life will have materialised elsewhere.

However, Frank has also been thinking about the 'L' term in the





Drake equation, that's the lifetime of an intelligent communicating civilisation. In his book *Light of the Stars*, he puts forward an explanation to the Fermi Paradox. Although he suggests that intelligent civilisations almost certainly have existed in the galaxy at one time, that's not the same as saying that they exist now. It all depends on how long such civilisations survive. If technological civilisations invariably annihilate themselves in a matter of a century or two, due, say, to runaway global warming, we could currently be the galaxy's only intelligent civilisation.

Given the continuing lack of clarity over the likelihood of extraterrestrial intelligence, theoretical studies have been augmented by the practical approach of trying to find evidence of its existence. Needless to say, this is hugely taxing, requiring huge radio telescopes and plenty of computing power to process the data streams.

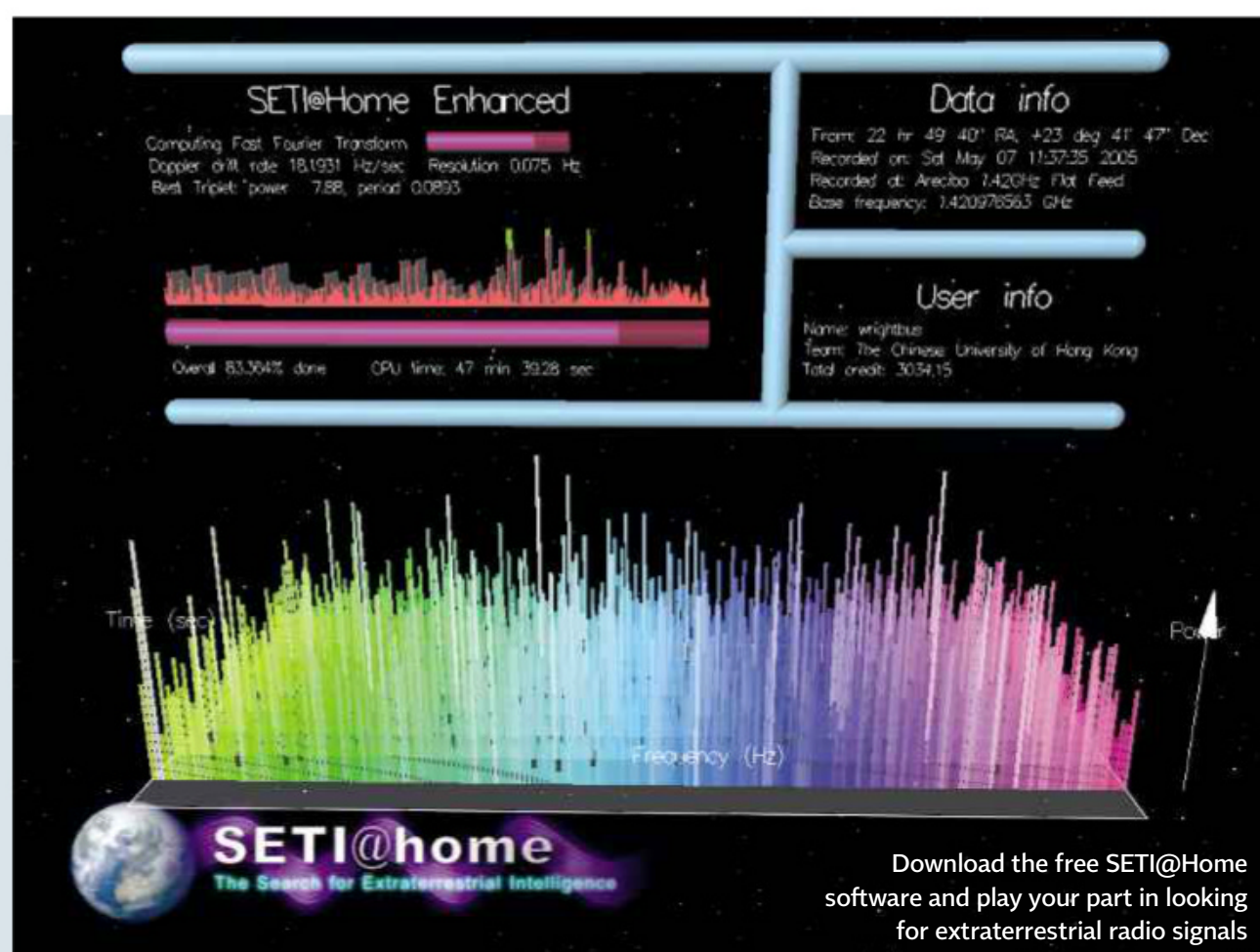
THE SETI INSTITUTE

The mission of the SETI Institute is to "explore, understand and explain the origin and nature of life in the universe and the evolution of intelligence". As the name implies, one of the Institute's primary focuses is the search for extraterrestrial intelligence,

a programme of research it undertakes using the Allen Telescope Array – a multiple dish radio telescope – to listen for radio signals that have all the hallmarks of originating from an alien civilisation.

Given the number of stars in the galaxy – the very fact that led many to

↑ Despite mankind being in space for almost 60 years, we're still no closer to answering that age-old question, 'Are we alone?'



SETI@HOME

Fancy getting in on the SETI act by processing radio telescope data yourself? Well, head off to setiathome.berkeley.edu, download the software that runs in the background whenever your PC is idle, and you might just make a name for yourself as the person who discovered extraterrestrial intelligence.

The SETI@Home project, managed by the University of California, Berkeley, uses data that's piggybacked from other observations made at the Arecibo radio telescope in Puerto Rico and the Green Bank radio telescope in West Virginia. Data is split into segments and automatically farmed out to the current 100,000 users worldwide whose PCs, when combined, effectively create a distributed supercomputer.

The number crunching is similar to that carried out by the SETI Institute, although the SETI@Home team claim that they're able to search for signals 10 times fainter than any other SETI initiative.

This doesn't come without a price, however. The coherent integration process that achieves this is just another computationally intensive element of SETI data processing.

believe that we can't be alone – it's not hard to appreciate something of the challenge in searching for extraterrestrial intelligence. So how does the SETI Institute address the question of knowing where to point the array? Dr Seth Shostak, senior astronomer and Institute Fellow, explains the normal method is to adopt a broad-brush approach to increase the chances of finding something.

"You would configure it in a way to look at a wide area of the sky, rather than a tiny little patch of the sky," he observed, before acknowledging that there are times when you might choose to observe a smaller portion of the sky to obtain stronger signals.

"Is it better to look at five times as many star systems, or is it better to look at a smaller number of star systems with five times more sensitivity?" Shostak asks.

"That depends on your estimate of what you think the aliens are doing. Nobody knows whether we should expect deliberately beamed transmissions or just pick up their



leakage that wasn't really intended for us. The advantage of leakage, of course, would be that you don't count on the aliens as having sufficient interest in us to send anything our way. On the other hand, a targeted signal would be much easier to detect because they would make it intense and they would put all the information into a very narrow band to make it easier for us to find."

However, beamed transmissions are probably unlikely. "For any star system more than about 35 light years away – and that's the majority of them – there's not been enough time since the Second World War for our strong transmissions at high frequency, the ones they could pick up like radar, to reach them, and for them to have decided to send something back relentlessly," Shostak says.

It's not only a matter of where to look in the sky. The needle in a haystack problem is compounded by the difficulty of knowing what frequencies to look at in the radio spectrum. Shostak explains how they look for narrow signals because they're much easier to detect.

"We assume that any signal will have narrow band components. Narrow band in this instance is about one hertz, and these are much easier to see than the broadband components of the signal that carry the information," he says.

Even so, the broad-brush approach still improves the likelihood of finding something out there.

Shostak adds: "Your receiver swallows as much bandwidth as it can, and you use a Fourier Transform

↑ At the birth of SETI, no exoplanets (planets orbiting other stars) were known. The first was found in 1992 and now, thanks mainly to the Kepler Space Telescope, astronomers know of 4,103

to break this up into narrow channels. We observe with 72 million channels at once."

When asked how likely the SETI approach is to providing answers to the question of whether we're alone, Shostak's response was predictable.

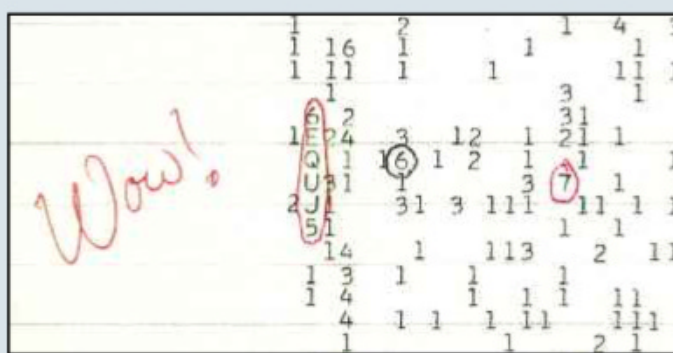
"That's like asking James Cook, 'What are the chances you're going to find the North West Passage?'. He didn't know. But the important point is that SETI is the beneficiary of improvements in technology known as Moore's Law, which means that the searches are increasing relentlessly in speed. So by 2035, we'll be able to look at a million star systems. Is that enough of a sample to be able to say that now there's a chance of success? I'd bet everyone a cup of Starbucks that it is."

THE WOW! SIGNAL

At first sight, astronomer Jerry R Ehman's task at Ohio State University's radio observatory didn't sound too enthralling. All that changed in August 1977. As usual, he'd been analysing the huge volumes of line printer paper from the observatory's IBM 1130 computer, when something caught his eye. This particular signal was so arresting that Ehman circled it in red, writing Wow! against it. To this day, it's called the Wow! Signal.

The radio observatory had been built as part of the University's SETI programme. And that signal looked nothing like anything anyone had ever seen before. The signal lasted 72 seconds, it was 30 times stronger than the background noise, and it appeared to be a signal that couldn't have been generated on Earth.

Needless to say, scientists have looked again and again on the same frequency, and in the same direction, but nothing similar has ever been heard. Although natural causes of that signal have more recently been put forward, it remains the most likely candidate for an extraterrestrial signal.



↑ It's just possible that an extraterrestrial radio signal was received back in 1977

THE COMPUTING POWER BEHIND SETI

Talk of Moore's Law underlines the need for sophisticated computer hardware in SETI, but just what is the processing requirement and what hardware is used to achieve it? Shostak emphasised that, wherever possible, the Allen Telescope Array captures as much data as possible to improve the likelihood of finding that tell-tale signal. However, having captured data from a reasonably large area of the sky over a broad range of frequencies, from 1GHz to 3GHz, it's necessary to home in on single areas of the sky and search for signals just one hertz wide from the massive 140Gbit/s data stream. And this is just for the current 42 antennas, let alone the 350 dishes that will be present when the array is complete.

Selecting a very specific part of the sky – perhaps one with a star



↑ The SETI Institute's Allen Telescope Array in California currently has 42 six-metre dishes, but it's planned for this eventually to be increased to 350

known to have potentially habitable planets – makes use of the fact that the Allen Telescope Array contains 42 separate dishes six metres in diameter, instead of one huge one. This allows the signals from multiple antennas to be phase-shifted and added together in order to generate a very narrow field of view, just 30 arc seconds wide, and to steer it under software control, to the area of interest. This is a hugely processor-intensive task.

Then we come to the breaking up of a broad radio signal in order to look for very much narrower signals. This is carried out by a process called a Fast Fourier Transformation and, bearing in mind that the three gigahertz of bandwidth has to be split into 72 million segments, it's perhaps not too surprising that this too will give ordinary computing hardware a run for its money.

And finally, there's the need to scrutinise those signals to see if any have potentially been generated by extraterrestrial civilisations. This involves discounting any that could have been generated on Earth – itself a huge multistage process – while keeping any that have the expected characteristics of an artificially generated signal. When we also remember that a signal generated on another astronomical body might exhibit a change in frequency with time due to a variable Doppler Shift, it's clear that such a signal might migrate from one channel to another, to another. Again, we can see something

FROM SETI TO METI

Active SETI, otherwise known as Messaging to Extra-Terrestrial Intelligence (METI), is a somewhat controversial alternative to the SETI approach discussed in this article. Instead of looking for signals from extraterrestrial intelligence, its aim is to announce our presence to any civilisations that might be interested.

While opinions on the wisdom of this approach differ in the SETI community – with some arguing that agreement should be obtained from the worldwide scientific, political and humanitarian society before any such attempt is made – METI initiatives have already taken place.

The first and most publicised of these was the addition of a plaque to the Pioneer 10 and 11 spacecraft that were launched in 1972 and 1973, and have subsequently become the first man-made objects to leave the confines of the solar system for interstellar space. The plaques of gold anodised aluminium are engraved with line drawings of humans with a rather crude drawing indicating the location of our home planet.

While the Pioneer plaques are surely very unlikely to be encountered by extraterrestrials, several radio signals have also been sent, starting in 1974 with a message sent from the huge Arecibo radio telescope in Puerto Rico in the direction of the M13 star cluster.

It was a low-resolution monochrome digitised image containing a stylised picture of a human, plus several other elements which, it was argued, would be meaningful to intelligent civilisations.

Given the date, the similarity of that image to games on early home PCs isn't too surprising. That image will reach its destination in around 25,000 years. If that time period comes as something of a relief, you'll be less pleased to hear that one METI signal, sent in 1983, will already have reached its target, and several others will do so in the next few decades.



↑ This low-resolution image – the actual message was monochrome – was transmitted in 1974 towards the M13 star cluster

of the enormity of the requirement to conduct all this in real time.

You might reasonably expect that this is a job for a supercomputer, but actually standard PCs are used. Where they differ from the one on your desk is that these PCs have dedicated hardware to offload the heavy number crunching. Included here

are GPUs, perhaps not too surprising since these have recently become almost standard components in the world of high-performance computing. Perhaps less well known is the use of FPGAs. Otherwise known as Field Programmable Gate Arrays, these devices use software to reconfigure the hardware to perform specific

tasks at lightning speed with the potential for massive parallelism.

ALTERNATIVE APPROACHES

Here we've concentrated on listening for radio signals. While this approach might account for 90% of the effort being put into SETI, though, it's not the only way of trying to find little green beings.

One other method is referred to as optical SETI, and it takes, as its assumption, that extraterrestrials might choose to use laser beams instead of radio signals in their attempt to attract the attention of other civilisations in the galaxy. Now, of course, we're into the realm of image processing. But perhaps the method that has most been in the news recently is one of looking for alien artefacts.

One such approach, for example, assumes that advanced civilisations might solve their energy problems by building huge solar arrays in orbit around their closest star. This would manifest itself in the form of unnatural changes in the brightness of that star. If some conspiracy theorists are correct, we don't have to go looking for artefacts because they've already come to us and are under lock and key at Area 51, but that's another story.

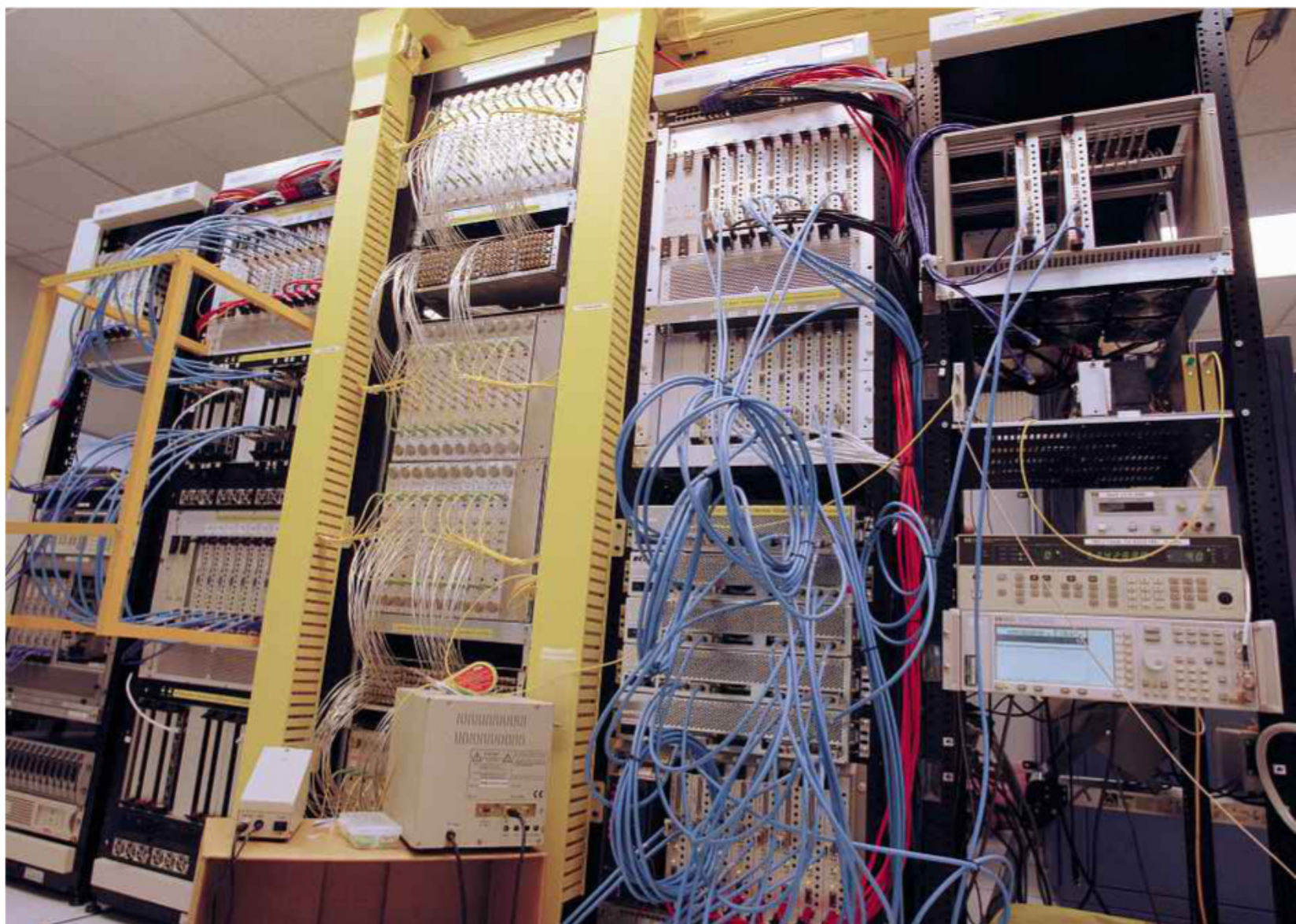
↑ By using esoteric custom hardware, data from the Allen Telescope Array can be processed in real time using a network of standard PCs

Our emphasis here has been the technology of SETI. However, we'll give the final word to Dr Shostak, who told us about some of the most common questions he's asked. There are no answers, but at least these questions might give you some food for thought. Prompted by the conspiracy theories, 'What happens if the signal is picked up?' is one oft-asked question. 'Would the public even learn about it or would the government keep it quiet?' is another popular one.

Needless to say, a lot of the questions come closer to home, as Shostak illustrated with the next question. 'How is it going to affect me? I'm selling fish here in Swindon, is it going to affect my life in any significant way?'

But the last one he mentioned is perhaps the most profound. 'If we pick up a signal, should we respond by saying, "Hey we're the Earthlings, we'd love you to buy our used cars", or is that a bad idea?' 🗣️

Photo: Seth Shostak/SETI Institute

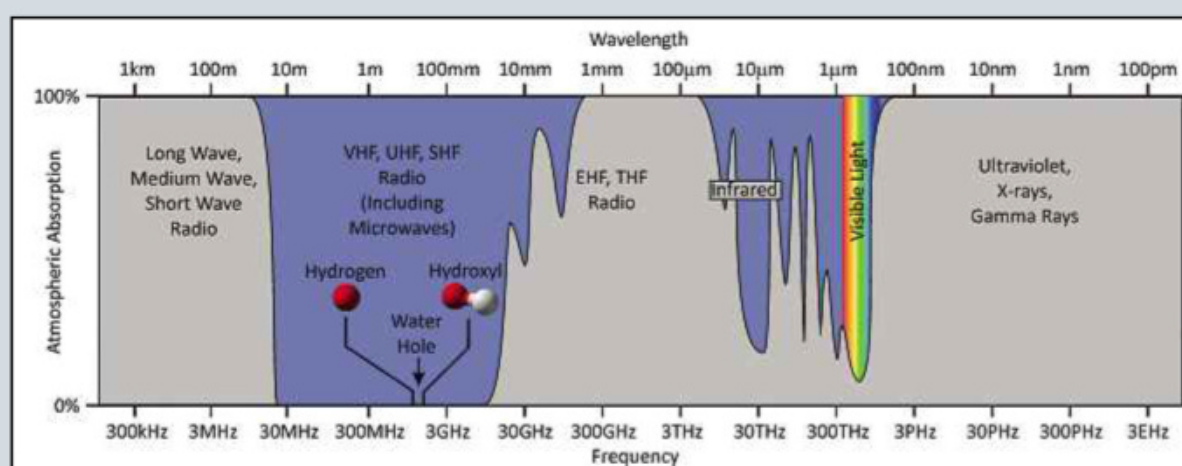


THE WATER HOLE

Although the SETI Institute looks at huge numbers of channels in its search for extraterrestrial intelligence, traditionally, SETI researchers have tended to concentrate their efforts on a very specific band of frequencies for a well-argued reason.

First of all, a graph of absorption against frequency across the electromagnetic spectrum shows two main windows through which radiation could reach the Earth. All other frequencies are blocked due to a range of natural phenomena. One of these windows corresponds to the visible spectrum, and the other is in the microwave region, otherwise known as parts of the UHF and SHF radio spectrum. Therefore, these are the two regions used in optical and radio astronomical observations respectively, and they are also the only sensible contenders for SETI.

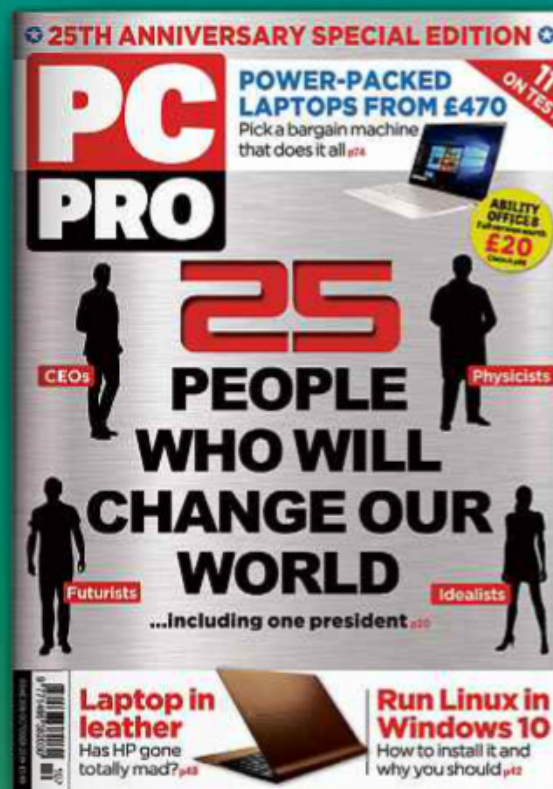
Although the microwave region is a window of transparency through the atmosphere, it contains a couple of signals that would cause interference to observations. These are caused by natural effects involving the hydrogen atom at about 1.4204GHz and the hydroxyl radical at 1.66GHz.



↑ Most of the electromagnetic spectrum is shielded from the Earth, but the so-called water hole is where extraterrestrials might try to contact their galactic neighbours

It has been argued that any advanced civilisations attempting to make contact with other worlds would be aware of the signals at these two frequencies, and that they would also recognise them as being caused by the disassociation products of water, the substance that's essential to life as we know it. It is speculated, therefore, that extraterrestrial civilisations would be drawn to transmitting in the 'water hole', the clear frequencies between those two natural signals, in their attempt to communicate with their neighbours in the galaxy.

From Apple to Zeiss, and everything in between

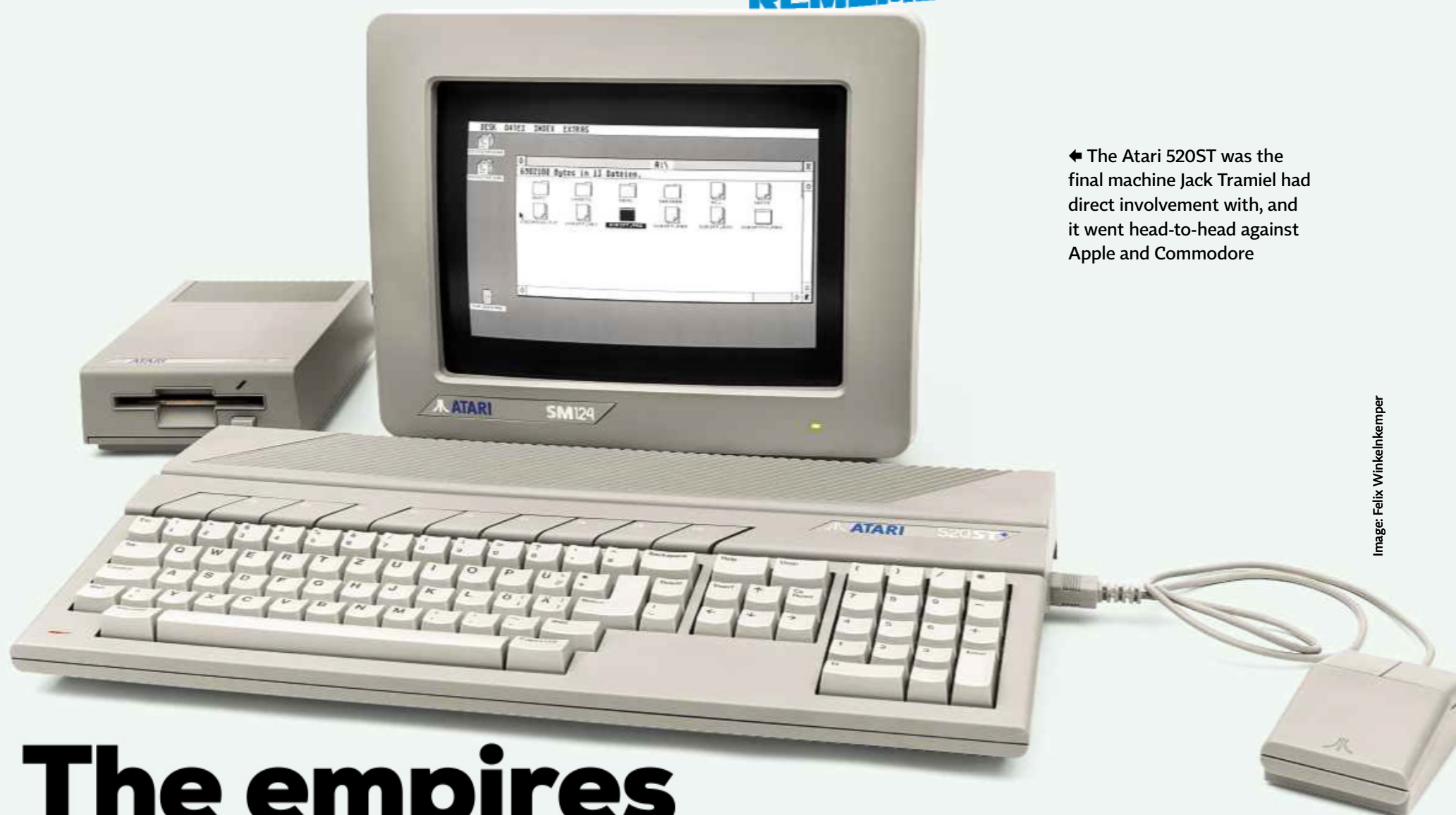


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RETRO

COMPUTING HISTORY
REMEMBERED + REBOOTED



◀ The Atari 520ST was the final machine Jack Tramiel had direct involvement with, and it went head-to-head against Apple and Commodore

Image: Felix Winkelkemper

The empires that Jack built

Rescued from a Nazi labour camp, Jack Tramiel eventually entered the world of computers and declared business was akin to war, as **David Crookes** explains

On 16th December 1985, journalist Michael Schrage held a tongue-in-cheek awards ceremony for the computer industry within the pages of *The Washington Post*. He said his 'PC of the Action' awards would add a little humour in a year that had plumbed the depths of despair, handing the 'Lazarus, Never Say Die' award to Microsoft for finally releasing Windows and 'Best Jobs Hunter' to Apple's lawyers.

In among these was an award labelled 'Survivor of the Year and, Jeez, He's Got Sharp Teeth' – an accolade given to Jack Tramiel. He was deemed worthy of this honour because he was "still running Atari and is shipping products that people are buying". It summed up Tramiel perfectly, since he was not only known to be a

gruff, rude, ruthless yet savvy businessman who had survived a most terrible period of history, he'd also pulled off a near-miracle.

Although many would question his tactics, he had turned around Atari's fortunes having bought it and pulled it away from the brink of collapse. The fact he had helped push Atari to the edge of that cliff thanks to his previous success with Commodore was

➤ Jack Tramiel spoke at a 25th anniversary event to mark the 1982 launch of the Commodore 64

ironic. But here he was on the other side of adversity, experiencing an enlightening high after a dark low – albeit nothing like he had suffered in his early years.

IN THE GHETTO

Tramiel was a Polish Jew, the son of Abram Josef Trzmiel and Rifka Bentkowska, born in Lodz, Poland, on 13th December 1928. When the Germans invaded on 1st September 1939, he and his parents were confined to the city's ghetto, the second-largest in German-occupied Europe,





▲ Launched in 1977, the Commodore PET was the company's first mass-market personal computer

housing up to 163,777 residents. His father repaired shoes to earn just about enough to provide for a family now living in a single room. In 1944, however, the Nazis liquidated the ghetto and began deporting inhabitants to the Auschwitz-Birkenau concentration camp.

Tramiel and his parents were examined by the notorious SS officer Dr Josef Mengele, who decided to send the 17-year-old and his father to the labour camp Ahlem, built on a hill overlooking Hanover. The prisoners were forced to construct an underground tunnel to house the operations of the Continental Gummi-Werke AG rubber factory, as well as that of the tank company Maschinenfabrik Niedersachsen Hannover. Tramiel would later say he watched his father die when guards injected him with petrol.

Fortunately, his mother, who had been told to remain in Auschwitz-Birkenau, survived, but the pain of those years – and the death of many relatives – lay heavy. Tramiel

and the prisoners had been forced to dig their own graves towards the end of the war and they were thankfully liberated in the nick of time by the United States army in April 1945. By then the teenager's weight had plummeted to just five stone but he recovered, married Bergen-Belsen survivor Helen Goldgrub and

the pair emigrated to the US, a country to which he felt indebted for setting them free.

Tramiel joined the US army and maintained official equipment and typewriters. Upon leaving in 1952, he used a GI loan of \$25,000 to found a repair shop called the Commodore Portable Typewriter Company while also working as a taxi driver. When he signed a deal to assemble and sell typewriters for a Czechoslovak typewriter company called Zbrojovka Brno NP, he moved to Toronto to get around Warsaw Pact restrictions. It resulted in Commodore Business Machines being formed in 1955 and, following a spell selling adding machines and pocket calculators, Tramiel was persuaded to try his hand with home computers.

TEXAS HOLD-UP

It was, in truth, a necessary step. Just as Japanese manufacturers had eaten away at the typewriter market and begun producing less expensive adding machines, now Commodore was being held out to dry by Texas Instruments (TI), which had provided

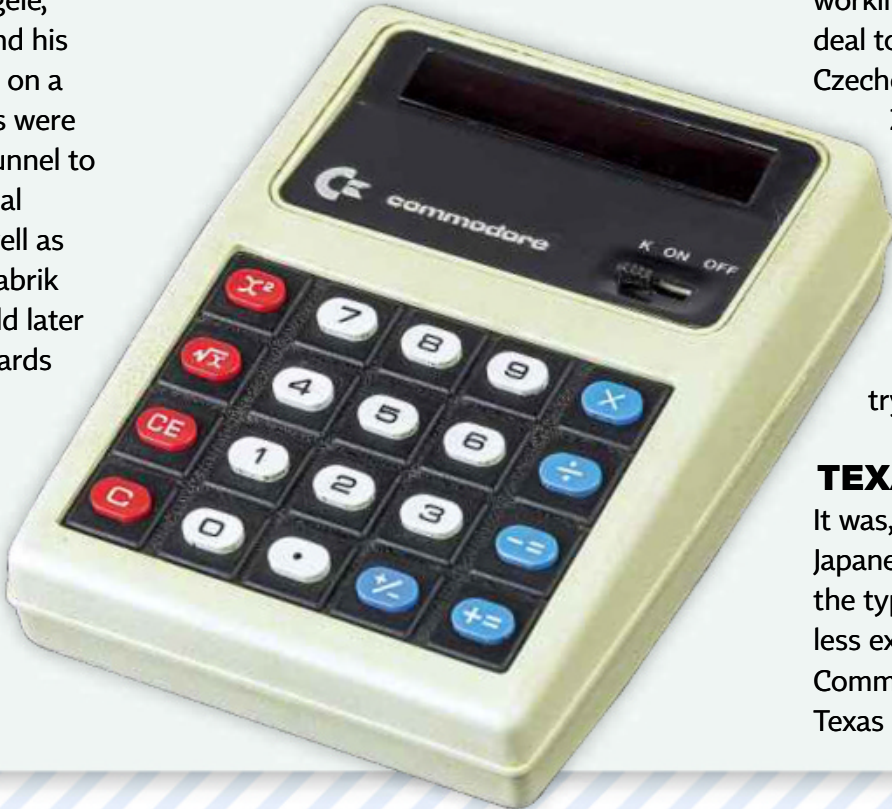


Image: © Raimond Spekking

► Commodore was a major producer of calculators based on a Texas Instruments chipset before it moved on to computers



↑ Having noticed that memory prices were falling, Jack Tramiel ordered the Commodore 64 to have 64KB of RAM

integrated circuits for the production of calculators. TI had decided to increase the price of its chips, while making its own calculators cheaper than those made by Commodore and other rivals. The move almost drove Commodore out of business, but it was rescued by a Canadian businessman called Irving Gould.

GOULD STANDARD

Gould injected \$3m into Commodore, which was used to buy the IC design and semiconductor manufacturer MOS Technology. Tramiel had figured that it would be better for Commodore to make its own chips, and it was MOS's lead designer, Chuck Peddle, who raised the potential of the home computer market.

MOS had developed a cheap microprocessor, the 6502, which

Steve Wozniak and Steve Jobs had used in their Apple I. Wozniak had switched to the chip after finding it was a seventh of the price of a Motorola 6800, and he stuck with it for the Apple II. Commodore had been offered Apple's machine but decided Jobs wanted too high a price. Instead, Commodore decided to place the chip at the heart of its own debut computer: the Commodore Personal Electronic Transactor, or PET. This was announced in 1976 and readied for the Consumer Electronics Show of January 1977.

The PET 2001 was a success, becoming the first computer to retail for less than \$1,000. As soon as he was able to, Tramiel looked for a market outside of the United States and, poignantly, targeted West Germany. He travelled to the country himself to meet potential buyers, telling them he had survived the Holocaust.

"I went directly to the front lines," he would later say, adding that his audience was keen to hear what he had to say.

Not that everything went smoothly. In 1980, the wiring on a coffeemaker on board Commodore's corporate plane, dubbed the Pet Jet, set fire on a flight from Chicago to Commodore's headquarters, which had been moved to California. It landed safely in Des Moines, Iowa, with its right side engulfed in flames and with smoke filling the cabin, skidding down the runway to such an extent that it overshot. Luckily, Tramiel and the other passengers were not harmed. Survival was seemingly in his blood.

THE PEOPLE'S COMPUTER

Commodore followed up the PET with the Commodore VIC-20, once more making use of the MOS Technology 6502 chip. Again, the computer sold in droves, this time becoming the first to top a million units, helped by the \$300 price, which was around half that of its competitors. Plugging into Tramiel's desire for low pricing, the cost also gradually fell as the years went by, making the machine even more attractive. Tramiel famously told the press that "business is war", and it became something of a motto.

The VIC-20 was also sold in West Germany, where it was renamed the VC-20. It ensured the computer didn't sound like the German swearword 'fick', and it also allowed Commodore to make out that the letters stood for VolksComputer in its marketing. This so-called 'people's computer' led to the creation of the Commodore 64, which sold more than 20 million units after going on sale in January 1982, bringing in a whopping \$1bn.

◆ The VIC-20 became the first computer to sell a million with Jack Tramiel (left) celebrating alongside 'VIC Czar' Michael Tomczyk, who developed and launched the computer



➔ The price of the computer was promoted as much as the innards, with Commodore stressing value for money

Tramiel was on a high, and the ruthless efficiency of his approach to business was admired by many. The Commodore 64 went up against the Atari 8-bit 400, the Atari 800 and Apple II in the US, while competing against the likes of the ZX Spectrum and eventually the Amstrad CPC in Europe.

Commodore was putting its machine into department stores and aggressively pricing to such an extent that its initial on-sale cost of \$595 fell by \$200 within two months and by \$300 the following year, with some retailers going as low as \$199. Certainly in the US, it was hard for rivals to compete, and the effects were so great that TI ended up being forced out of the home computer business (along with Mattel and Timex Corporation) – something that Tramiel relished.

“We need to build computers for the masses, not the classes,” he said at the time, and he would do all he could to get the cost of manufacturing to its lowest possible point. He would put immense pressure on his engineers and task them with looking for cheaper ways to create components. If something felt extravagant, he’d order it to be removed.

He didn’t particularly care for design. *Time* magazine said he was the ‘anti-Steve Jobs’, which is apt given the horrendous breadbin design of the VIC-20 and C64. Tramiel didn’t skimp on talent, however: many of those engineers were at the top of their game.

So too was the marketing department, which, with Tramiel’s full blessing, sought to put one over on the competition. “See what happened when we put a Commodore business computer in the same room with an Apple,” one advert stated, promoting the short-lived Commodore CBM in 1983. “Commodore ate the Apple.” It was typical of a company headed by a man whose bombastic spiel was great press fodder.

“Business is like sex. You have to be involved,” he once said. “It turns me on any time I can

➔ Jack Tramiel ordered the launch of Atari’s 8-bit XE computers when he took over, aimed at extending the life of the XL series while targeting the eastern European market



➔ Jack Tramiel ensured Commodore computers were pitched against rivals such as Apple

take a product costing thousands of dollars and I can sell it for hundreds.”

He enjoyed what he saw as serving society while satisfying his ego, and he became ever more confident. If the Japanese had impacted his business before, he was ready this time.

“The Japanese are coming, so we will become the Japanese,” he quipped. He also said there were three principles in business: “hard work, hard work and hard work.”

He loved to be in control. Any expenses that exceeded \$1,000 had to be passed by him, and he also played hardball with dealers. But a major falling-out with Gould saw him suddenly resign from Commodore, ending his roles as president, chief executive and director.

“Personal reasons prevent my continuing on a full-time basis with Commodore,” he said in a statement, with a source telling *The New York Times*: “It was a problem over a long period of time and it finally came to a head.”



FAMILY TIES

It was understood that Tramiel’s one-man approach to management was making it difficult for Commodore to recruit and retain executives, and that was seen as a major issue, even though the company was at an all-time high. Rumours abounded that Tramiel wanted to install his eldest son, Sam, as president, with his other sons Gary and Leonard given high-ranking financial and software roles respectively. This desire to create a Tramiel dynasty was strong enough for him to quit rather than compromise.

Given he was 56 years old, he could have retired. But after a three-month cruise, he sought a way back. He created a new company called Tramel Technology (missing out the ‘i’ in his name) and looked to work on a new 16-bit machine that would beat Commodore’s proposed Amiga. He then noted that Warner Brothers, which had bought Atari in 1976, was having trouble with its crumbling subsidiary, given it had reported a yearly loss of \$538.6m.

Tramiel, whose price-cutting efforts as well as the videogame crash of 1983 had caused such problems at Atari, stepped in with a complex offer, which saw Warner receive no cash but \$240m in long-term notes and warrants for a 32% interest in the new venture – effectively a string of IOUs. Warner retained the coin-op games division and the



↑ Jack Tramiel wanted a low-cost colour computer that could be connected to a television, and it resulted in the VIC-20

telecommunications part, Ataritel, with Tramiel being allowed to buy a million Warner shares at \$22 each. Analysts suggested Warner had given Atari away in the hope Tramiel would turn it around, but Tramiel went on to hammer down the payments owed to Warner and also brought his sons on board, with Atari's fortunes rising and Commodore staff poached.

Atari stalwarts were frightened. Some threatened to quit, having heard stories from others at Commodore (and of businesses stung by Tramiel's penchant for delaying paying suppliers for so long, many almost went to the wall).

"I love cutting waste," Tramiel said, as 1,050 of the 1,200 US staff were axed. Across the world, Atari's 5,000 employees became 1,500, but it nevertheless looked to sell more than 500,000 800XLs over the Christmas season to put it back in the black, with factories in Taiwan and Ireland churning them out.

ALL SYSTEMS GO

Tramiel then ordered a rejig of the Atari line but, more importantly, he had his engineers design a new personal computer in less than a year – a task that also included creating a new operating system. This would become the

Atari 520ST home computer running The Operating System (TOS), which was often dubbed the Tramiel Operating System, as well as the Mac-like Graphics Environment Manager (GEM), which was licensed from Digital Research. The computer went up against Commodore's Amiga, with the similarities between the two prompting wits that were later settled.

Based on the Motorola 68000 CPU – the same as the Amiga and the Apple Mac – the Atari 520ST was dubbed the Jackintosh by the press, and it did well in Europe thanks to its low cost and MIDI capabilities. As the first

NEWS

● NEW GAMING HANDHELD COMPETING WITH MINI RE-RELEASES

Although there are many retro-orientated handheld consoles on the market (together with a good number of DIY jobs that use a Raspberry Pi), the forthcoming Evercade device looks promising, not least because it supports physical media and has the backing of some big-name publishers.

It looks set to offer officially licensed classic 8-bit and

16-bit games such as Earthworm Jim, Switchblade, Centipede and Pac-Man from the likes of Atari, Namco, Interplay, Piko, Mega Cat Studios and Data East. Sold on compilation cartridges, the games will run on a 4.3in screen, although it will also be possible to hook up to a TV via an HDMI connection and enjoy HD up-scaling.

Nine cartridges of between six and 20 games will be available at launch in March 2020 at a cost of £15 each, with the handheld itself priced at £60. The console – which comes in black or white – will also have a built-in rechargeable battery lasting up to four hours and a dedicated game-save button. What's more, Evercade is hoping to attract indie developers with some

independent titles already announced. Find out more by visiting evercade.co.uk.

● VIEW A WEBSITE HOSTED ON A 30-YEAR-OLD MAC

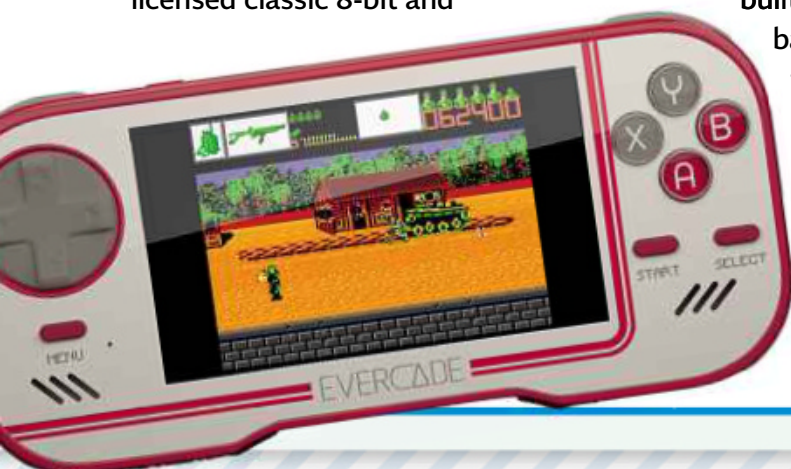
The World Wide Web was invented by Tim Berners-Lee in 1989, but could a computer released in that year be used to host a website today?

It was a question sales engineer Huxley Dunsany asked of his Macintosh SE/30 running MacOS 7.5.5. And the answer? Well, yes and no – for while it does indeed host and serve the site, (rhyal.com, the name of his son), it has needed a few modifications in order to do so.

Dunsany explains that he has upgraded the machine with a custom 32-bit ROM

and that the 2MB of RAM and 80MB hard drive have been replaced with 68MB of RAM and a 4GB solid-state drive. Ethernet capabilities have also been added.

The resulting site is simple. It contains a dithered GIF image along with text and a guestbook, and it goes offline when visitor numbers exceed 1,000, forcing a reboot. Even so, it's proven to be a popular curiosity. Maybe someone will try with a Dragon 32 next.



➔ When Jack Tramiel took over Atari, he axed the high-end 800 XL models in favour of redesigned versions of the lower-end machines

machine to have built-in MIDI In and Out ports, it became a favourite among musicians.

Even so, Tramiel's tough reputation preceded him. Retailers were reluctant to do deals, and there were battles with software companies (Lucasfilm managed to get out of a pre-arranged partnership with Atari, with an unimpressed Steve Arnold, who headed the company's Games Group, comparing Tramiel to Jabba the Hutt). Tramiel also delighted in any problems Commodore was having and, by the late 1980s, it appeared Atari had turned itself around and was on top.

MEGA SUCCESS


The ST saved Atari. It led to versions with built-in floppy drives and a business model called the Mega. There was an STE version adding more colours and stereo sound. Tramiel would fly to Germany for trade shows in order to promote these machines and he would often stay near Hanover.

At that point, however, Tramiel looked to become less hands-on, and son Sam became president and CEO, seeing Atari through the less-than-successful era of the handheld Lynx and 64-bit console, the Jaguar. Tramiel, meanwhile, showed his ongoing desire to ensure the memory of those terrible war years

survived. He co-founded the United States Holocaust Memorial Museum in Washington DC in 1993, which has since attracted more than 40 million visitors, and he became involved in other charitable projects, too.

He also returned to Atari for a short spell in 1995 when Sam suffered a heart attack, before selling the company to Jugi Tandon Storage in 1996, becoming a board member of the renamed JTS Corporation and moving to Monte Sereno in California to retire. This brought an end to his corporate life, and his attention moved back to the personal. In this, he showed a softer side

and he became ever more determined to keep the memories of the Holocaust alive.

Indeed, he was forever indebted not just to those who helped him – in 2003, he unveiled a plaque at the museum inscribed: "To Vernon W Tott, My Liberator and Hero" – but to those who had been killed. He wanted to keep their memories alive as best he could. As such, when he died of heart failure, aged 83, in 2012, he did so having left a legacy in more ways than one, ensuring his journey from the concentration camp to a captain of the computer industry will never be forgotten. 



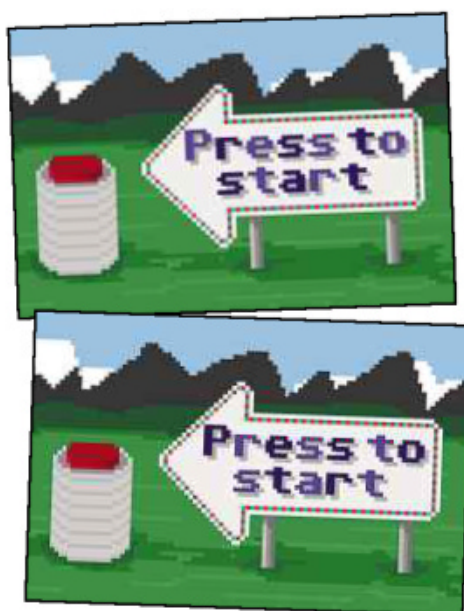
● DOWNLOAD INTEL DRIVERS FOR RETRO SCALING SUPPORT

Intel's newly released Ice Lake 10th-gen Core mobile processors make playing retro games on a PC a far crisper experience if you're lucky enough to have the latest GPU – so long as you download the beta drivers, anyway.

The drivers offer pure integer scaling, which scales up existing pixels by a whole number multiplier, as well as nearest neighbour interpolation to fill in the missing colour values of upscaled images so that the result is less blurry on a modern screen.

Intel says it will also make future indie titles look better.

"We're listening to our community. You wanted a way to experience pixel-art games at their best so we created Retro Scaling. Enhance the latest indie releases and timeless classics so



they look their best on modern HD displays," says the firm.

Get hold of the drivers by visiting tinyurl.com/382retro1.

● SOUND OFF WITH AN AMSTRAD CPC

If you'd like better audio capabilities from an Amstrad CPC 464, 664 or 6128, then you ought to sound out this wonderful project by Michael

Wessel. He's created a hardware expansion card called LambdaSpeak 3 that emulates Amstrad's official SSA-1 speech synthesiser and stereo amplifier. What's more, it also offers four-channel PCM sample playback so that the CPC can be used with a drum machine sequencer program.

Fitted with an Epson S1V30120 TTS chip running DECTalk 5, it's capable of natural sounding speech and can control an MP3 player or MIDI module thanks to its UART interface.

Indeed, version 53 of the firmware was recently released, offering a full duplex MIDI in/out real-time mode.

"The main excitement and motivation for the project came from being able to bring DECTalk to the CPC – the most versatile and natural sounding

text-to-speech engine that exists 'on a chip'," Wessel tells us.

"In the 80s, DECTalk hardware synthesisers were out of the price range for the hobbyist and cost thousands of dollars."

You can get the full lowdown on the project, complete with information about its components and links to files, by going to tinyurl.com/382retro2. Wessel says he is also offering fully assembled versions for sale, costing from £90 depending on the required options, so feel free to approach him via the site.



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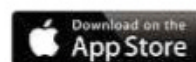
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In need of directions

I've had my Volkswagen Tiguan for more than a year, and we're about to use it on a family driving holiday to France. In the UK, we tend to use either Android Auto or Apple CarPlay to navigate, but we're concerned that doing so on holiday will blast through our data allowance and land us with big roaming charges. Instead, we'll use the car's satnav, the maps for which needed an update.

Unfortunately, when attempting to refresh them, I seem to have broken the system. I downloaded Volkswagen's DiscoverCare software, which didn't seem to offer the same Europe-wide mapping that's already on the system: instead, I had to choose from map bundles with partial coverage. The software backed up the satnav's SD card data, but then it failed when copying the new data on to the card. Although there seems to be data on it, the car says that it can't find the maps.

We're left without satnav, and I don't want to pay the dealership for an up-to-date SD card. Is there any way to recover it manually?

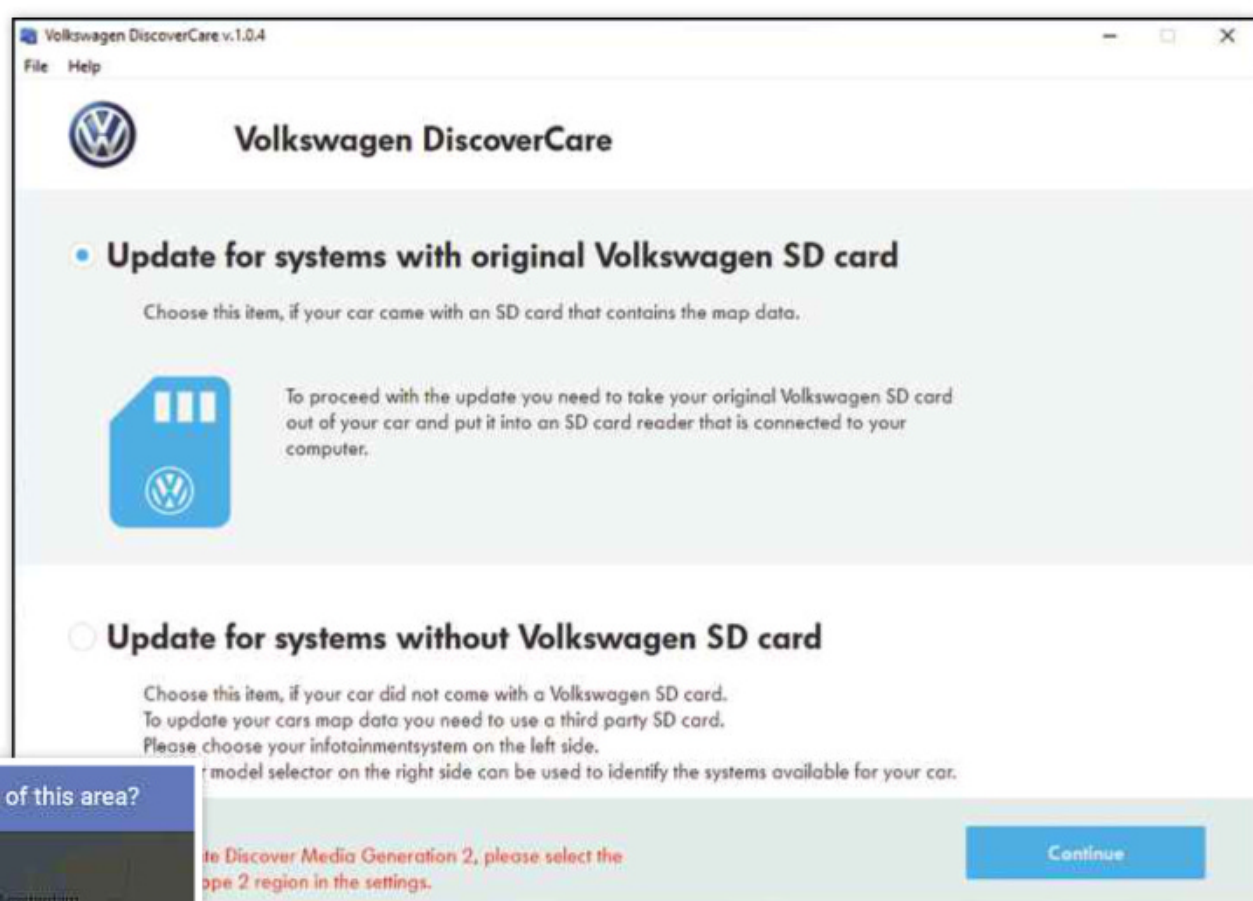
Paul Scott

We also encountered problems trying to update a VW navigation system with DiscoverCare. Fortunately, the map data is stored in a simple file structure and it's easy to update the SD card without the program's help. Visit tinyurl.com/382helpfile1, navigate to the correct model, year and navigation system for your car, then scroll down to find the available map data bundles. Click the Download button for European country bundle 1, which appears to contain a near-complete map of Europe.



↑ Google Maps lets you download multiple offline maps, each of which can cover a wide area

contain the extracted files. When this process has finished, open the folder to which you extracted the archive and manually copy the extracted data on to the SD card:



↑ Volkswagen's DiscoverCare ought to make map updates easy, but we experienced failures writing to the SD card

While the huge update is downloading, move the current contents of the SD card to a folder on your PC. And while that's ongoing, open a new browser tab, visit www.7-zip.org and download and install the 64-bit version of the 7-Zip archival software.

When the satnav data has downloaded to your computer, run 7-Zip, navigate to the downloaded file and click once to select it. Click Extract, then specify a new folder to contain the extracted files. When this process has finished, open the folder to which you extracted the archive and manually copy the extracted data on to the SD card:

make sure that the Maps folder is in the root of the SD card. Once the copy is complete, slide the card lock to prevent the map data being erased and re-insert the SD card in the car's slot. The system should now recognise the updated map data.

As an aside, you may be able to avoid big downloads in France by using Google Maps' offline maps feature. Start Maps on an Android phone, tap the menu button in the search box, select Offline maps, then choose Select your own map. Pinch the screen to zoom out, position the area box to include the region you're visiting, then tap Download. If you can't get the whole area in the box – if you're driving to the South of France, for example – you can repeat the process to map the entire area you need. Note that while this will save on map downloads, Maps will still need to use some data for route finding and live traffic information.

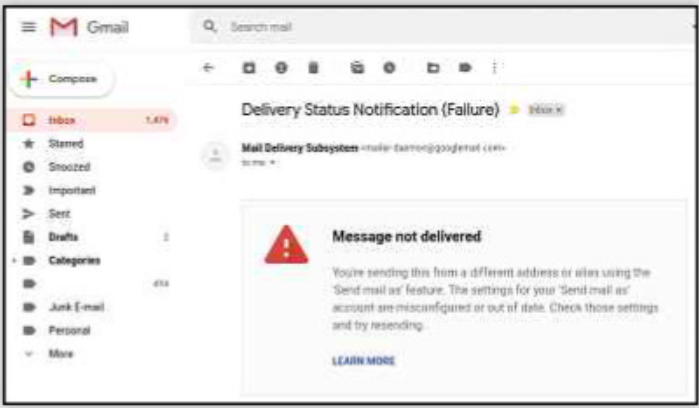
Bouncing emails

I use a Google Mail account for my personal email. For most purposes I use the @gmail.com address associated with it, but family and some old friends still use an email address that I set up on a domain I own. My son helped me configure Google Mail so that it could receive mails sent to this address, and we added it as an alias on my Google account so that I could also send from it.

It's been working fine for a few years, then suddenly it stopped working. I can receive emails, but when I send, it fails with a delivery status notification telling me my settings are misconfigured or out of date (I haven't changed any settings). I thought the problem was intermittent until it dawned on me that I simply don't send with that alias very often. My son's travelling; can you help me work out the problem?

David Simpson

When we looked into the issue, it emerged that Sky is your ISP, and you've configured



↑ 'Too many bad auth attempts' means you have a login or permissions problem

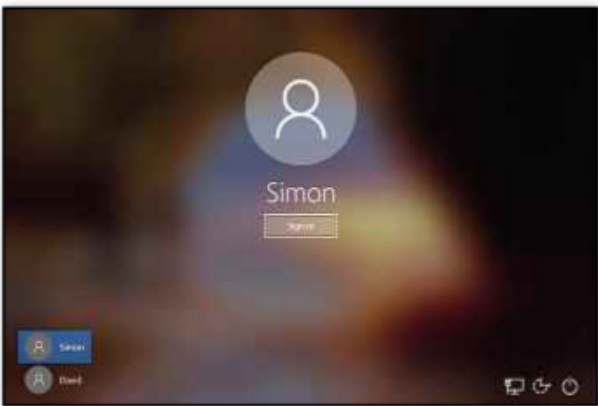
Google Mail to use Sky's secure mail transfer protocol (SMTP) server to send mails from the problem email address. This summer, a number of Sky accounts were accessed in an attack. Although yours wasn't one of them, the company reset its users' passwords as a precaution. When this happened, Google could no longer access Sky's server to send mail on your behalf. The fix is to open Settings in Google Mail, navigate to the Accounts and Import page, then edit the settings for your alias and update the password.

All a blur

Since updating to Version 1903 of Windows 10 Pro, my Lock Screen picture is out of focus when the computer starts. This happens whether the Lock Screen content is set to Windows Spotlight or Picture. I used to enjoy seeing the various landscapes, but now they're all fuzzy. Is there a reason for this, and any way to prevent it?

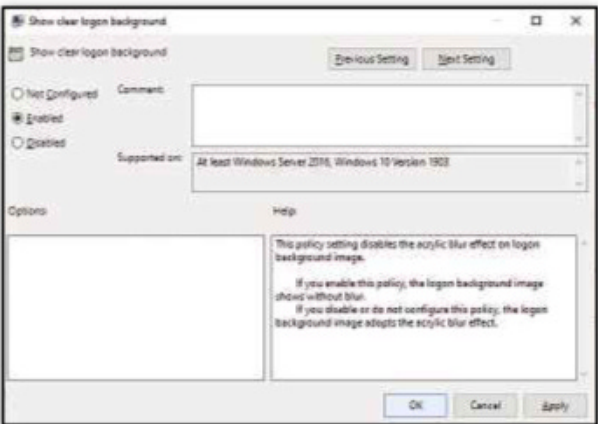
Rodney Broom

We're not sure why Microsoft made the change, but there are several solutions of varying complexity. The easiest is not to log in; after about 30 seconds the prompt will disappear in favour of Windows Spotlight information, and the picture will come into focus. The next easiest option is to open Settings using the gearwheel icon on the Start menu, go to the Personalisation section, select Colours, then switch off Transparency effects. Unfortunately, this affects all the aspects of the Windows interface where transparency is used, which probably isn't what you want.



↑ From version 1903, Windows 10 blurs the login screen picture

There are two methods to achieve what you want. As you have Windows 10 Pro, the easiest option is to use the Group Policy Editor, which is easier than the alternative of manually creating a Registry key. Open the Start menu, type **gpedit** and run Edit Group Policy from the results. Under the Computer Configuration heading, expand Administrative Templates, then System, then select Logon. In the right-hand pane, double-click Show clear logon background, then in the dialog that opens, select Enabled and click OK. Now close the Group Policy Editor, and the next time you lock or restart your PC you should find that the background picture is crisp.



↑ If you have Windows 10 Pro, you can use the Group Policy Editor to make the picture clear again

Picture imperfect

I enjoyed your recent article 'Use Word like a pro' (Shopper 379), but you didn't mention what I feel is one of the most frustrating aspects of Word. When copying a mix of images and text from a web page, sometimes it works, but usually it doesn't, with the images just being replaced by blank spaces. Right-clicking on the spaces reveals a URL link to a source image, so Word knows what the images should be, but won't insert them.

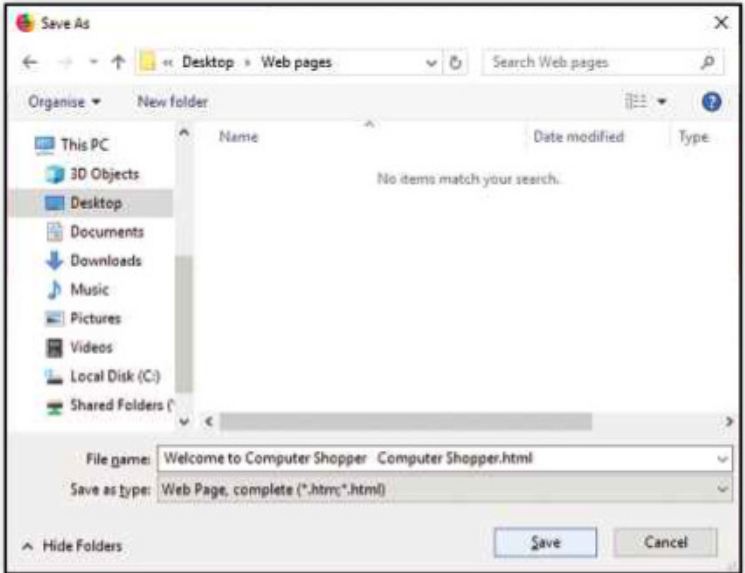
It's possible to save images from the web and insert them individually into a document, but this is very time-consuming. I have delved into Word's settings, but nothing I've tried has made a difference. Is it not possible to force Word to insert images

rather than their links? I've tried with Word Professional 2010 and Word Home & Student 2013, Firefox and Windows 10.

Nick Taylor

Web pages are often complex, with hidden formatting or scripts that can prevent a simple copy and paste of their contents. You don't mention why you want to paste web pages into Word, but whether you want to save or edit them it's not the ideal platform. If your purpose is the former, we'd recommend you open Firefox's menu, choose Save Page As, then save the page as an HTML file. Then you can double-click the saved file to view it in Firefox. If you want to edit the page, you can open the HTML file in a web editor such as the free Website X5 Go (www.websitex5.com). In theory, all the necessary scripts and images should have been saved into a sub-folder.

If you have your own reasons for sticking with Word, you'll get the best results by saving the HTML web page as above, then opening the HTML file from Word's File, Open dialog box. However, you're still likely to find that the formatting is incomplete and that some images are missing. Whatever your reasons, remember the HTML and other elements of a website are likely to be subject to copyright, so you shouldn't reuse significant portions for your own projects.



↑ You can save a complete web page for later viewing or editing, but we wouldn't use Word for either

Not so shiny Chrome

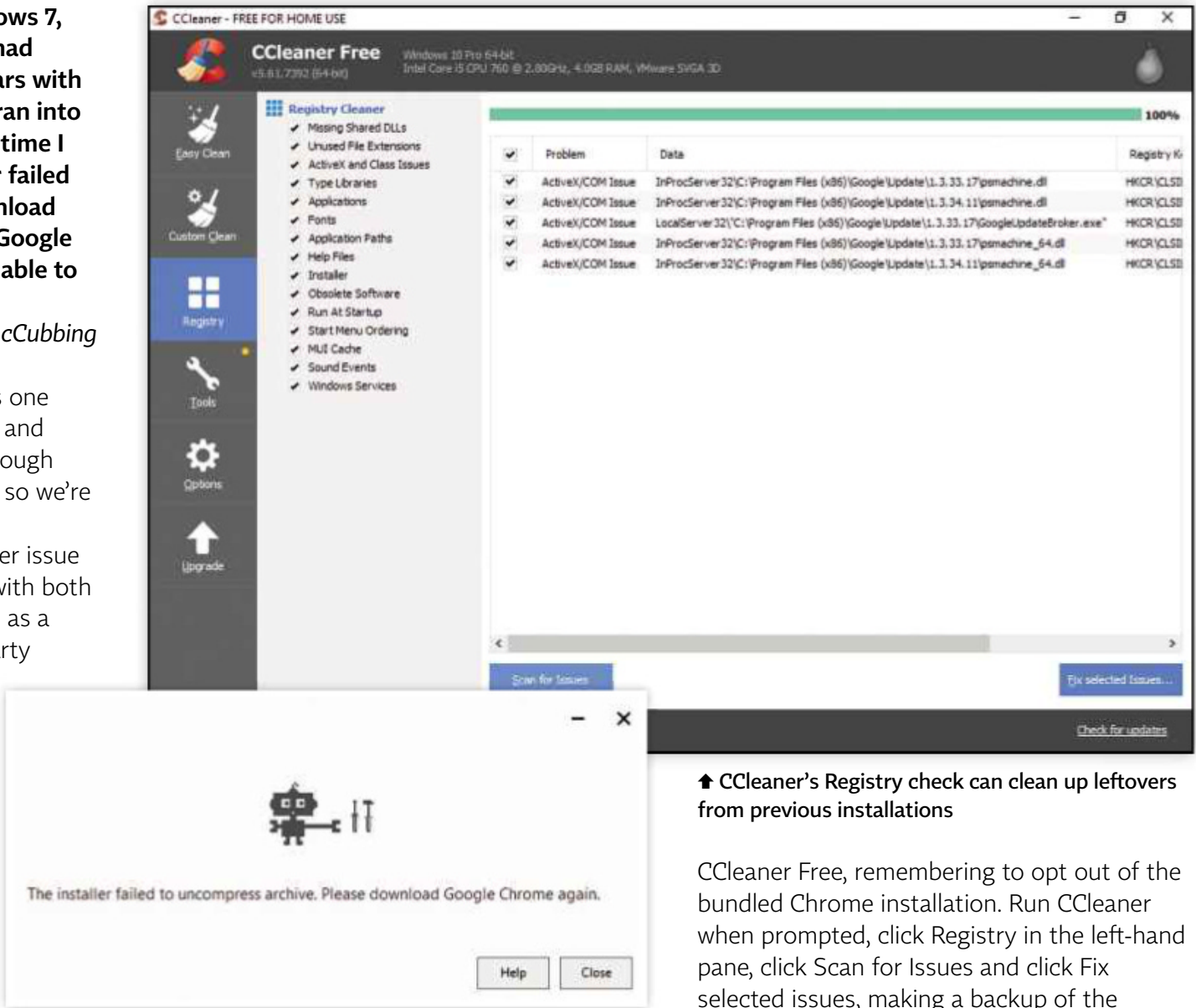
I've got a PC that used to run Windows 7, which I upgraded to Windows 10. I had Chrome installed and used it for years with no issues, but after uninstalling it I ran into problems trying to reinstall it. Each time I try, I get the message, "The installer failed to uncompress archive. Please download Google Chrome again." I contacted Google support, but they said they were unable to help me. I wonder if you can?

John McCubbing

As with many non-specific errors, this one seems to have many potential causes and fixes. Unfortunately, we don't have enough information to re-create the problem, so we're only able to give generic advice.

Several users claim that the installer issue is related to their antivirus software, with both Kaspersky and Sophos products cited as a potential cause. If you have a third-party security suite, try temporarily disabling it, running the upgrade, then re-enabling protection afterwards. Some users of Kaspersky Total Security have reported that they needed to fully uninstall the product before Chrome would reinstall. If you try this, don't forget to reinstall Total Security afterwards.

Others have suggested that the problem is linked to a lack of permission for the installer, or to remnants of the previous Chrome installation. You can tackle both possibilities by opening the Start menu, searching for disk and running Disk Clean-up



Antivirus software can occasionally interfere with some software installations

CCleaner's Registry check can clean up leftovers from previous installations

CCleaner Free, remembering to opt out of the bundled Chrome installation. Run CCleaner when prompted, click Registry in the left-hand pane, click Scan for Issues and click Fix selected issues, making a backup of the Registry when prompted.

Finally, visit tinyurl.com/382helpfile2 to download the self-contained Chrome installer. Right-click the downloaded file, select Run as administrator, and with any luck it should now complete without throwing up the error.

Getting the band back together

My friends and I used to be in a band back in our school days. Thirty-something years later, we've decided to get back together and try to remember and record some of the old songs. Our guitarist is sketching out riffs and ideas on his iPhone using the Caustic 3 app. I've installed the Android version, and was hoping to use it to create some percussion and bass tracks. Years ago I bought an M-Audio Keystation Mini 32 keyboard, which I hoped might be good enough to use as an input device, but its lead won't fit my phone. Is it possible to get one that will, and if so, will the keyboard work?

Glenn Armitage

The Keystation Mini 32 has a USB Mini socket, so its supplied cable has a USB Mini plug on one end and a standard USB Type-A connector on the other. To connect it directly to your phone, you'll need a USB

If you can't get the Android app to recognise your MIDI keyboard, try on the PC

on the go (OTG) cable that has a USB Mini-B plug on one end, and a USB Micro-B plug on the other.

While this will take care of the physical connection, unfortunately there's no guarantee that the keyboard will work with all Android devices: OTG support can be rather patchy. If it's going to work, you'll see an Android system notification when you first plug the keyboard in, and it should be available as a MIDI input source in the app. If you don't see the



notification you're probably out of luck, but there is a PC version of Caustic 3. The keyboard should work correctly with this, using its original cable.

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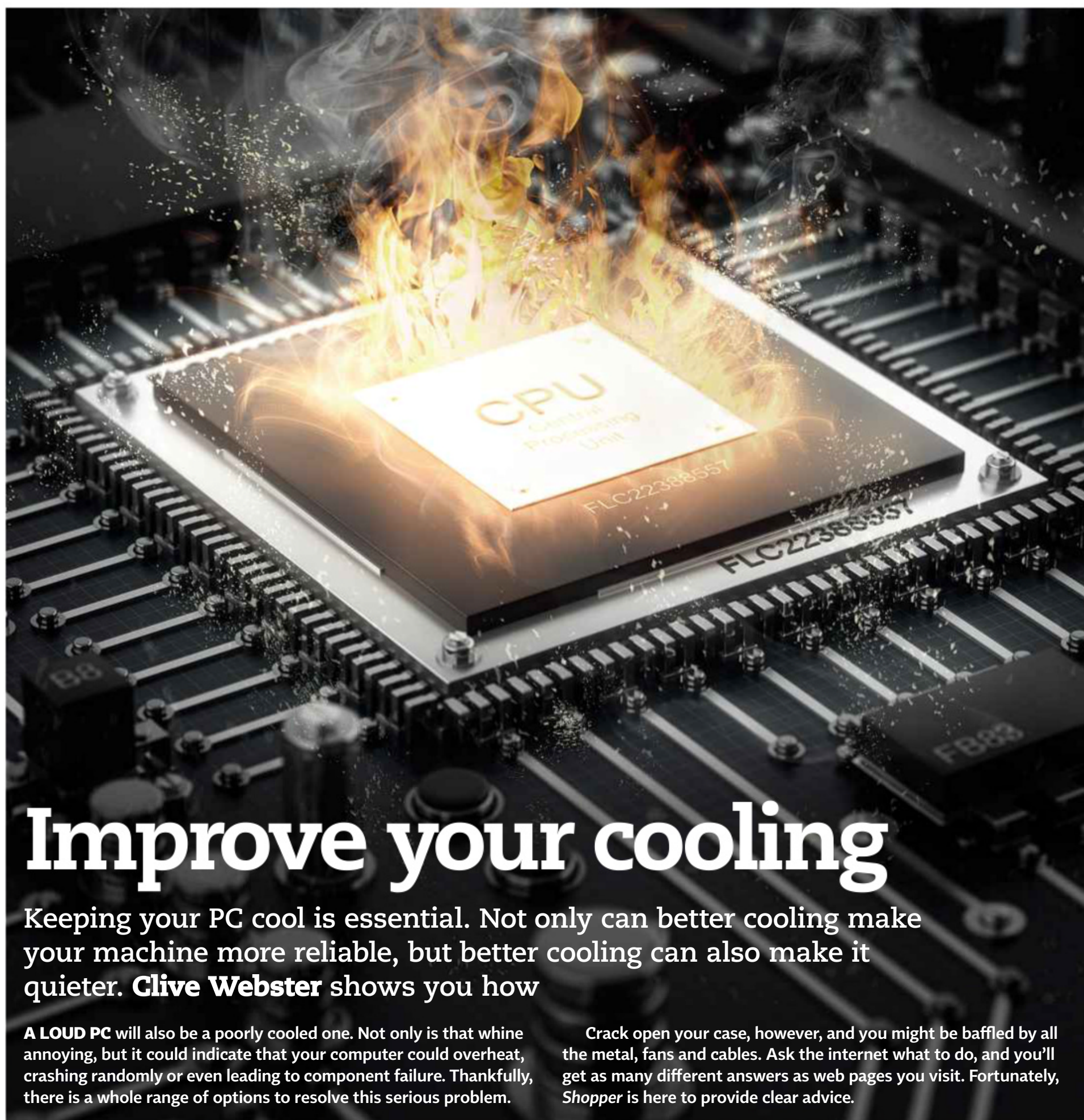
How much does it cost to run? !?

CHARGING STATION

Advanced Projects

Clive Webster has been tinkering with computers ever since Windows 98 forced him to manually install his drivers

clive@computershopper.co.uk



Improve your cooling

Keeping your PC cool is essential. Not only can better cooling make your machine more reliable, but better cooling can also make it quieter. **Clive Webster** shows you how

A LOUD PC will also be a poorly cooled one. Not only is that whine annoying, but it could indicate that your computer could overheat, crashing randomly or even leading to component failure. Thankfully, there is a whole range of options to resolve this serious problem.

Crack open your case, however, and you might be baffled by all the metal, fans and cables. Ask the internet what to do, and you'll get as many different answers as web pages you visit. Fortunately, *Shopper* is here to provide clear advice.



↑ It's worth checking the cooling inside your PC regularly, and especially if you've just installed a new piece of hardware

POOR COOLING MAKES for a very annoying PC. Whirring fans are distracting whether you're working or trying to enjoy some music or a film. Even worse, overheating components can cause your PC to crash. It's worth checking your cooling every so often, particularly after installing some flashy new hardware. Even a £5 fan can make a big difference.

First, you need to assess your current cooling and identify any issues. If your PC is loud when it's not doing anything, you have

two potential problems: either you have a very cool PC and your fans are working harder than they need to, or you have a hot PC and your cooling isn't really adequate.

You can tell if your PC is prone to overheating, or which component might be overheating, as the fans will spin up and

Cold heatsinks might indicate a poor contact with the chip underneath: the chip will be running far too hot, so you'll need to reattach the heatsink. Conversely, if the heatsink is scorching hot, it's not getting enough airflow.

While you're poking around, try stopping the fans: just press gently on the solid

You can tell if your PC is prone to overheating as the fans will spin up and become quite loud



↑ Don't poke anything into the fan blades while they're spinning, as you could cause some damage

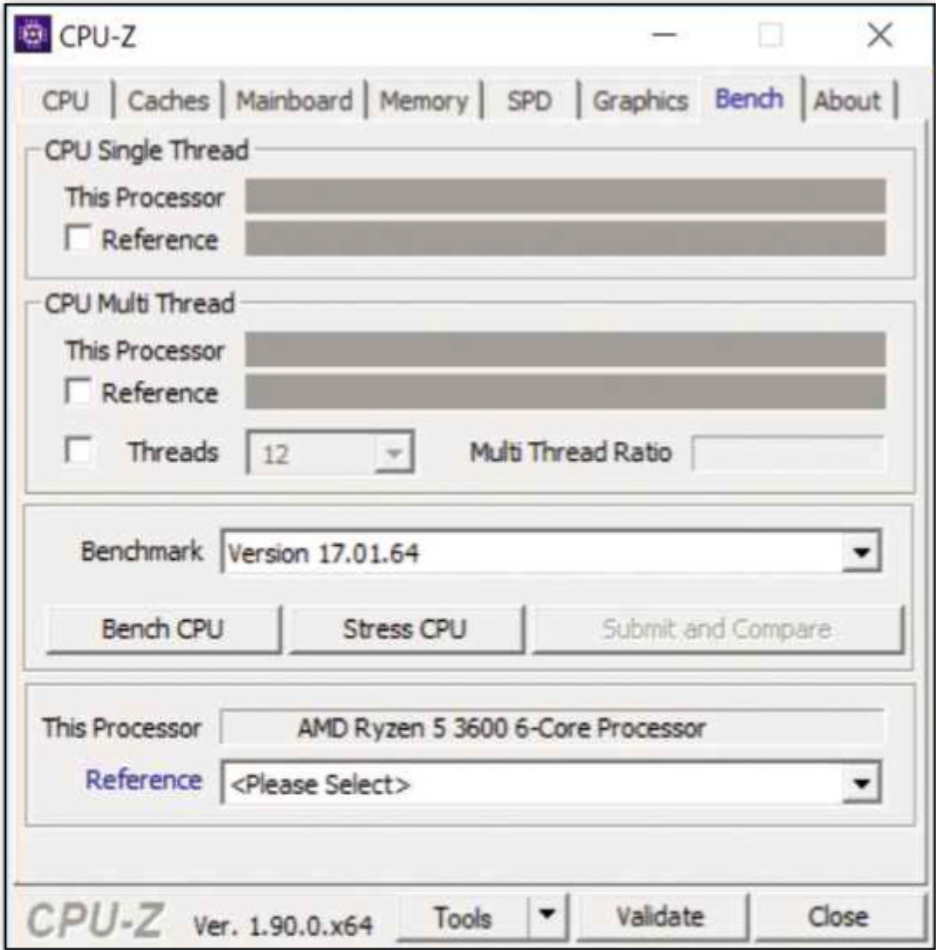
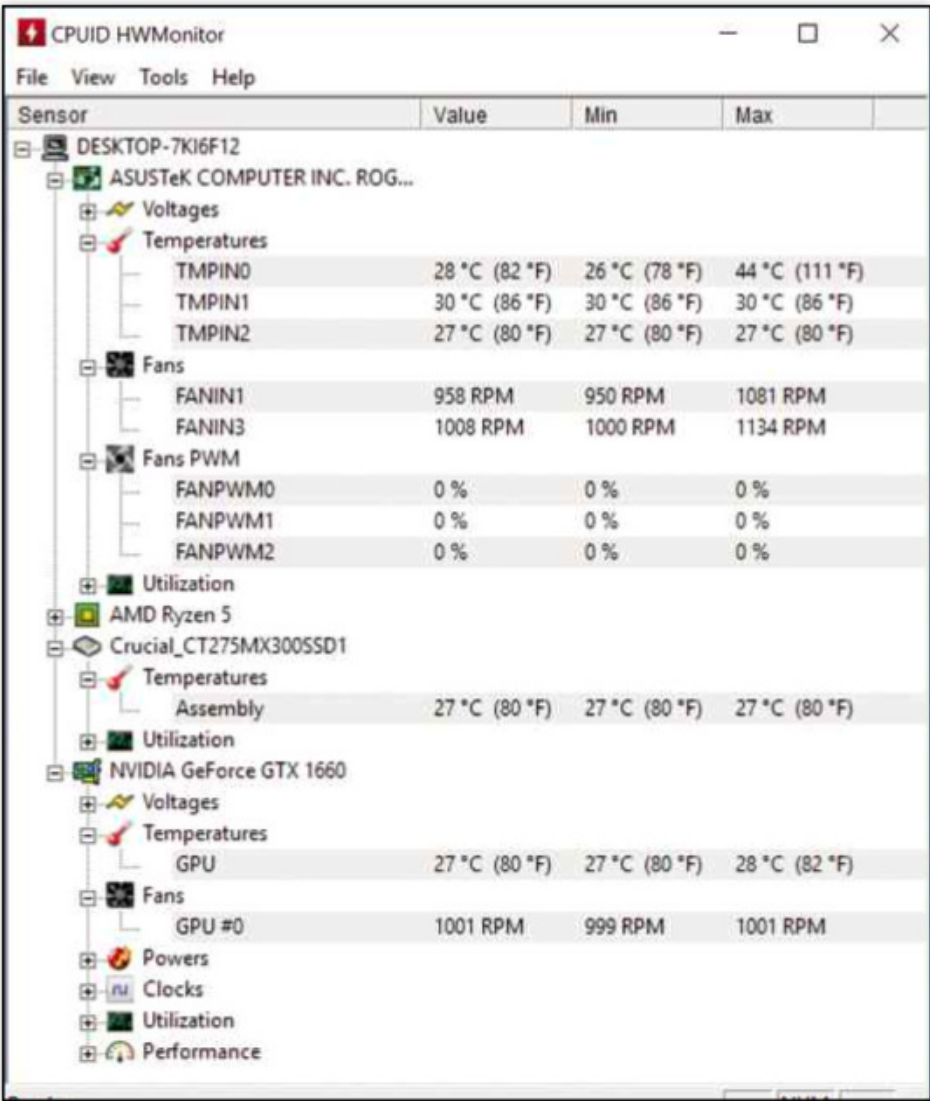
become quite loud when you're running certain software or working on a particular task. If your PC is loud when you're editing videos or batch-processing images, your processor is probably running hot. If gaming turns your PC into a wind tunnel, your graphics card is probably the culprit, but your CPU's cooler could also be working too hard.

FINDING THE CAUSE

You can do a few quick manual tests to check if your cooling is adequate. With your PC running, open your case and carefully touch all the heatsinks (to avoid static, discharge yourself on a radiator first). If your PC is idling, the heatsinks should be warm but not hot.

portion at the centre, as poking anything into the spinning blades can cause damage, for example, to your fingers. It's fine to do this for a second or two; you won't damage the motor or cause anything to overheat. By stopping each fan individually, you might be able to find a loud one that you can replace.

A loud fan blowing hard on to a cool yet well-seated heatsink might be an opportunity to dial down the fan speed. You should be able to do this via the BIOS, so check your motherboard's manual. However, before lowering your fan speeds, you need to check what your cooling is like when your PC is working hard, and for that you'll need to run stress-test tools.



⬆ Note the Tj Max, the maximum safe temperature for your processor

⬆ HWMonitor gives you a huge amount of real-time information on every aspect of your computer

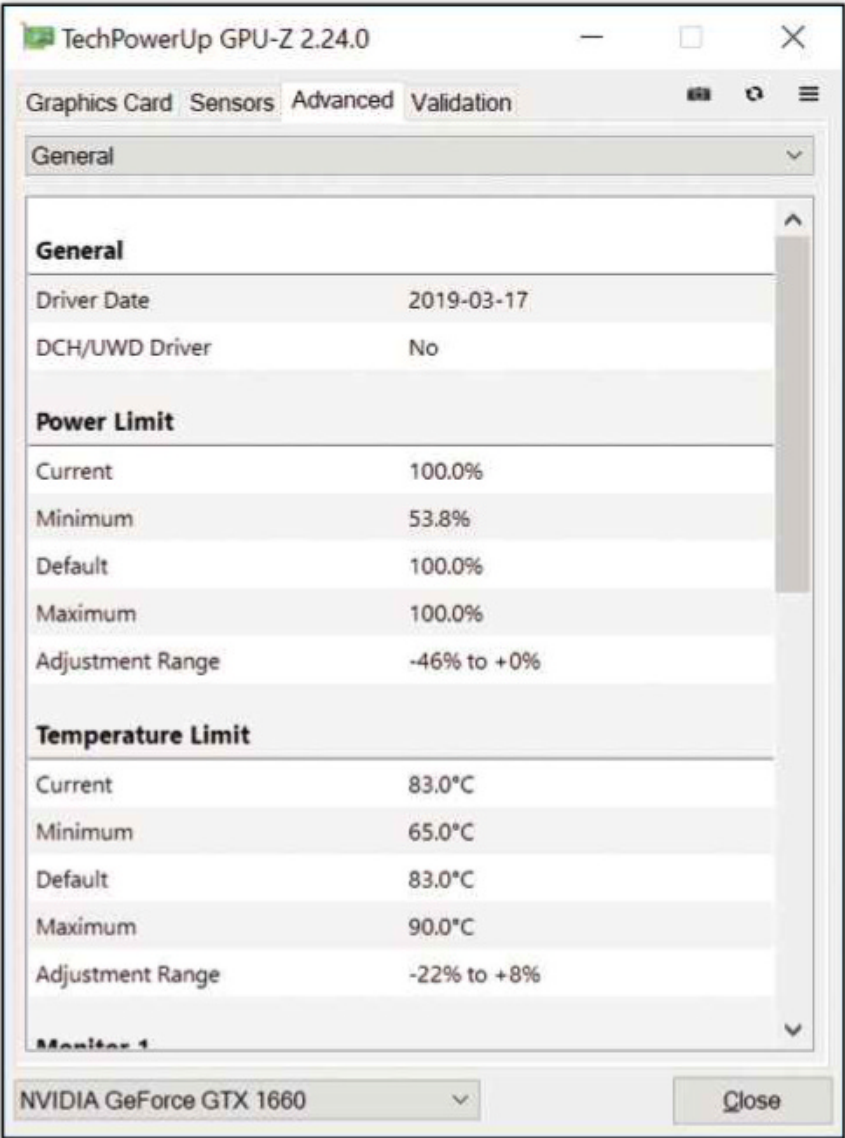
Go to www.cpubid.com, and download HWMonitor and CPU-Z. Then head to geeks3d.com and download FurMark. Finally, go to www.techpowerup.com/gpuz and download GPU-Z. These four tools should work with any and all hardware.

Once installed, launch HWMonitor and you'll see a huge list of real-time technical data. Intel processors have a built-in temperature sensor, which you'll find in the processor section. AMD CPUs don't have built-in sensors, instead relying on a sensor embedded in the motherboard socket, so you'll find the processor temperature listed in the motherboard section (typically the first listing, with the highest figures).

STRESS-TESTING

To stress-test your processor, launch CPU-Z and note the Tj Max temperature; this is the Thermal Junction Maximum, the highest safe operating temperature of your CPU. Your processor shouldn't run within 10°C of the Tj Max. Open the Bench tab of CPU-Z and click Stress Test. The temperature of your processor should start to rise, and you'll probably hear the cooler's fan spin up. After a while, the temperature should plateau; if not, you've got a serious problem. Shut down the PC and attend to the processor cooler immediately: either it's not seated properly or you need an upgrade. Equally, if the temperature was fine but the noise was too loud, a cooler upgrade is in order.

To test your graphic card's cooler, load GPU-Z and open the Advanced tab. Toward the bottom you'll see a section for temperatures, with a maximum of typically 90°C. Note this temperature and close GPU-Z. Find the graphics card section of HWMonitor; it will be labelled AMD or Nvidia, regardless of who actually made your card.



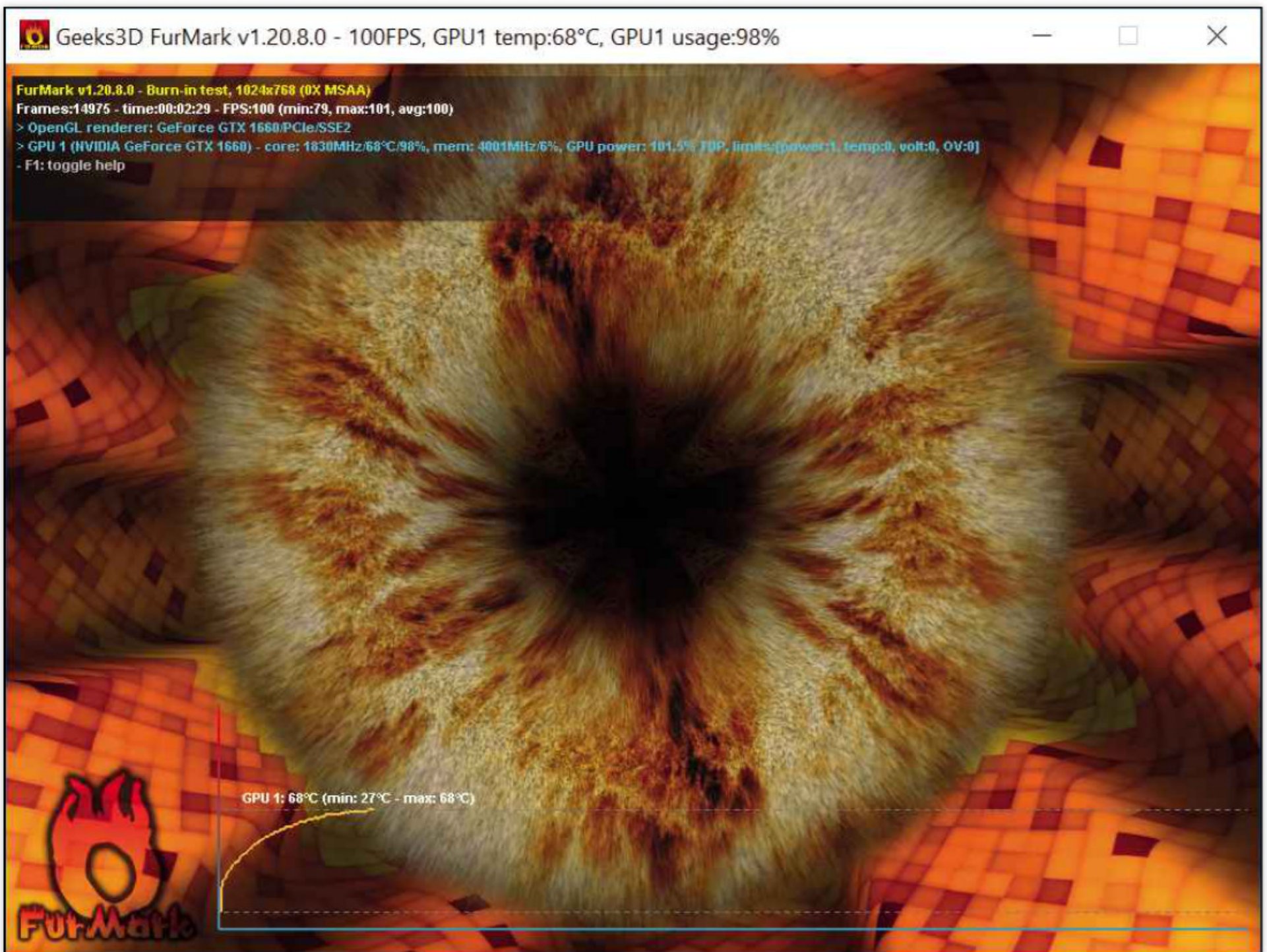
Now launch FurMark, click GPU Stress Test, then click Go. Agree to the warning (it's more of a disclaimer than a genuine worry) and you'll see the infamous furry doughnut. The effects and patterns are incredibly difficult for a graphics card to render, a useful worst case to test your card's cooling.

FurMark graphs your graphics card's temperature over time, so you might not even need to use HWMonitor. Again, hopefully the temperature will plateau after a few minutes, otherwise you've got a serious issue.

FREE AND CHEAP FIXES

Heatsinks clogged with dust are unlikely to cause overheating, but there's no harm in blowing the fluff out. A £5 can of air duster can be very helpful. Any more stubborn blockages within the fins of a heatsink should be removed. Another cheap fix is to ensure your motherboard's UEFI is up to date. CPU-Z will tell you the manufacturer and model of your motherboard, and you can then go the manufacturer's website to download the latest version and find instructions. You might need to download the motherboard manual. For example, the standard AMD cooler of our Ryzen 5 3600 (£189, www.scan.co.uk) refused to spin up, causing the processor to hit its Tj Max and start throttling its speed. Updating the UEFI of our Asus Strix

⬆ Use GPU-Z to discover the maximum temperature of your graphics card



↑ FurMark's falling furry doughnut is an infamous stress test for your graphics card

B450-F Gaming motherboard (£125, www.scan.co.uk) solved this problem for free.

Case fans can also make a big difference to overall cooling. However, you'll find lots of conflicting advice as to how many fans to use, how big they should be, and where to place them. Keen to provide some definite answers, we tested various layouts using our

Asus motherboard and Ryzen 5 inside a Corsair Carbide 275R case (£73, www.scan.co.uk) with an EVGA GTX 1660 XC Black graphics card (£220, www.scan.co.uk).

The Carbide case comes with two 120mm fans, placed in the standard configuration: a low front intake and a high rear exhaust. We experimented with disconnecting and

moving these fans, and also adding a third 120mm fan in the case's roof vent.

We've highlighted some of the findings in the box on page 128. Most alarming were the temperatures when no fans were powered. Despite the Corsair case having many open vents, the heat just built up, with the processor hitting 93°C, the graphics card



↑ Try updating your motherboard's UEFI before buying anything, especially if your board or processor are new



➔ The Corsair Carbide 275R uses the standard single input/single output fan arrangement, but is this configuration best?

reaching 83°C and the chipset 51°C. Clearly, we can't rely on the plain physics of convection: fans are definitely needed to move air actively across our hot components.

However, it only took the single rear fan to bring temperatures down to more reasonable levels. The maximum processor temperature dropped 16°C, while graphics card temperature fell 9°C and chipset temperature by 10°C. Not a bad result, considering a decent case fan costs £5 to £8.

Surprisingly, we found little change when also connecting the front fan. The chipset temperature dropped another 4°C – the front fan is essentially blowing directly on to it – but drops elsewhere were only one or two degrees at most. Equally, moving the front fan to the roof only led to a decrease of 1°C for the graphics card and chipset.

Filling all three fan slots was also underwhelming. The processor, motherboard and SSD ran only 1°C cooler than with only the rear fan, with the graphics card shedding 2°C. It may be tempting to use one fan (as a rear exhaust) to deliver quiet cooling, but we'd still use a front intake fan to supply airflow for the chipset.

A NEW COOLER

We feel a bit squeamish about running a processor at stock speeds at 77°C, so a

better cooler was in order. A £25 Arctic Freezer 33 eSports One is a great choice if you're on a budget, but we fancied a big upgrade and tested a Corsair Hydro H100i RGB Platinum (£110, www.scan.co.uk).

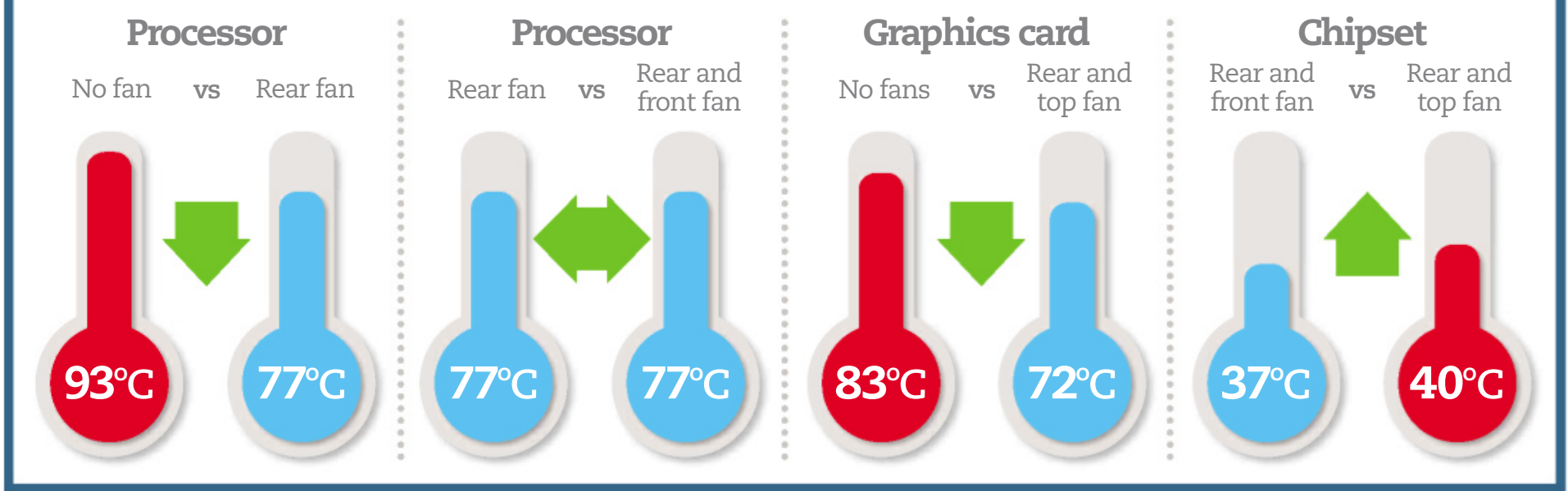
This sealed unit watercooler has a few flashy extras, not least the rainbow-pattern LEDs, and onboard temperature and fan controllers. Fitting the unit can be a bit fiddly,

however, and we chose to attach the fans to the radiator first, and then loosely install the waterblock before screwing the radiator to the roof of the case and finally tightening the clips on the processor socket. Cable routing is tricky, but the Carbide 275R has plenty of handy holes to hide the clutter.

Once installed, the results were impressive. With the front and rear case



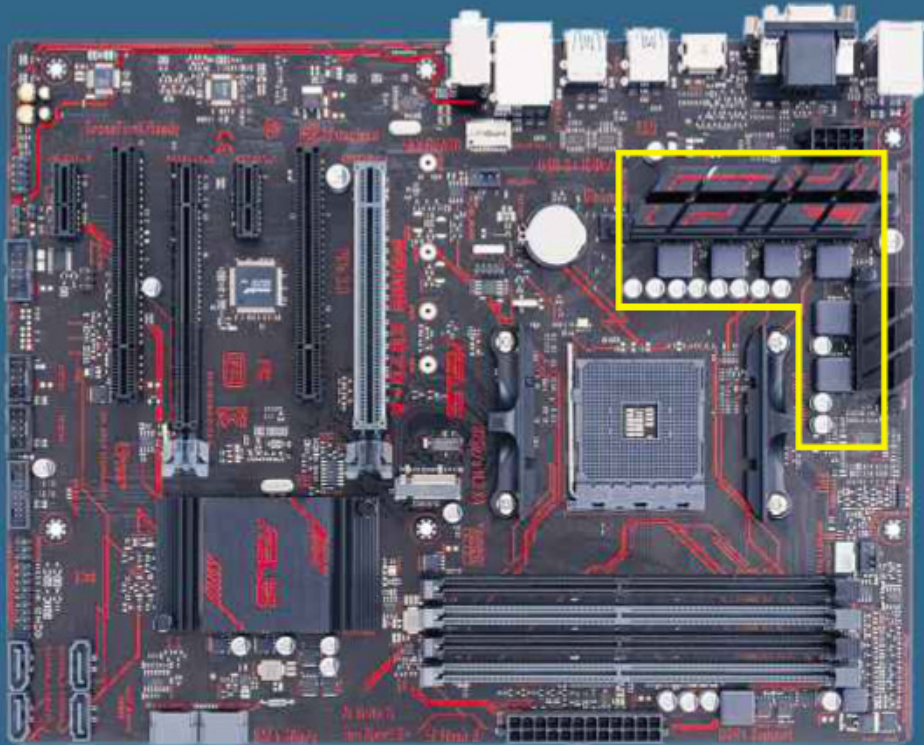
Cooling results



The unusual suspects

Aside from the processor, there is another large chip on your motherboard called the chipset. This is placed towards the lower-right corner, and may be covered by a heatsink. To stress-test the chipset, try running a full virus scan, and monitor the temperature through HWMonitor (it will be the second-hottest value listed under the motherboard section). Chipsets shouldn't exceed 50°C. If yours does, you'll need to check that the heatsink is attached properly, or direct a fan towards it.

Around the processor socket is an array of circuitry that converts the 5V input from the processor's dedicated power cable to the 1-1.5V voltage that modern processors require. As such, these Voltage Regulation Modules (VRMs) require a reasonable amount of cooling. More expensive motherboards cover their VRMs with a heatsink. It's tricky to measure the temperature of your VRMs, so make sure there's decent airflow over them.



↑ The highlighted area contains some high-energy components, called VRMs. These can overheat under certain circumstances



↑ Unless your PSU has built-in monitoring, such as Corsair's iCUE system, it can be tricky to identify a problem

Your main power supply unit (PSU) shouldn't run overly hot if its power output is well matched to the power demands of your PC. It's quite difficult to calculate what wattage is adequate, but a powerful PC with a single powerful graphics card shouldn't need much beyond 650-750W. Some power supplies, such as Corsair's AX range, have built-in monitoring, which you can access in Windows through its iCUE software.

A mechanical hard disk has a maximum operating temperature of around 60°C, at which point the lubricants in the motor will degrade. A virus scan will stress-test your hard disk, and HWMonitor can report the temperature. SSDs are more robust and have a maximum operating temperature of around 70°C. If your SSD is anywhere near that temperature, you need to have a rethink about how you cool your PC or where you've mounted your SSD.

While almost all memory comes with a heatsink covered in flashy branding (and sometimes flashy LEDs), it's very rare for memory to overheat. However, memory modules can fail. Run the Windows Memory Test if you suspect a memory fault.



← Corsair's iCUE can also control a Hydro water-cooler, giving you control from within Windows

setup, there wasn't the same extra noise when stressing just the processor. However, the extra cooling power means that you play more with fan speeds while keeping the processor under 70°C. The Asus Strix board has many fan control settings for the case fans in its UEFI, but the USB connection of the Hydro cooler also lets you control the speed of the radiator fans in Windows via the iCUE software. Just remember that the temperature readout is the temperature of the coolant, not the actual processor. Our coolant peaked at 29.5°C, but the processor was definitely much hotter.

fans (plus the now two roof fans of the radiator) the maximum processor temperature dropped another 12°C, while the graphics card and chipset also lost another 2°C. Disconnecting the rear fan caused a 2-4°C rise in temperatures

across the system – that might be acceptable, but it's surprising given the two roof exhausts of the radiator.

Water cooling isn't just about lower temperatures, however: it's also meant to make your PC quieter. Using the default

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