



Educators and students: Get a responsive Chromebook to help assess student work, plan lectures, communicate remotely, and more

Two Intel Core processor-powered Chromebooks took less time to complete tasks in certain apps than a Chromebook powered by an AMD Ryzen 7 3700C processor

Executive summary

At Principled Technologies, we compared the responsiveness of the following three Chromebooks™ for tasks in a variety of apps that educators and students might use for work:

- Intel® Core™ i7-1185G7 processor-powered Chromebook
- Intel Core i5-1145G7 processor-powered Chromebook
- AMD Ryzen™ 7 3700C processor-powered Chromebook

We found that the Chromebooks powered by Intel Core processors saved time on tasks in apps such as Google Drive™ and Adobe® Lightroom®. We also found that the Corel® virtualization app Parallels Desktop® ran well on the Intel Core processor-powered Chromebooks, meaning that teachers and students can migrate from their old Windows 10 device to a Chromebook without losing familiar workflows.

Today's educators must be prepared for days when the dining room table has to serve as a classroom or lecture hall. Having a Chromebook that gives quick access to cloud-based documents and files can help support teachers' and professors' work.

†HP Pro c640 G2 Chromebook with an Intel Core i7-1185G7 processor compared to a Lenovo® C13 Yoga® Gen 1 Chromebook with an AMD Ryzen 7 3700C processor.

‡See [the science behind this report](#) for detailed system configurations and benchmark results.

30%
less time
working with
documents, charts, and
presentations while on a
Google Meet call[‡]

25%
less time
unzipping, creating, and
more with photos during
a Google Meet call[‡]

How we tested

Google Workspace and Adobe app scenarios

We tested each Chromebook by hand-timing common scenarios in a variety of apps that educators and students use in the course of their work. This reflects how, in the real world, users rarely perform single tasks in isolation. To portray a remote learning experience, we connected the Chromebooks to a four-way video call via Google Meet for each scenario.

Other apps

In addition to our scenario-based testing, we hand-timed tasks in individual educational apps.

Benchmark tests

Finally, we ran two benchmark tests (WebXPRT 3 and Speedometer 2.0) on each Chromebook that measured web-app responsiveness.



In this report, text in the red boxes represent fictional scenarios and characters.

Though Dr. Allis Young is able to see most of her students in person this year, she makes sure to keep her Google Drive folder up to date for students who may unexpectedly need to be remote during the semester. Her Intel Core i7-1185G7 processor-powered Chromebook makes teaching, communicating with students, and editing lesson plans a breeze.

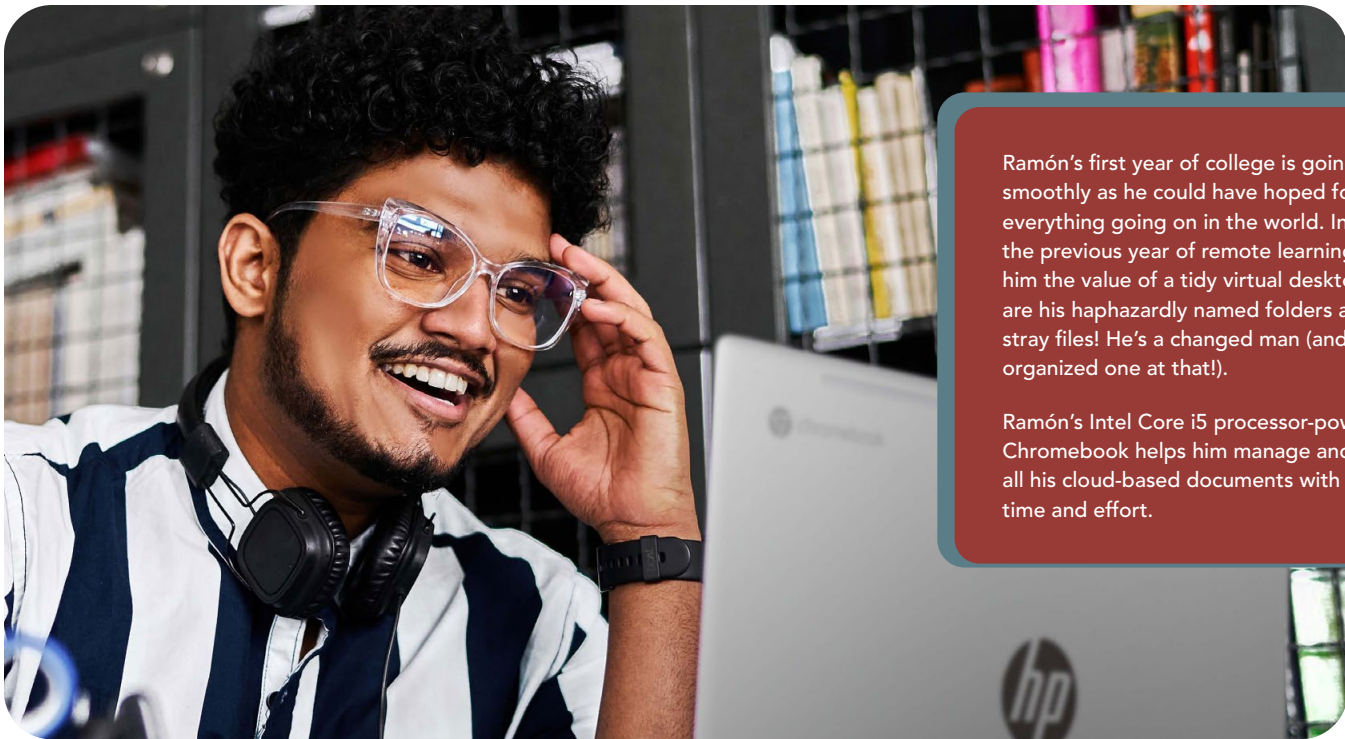


HP Pro c640 G2 with an Intel Core i7-1185G7 processor



HP Pro c640 G2 with an Intel Core i5-1145G7 processor

Note: Each of the graphs in this report uses a different x-axis in order to keep to a consistent size. Please be mindful of each graph's data range as you compare.



Ramón's first year of college is going as smoothly as he could have hoped for given everything going on in the world. In fact, the previous year of remote learning taught him the value of a tidy virtual desktop: Gone are his haphazardly named folders and stray files! He's a changed man (and a well organized one at that!).

Ramón's Intel Core i5 processor-powered Chromebook helps him manage and edit all his cloud-based documents with little time and effort.

Save time managing and editing files in Google Workspace apps

Figure 1 shows the timed multi-tasking results for our Google Workspace™ scenario. During these tests, each Chromebook completed tasks while connected to a four-way video call via Google Meet.

As an example of one specific task, the AMD Ryzen 7 3700C processor-powered Chromebook took 20.8 seconds to open a presentation in Google Slides™, while the Core i5 and Core i7 processor-powered Chromebooks took 13.4 and 12.7 seconds respectively.

Save up to 15.6 seconds working with documents, charts, and presentations during a Google Meet call

with Google Meet, Google Drive, Google Sheets, and Google Slides

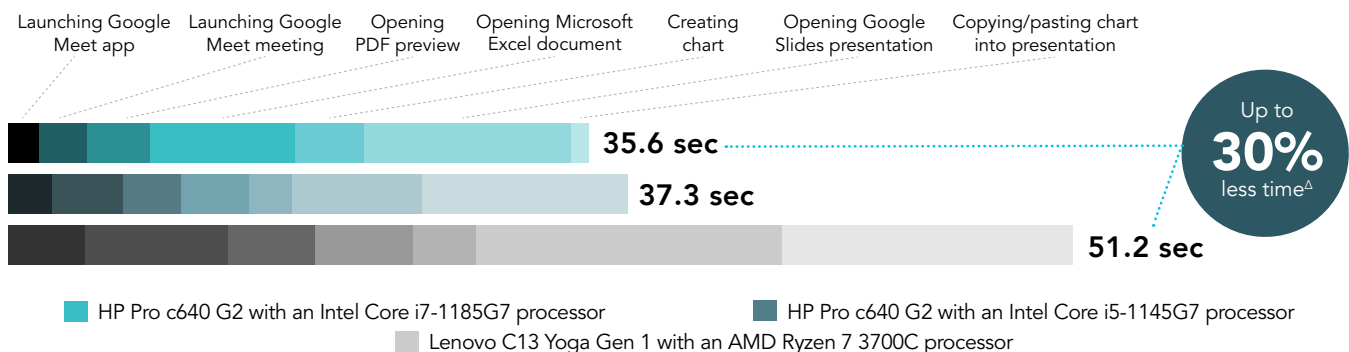


Figure 1: Time (in seconds) to complete tasks in Google Workspace apps while connected to a four-way Google Meet call. Less time is better. Source: Principled Technologies.

Google Workspace

Last year, Google rebranded its G Suite app offerings as Google Workspace—but you'll still get the same productivity and collaboration tools you've used in the past, including Google Docs™, Google Slides, Google Meet, Google Drive, and more.¹

^ASee [the science behind this report](#) for detailed system configurations and benchmark results.

After her trusty old laptop had a catastrophic accident last year (an awkward-fitting pair of shoes, a balcony—she doesn't want to talk about it), Luna switched to using an Intel Core i7 processor-powered Chromebook for her school assignments. Her Chromebook helps her quickly manage and edit large batches of photos.



Save time editing photos in Adobe apps

Figure 2 shows the timed multi-tasking results for our photo-editing scenario. During these tests, each Chromebook completed tasks while connected to a four-way video call via Google Meet.

Notably, the AMD Ryzen processor-powered Chromebook required 3 minutes and 56 seconds to export a set of 280 .JPG photos from Adobe Lightroom. However, the Intel Core i5-1145G7 processor-powered Chromebook shaved 36 seconds from that time (taking 3 minutes and 20 seconds), and the Intel Core i7-1185G7 processor-powered Chromebook saved 59 seconds (taking 2 minutes and 57 seconds).

Save up to 2 minutes and 35 seconds unzipping, creating, and more with photos during a Google Meet call

with Adobe Lightroom, Adobe Photoshop®, and Google Meet

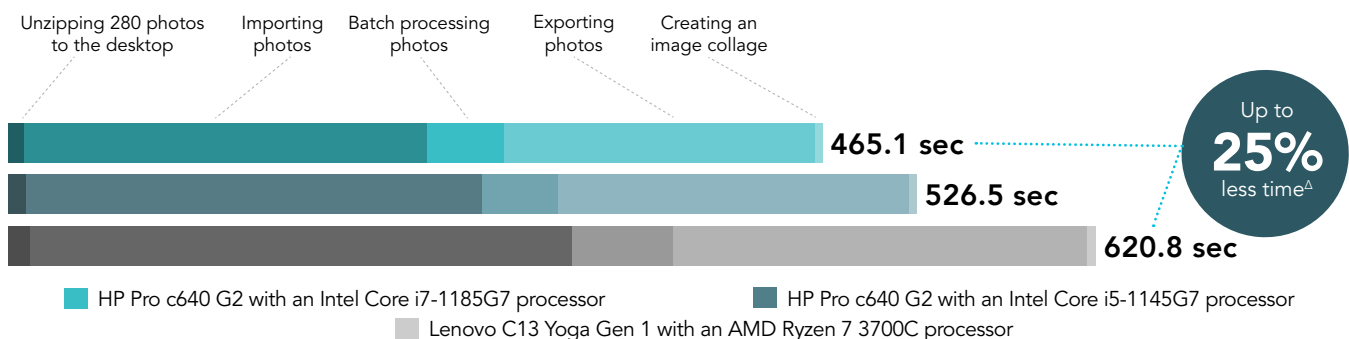


Figure 2: Time (in seconds) to complete photo-editing tasks in Adobe Lightroom and Adobe Photoshop® Express while connected to a four-way Google Meet call. Less time is better. Source: Principled Technologies.

Adobe Lightroom

Adobe Lightroom is a free photo editing and camera app that enables you to use customizable filters and other options to create your next photography project.²

Adobe Photoshop Express

Photoshop Express is a free photo editing app for Android™ devices. The integrations in Photoshop Express enable you to pull photos from Google Photos™ and other image hosting apps and websites.³

^ASee [the science behind this report](#) for detailed system configurations and benchmark results.



Kelly has been using Windows ever since he was a kid doing assignments in the school computer lab. But as he heads off to grad school, he wonders if it might be time for something new?

The issue is, Kelly's worried about having to learn a new OS when he'll have so much else on his plate. Luckily, Parallels software makes it easy to use Windows apps from a Chromebook—problem solved!

Switch between Chrome OS and Windows 10 on your device without missing a beat

For the past 15 years, the Parallels virtual desktop app has enabled users to run Windows operating systems and apps on Apple® macOS® systems.⁴ But earlier this year, Parallels brought Windows functionality to Chromebooks with the release of Parallels Desktop for Chrome OS.

We were able to run Parallels Desktop on each of the Intel Core processor-powered Chromebooks we tested. The Chromebooks performed similarly in most tasks we tested, though the Intel Core i7-1185G7 processor-powered Chromebook managed to save 17 percent of the time the Intel Core i5-1145G7 processor-powered Chromebook required to run a macro in Microsoft Excel.

Because the Lenovo device from our tests is not a Chrome Enterprise device, it was unable to run Parallels. Chrome Enterprise status does not affect performance, but it does affect compatibility with certain software.

Save up to 13.3 seconds using Microsoft Office applications through Windows using Parallels Desktop for Chrome OS

with Parallels, Microsoft Excel, and Microsoft PowerPoint

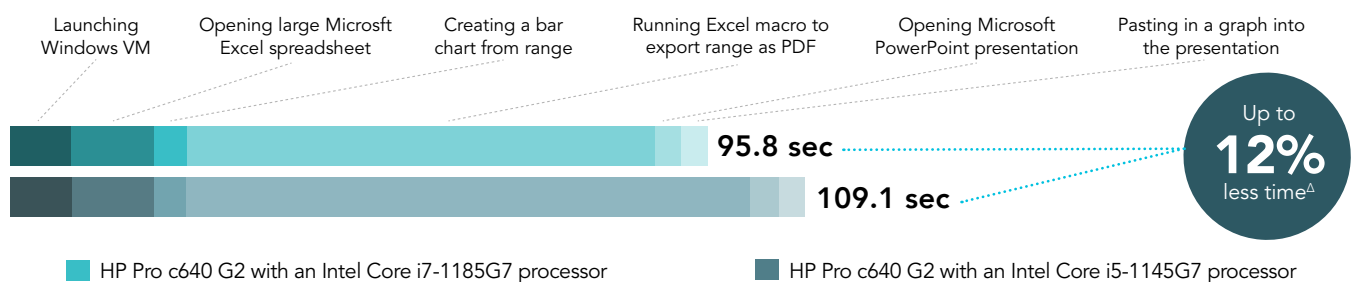


Figure 3: Time (in seconds) to complete tasks in Windows applications via Parallels Desktop for Chrome OS. Less time is better. Source: Principled Technologies.

Microsoft 365

Microsoft 365 is a cloud-based productivity suite that enables users to work in Microsoft Office apps on up to five devices concurrently. Apps include Word, Excel, PowerPoint, OneNote, Outlook, and Skype.⁵

^ASee [the science behind this report](#) for detailed system configurations and benchmark results.

Martin's a regular face to see around campus—not just one spot, either. If you can't find him at the library, he might be in the gardens, or the basement of the gym, or on the bench beside the school's mascot in the quad.

Wherever he goes, his Intel Core i5 processor-powered Chromebook helps him finish assignments, keep in touch with family, and even play games.



Work, chat, and game wherever you are with a fast Chromebook

Figure 7 shows the hand-timed results for four application tasks: sharing a Google Sheets spreadsheet with Zoom, using the Copy and Tinker function on an Autodesk® Tinkercad project, and launching the app and loading a code project in Minecraft: Education Edition. The Chromebooks powered by the Intel Core i7-1185G7 and Intel Core i5-1145G7 processors saved time on each task compared to the Chromebook with the AMD Ryzen 7 3700C processor.

Sharing a spreadsheet from Google Drive during a Zoom call

with Google Sheets, Google Drive, and Zoom

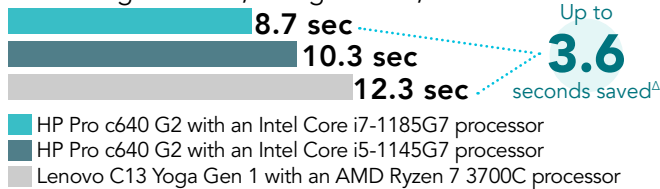


Figure 4: Time (in seconds) to share a spreadsheet from Google Drive during a Zoom call. Less time is better. Source: Principled Technologies.

Copying and tinkering with a project with Autodesk Tinkercad

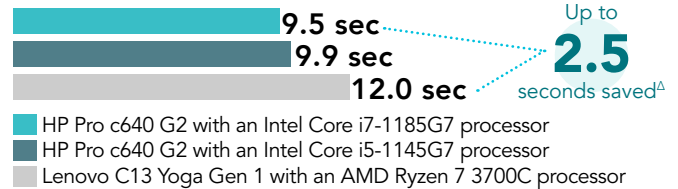


Figure 5: Time (in seconds) to use the Copy and Tinker function on a Tinkercad project. Less time is better. Source: Principled Technologies.

Launching the application with Minecraft: Education Edition

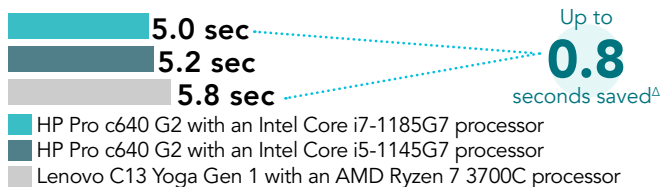


Figure 6: Time (in seconds) to launch Minecraft: Education Edition. Less time is better. Source: Principled Technologies.

Loading the demo with Minecraft: Education Edition

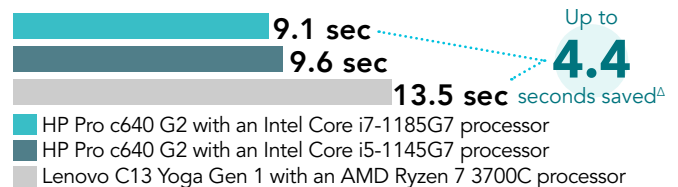


Figure 7: Time (in seconds) to load a demo for Minecraft: Education Edition. Less time is better. Source: Principled Technologies.

Zoom

Zoom is a teleconferencing and video chat app that enables users to connect, share ideas, and participate in remote events, seminars, and more. Individuals and companies around the world use Zoom as an integral part of their day-to-day operations.⁶

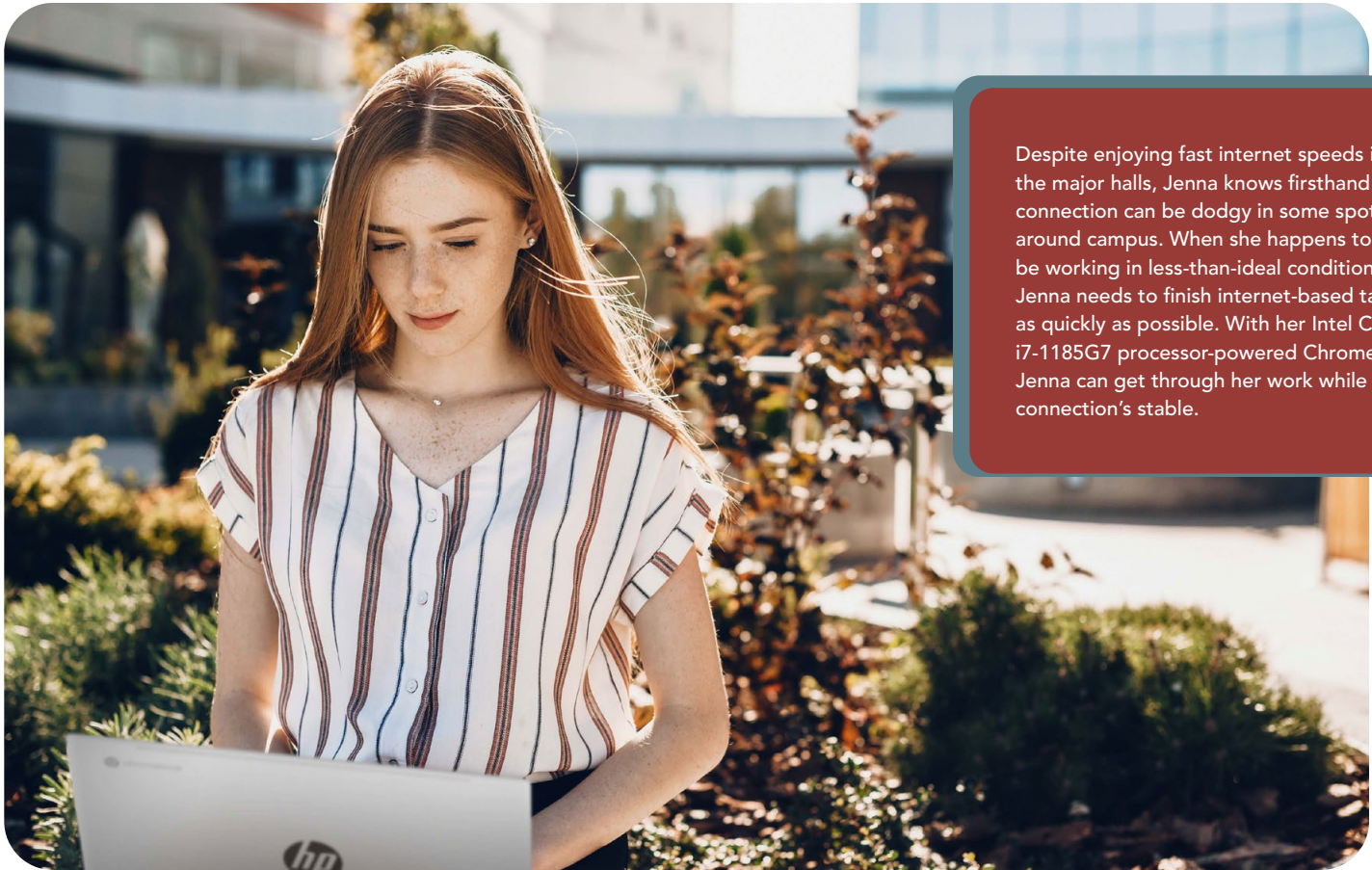
Minecraft: Education Edition

The best selling video game of all time isn't just for having fun outside of school.⁸ Minecraft has an education edition that features classroom management tools and pre-made lesson plans on everything from code to history to social emotional learning (SEL).⁹

^ASee [the science behind this report](#) for detailed system configurations and benchmark results.

Autodesk Tinkercad

Tinkercad is a browser based program for computer aided design. Common Sense Education® gave Tinkercad a 4 out of 5 star rating, citing its pedagogical applications.⁷



Despite enjoying fast internet speeds in the major halls, Jenna knows firsthand that connection can be dodgy in some spots around campus. When she happens to be working in less-than-ideal conditions, Jenna needs to finish internet-based tasks as quickly as possible. With her Intel Core i7-1185G7 processor-powered Chromebook, Jenna can get through her work while her connection's stable.

Benchmark performance comparison

To further compare these Chromebooks, we ran two benchmarks that measure web app performance: WebXPRT 3, a browser-based benchmark that uses HTML5 and JavaScript to assess a device's ability to handle tasks in online apps and websites, and Speedometer 2.0, which simulates users on a device and measures the time required for those users to complete web-based tasks. To ensure that network bandwidth did not affect performance differences, we tested each Chromebook on the same Wi-Fi network at the same time of day and in the same location.

Figures 8 and 9 show our results for the benchmark tests. Both Intel Core processor-powered Chromebooks we tested achieved higher scores than the AMD Ryzen 7 3700C processor-powered Chromebook, with the Intel Core i7-1185G7 processor-powered Chromebook obtaining the highest score of the three.

WebXPRT 3 score

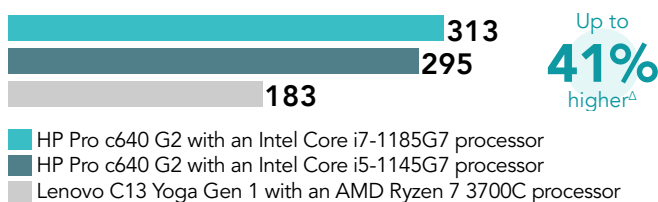


Figure 8: WebXPRT 3 scores. Higher scores are better. Source: Principled Technologies.

Speedometer 2.0 score

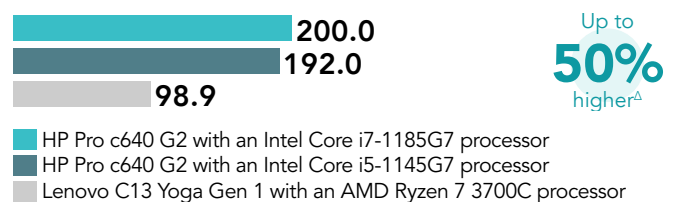


Figure 9: Speedometer 2.0 scores. Higher scores are better. Source: Principled Technologies.

^ASee [the science behind this report](#) for detailed system configurations and benchmark results.



Conclusion

It's important for educators and students alike to have a responsive work device that can keep up with hectic lives, heavy courseloads, and unexpected changes of plan.

In our tests comparing the responsiveness of three Chromebooks, we found that Intel Core i5-1145G7 and Intel Core i7-1185G7 processor-powered Chromebooks enabled us to save time completing tasks in several educational apps vs. an AMD Ryzen 7 3700C processor-powered Chromebook. Many of our tests involved completing tasks while each Chromebook was part of a four-way Google Meet call. In addition to displaying stronger app performance, the Intel Core processor-powered Chromebooks we tested also achieved higher scores on the web-based benchmarks WebXPRT 3 and Speedometer 2.0, which suggests that these Chromebooks may have stronger performance with web apps and sites.

- 1 "Introducing Google Workspaces and a new set of offerings to better meet your needs," accessed September 13, 2021, <https://workspaceupdates.googleblog.com/2020/10/introducing-google-workspace.html>.
- 2 "Adobe Lightroom," accessed September 13, 2021, https://play.google.com/store/apps/details?id=com.adobe.lrmobile&hl=en_US.
- 3 "Adobe Photoshop Express," accessed September 13, 2021, <https://www.adobe.com/products/photoshop-express.html>.
- 4 "Parallels Celebrates 14 Years of Innovations with Limited-Time Discount Offer on Parallels Desktop 15 for Mac," accessed September 13, 2021, <https://www.parallels.com/au/news/press-releases/show/200623-14-years-of-innovations/>.
- 5 Microsoft 365 for home use," accessed September 13, 2021, <https://www.microsoft.com/en-us/microsoft-365/explore-microsoft-365-for-home>.
- 6 "Video Conferencing, Cloud Phone, Webinars, Chat, Virtual Events | Zoom," accessed July 20, 2021, <https://zoom.us>.
- 7 Marianne Rogowski, "Tinkercad Review for Teachers," accessed September 13, 2021, <https://www.commonsense.org/education/website/tinkercad>.
- 8 Tom Warren, "Minecraft still incredibly popular as sales top 200 million 126 play monthly," accessed September 13, 2021, <https://www.theverge.com/2020/5/18/21262045/minecraft-sales-monthly-players-statistics-youtube>.
- 9 "Homepage | Minecraft Education Edition," accessed September 13, 2021, <https://education.minecraft.net>.

We concluded our hands-on testing on September 2, 2021. During testing, we determined the appropriate hardware and software configurations and applied updates as they became available. The results in this report reflect configurations that we finalized on August 23, 2021 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

To learn more about how we have calculated the wins in this report, go to <http://facts.pt/calculating-and-highlighting-wins>. Unless we state otherwise, we have followed the rules and principles we outline in that document.

Table 1: Results of our testing.

Task	HP Pro c640 G2 Chromebook™ with an Intel® Core™ i7-1185G7 processor	HP Pro c640 G2 Chromebook with an Intel Core i5-1145G7 processor	Lenovo® C13 Yoga® Gen 1 Chromebook with an AMD Ryzen™ 7 3700C processor	Chromebook with Core i7 processor vs. Chromebook with Core i5 processor	Chromebook with Core i5 processor vs. Chromebook with Ryzen 7 processor	Chromebook with Core i7 processor vs. Chromebook with Ryzen 7 processor
Scenario 1 (median sum of all tasks)	35.6	37.3	51.2	4%	27%	30%
Google Meet™						
Launching the application	1.9	1.9	2.1	0%	9%	9%
Launching a Google Meet meeting	3.0	3.1	2.8	3%	-10%	-7%
Google Drive™						
Opening a PDF preview from Google Drive	3.8	4.1	6.5	7%	36%	41%
Google Sheets™						
Opening a Microsoft Excel document from Google Drive	8.9	9.2	11.8	3%	22%	24%
Creating a chart	4.2	4.4	5.8	4%	24%	27%
Google Slides™						
Opening Google Slides presentation	12.7	13.4	20.8	5%	35%	38%
Copying and pasting a chart into Google Slides	1.1	1.2	1.4	8%	14%	21%

Task	HP Pro c640 G2 Chromebook™ with an Intel® Core™ i7-1185G7 processor	HP Pro c640 G2 Chromebook with an Intel Core i5-1145G7 processor	Lenovo® C13 Yoga® Gen 1 Chromebook with an AMD Ryzen™ 7 3700C processor	Chromebook with Core i7 processor vs. Chromebook with Core i5 processor	Chromebook with Core i5 processor vs. Chromebook with Ryzen 7 processor	Chromebook with Core i7 processor vs. Chromebook with Ryzen 7 processor
Scenario 2 (median sum of all tasks)	465.1	526.5	620.8	11%	15%	25%
Chrome OS™						
Unzipping 280 .JPG photos to desktop	9.3	10.7	12.9	13%	17%	27%
Adobe® Lightroom®						
Importing 280 .JPG photos	230.4	260.0	309.0	11%	15%	25%
Batch processing 280 .JPG photos	43.5	51.2	57.9	15%	11%	24%
Exporting 280 .JPG photos	177.9	200.3	236.1	11%	15%	24%
Adobe Photoshop® Express						
Creating a nine-image collage	4.0	4.3	4.9	6%	12%	18%
Windows apps running in Chrome™ with Parallels Desktop® for Chrome OS						
Parallels						
Launching Windows VM	8.5	8.6	N/A	1%	N/A	N/A
Microsoft Excel						
Opening large Microsoft Excel spreadsheet	11.3	11.2	N/A	-8%	N/A	N/A
Creating a bar chart from range	4.5	4.4	N/A	-2%	N/A	N/A
Running Microsoft Excel macro to export range as PDF	64.2	77.5	N/A	17%	N/A	N/A
Microsoft PowerPoint						
Opening a PowerPoint presentation	3.7	3.9	N/A	5%	N/A	N/A
Pasting a graph from Microsoft Excel into a presentation	3.6	3.5	N/A	-2%	N/A	N/A
Individually timed tasks in Chrome OS						
Zoom						
Sharing a Google Sheet from Google Drive	8.7	10.3	12.3	15%	16%	29%

Task	HP Pro c640 G2 Chromebook™ with an Intel® Core™ i7-1185G7 processor	HP Pro c640 G2 Chromebook with an Intel Core i5-1145G7 processor	Lenovo® C13 Yoga® Gen 1 Chromebook with an AMD Ryzen™ 7 3700C processor	Chromebook with Core i7 processor vs. Chromebook with Core i5 processor	Chromebook with Core i5 processor vs. Chromebook with Ryzen 7 processor	Chromebook with Core i7 processor vs. Chromebook with Ryzen 7 processor
Autodesk® Tinkercad						
Copying and tinkering a telescope project	9.5	9.9	12.0	4%	17%	20%
Minecraft: Education Edition						
Launching Minecraft: Education Edition	5.0	5.2	5.8	3%	10%	13%
Loading the Hour of Code 2019 (AI) Demo	9.1	9.6	13.5	5%	28%	32%

Table 2: Results of WebXPRT 3 benchmark testing.

	HP Pro c640 G2 laptop with an Intel Core i7-1185G7 processor	HP Pro c640 G2 laptop with an Intel Core i5-1145G7 processor	Lenovo C13 Yoga Gen 1 laptop with an AMD Ryzen 7 3700C processor	Chromebook with Core i7 processor vs. Chromebook with Core i5 processor	Chromebook with Core i5 processor i5 vs. Chromebook with Ryzen 7 processor	Chromebook with Core i7 processor vs Chromebook with Ryzen 7 processor
WebXPRT 3 score	313	295	183	5%	37%	41%

Table 3: Results of Speedometer 2.0 benchmark testing.

	HP Pro c640 G2 laptop with an Intel Core i7-1185G7 processor	HP Pro c640 G2 laptop with an Intel Core i5-1145G7 processor	Lenovo C13 Yoga Gen 1 laptop with an AMD Ryzen 7 3700C processor	Chromebook with Core i7 processor vs. Chromebook with Core i5 processor	Chromebook with Core i5 processor i5 vs. Chromebook with Ryzen 7 processor	Chromebook with Core i7 processor vs Chromebook with Ryzen 7 processor
Speedometer 2.0	200.0	192.0	98.9	4%	48%	50%

System configuration information

Table 4: Detailed information on the system we tested.

System	HP Pro c640 G2 Chromebook Enterprise	HP Pro c640 G2 Chromebook Enterprise	Lenovo ThinkPad C13 Yoga Gen 1 Chromebook
Processor	Intel Core i7-1185G7	Intel Core i5-1145G7	AMD Ryzen 7 3700C
Processor frequency (GHz)	3.00 – 4.80	2.60 – 4.40	2.30 – 4.00
Processor cores	4	4	4
Memory (GB)	16	8	16
Storage (GB)	256	64	256
Bluetooth	5	5	5
USB	2x USB 3.2 Gen 1 Type-A 2x USB 3.2 Gen 1 Type-C	2x USB 3.2 Gen 1 Type-A 2x USB 3.2 Gen 1 Type-C	2x USB 3.2 Gen 1 Type-A 2x USB 3.2 Gen 1 Type-C
Battery type	Lithium-Ion	Lithium-Ion	Lithium-Ion
Battery capacity (Wh)	58	58	51
Display resolution	14.0" 1920x1080	14.0" 1920x1080	13.3" 3840x2160
OS (version)	92.0.4515.162	92.0.4515.162	92.0.4515.162
System Weight (lbs.)	3.26	3.26	3.30

How we tested

Scenario testing

For our scenario testing, we opened the Google Meet application, and joined a four-participant video meeting. We tested each task for a given scenario sequentially.

Scenario #1

Google Meet

Launching Google Meet

1. Simultaneously start the timer and launch the Google Meet app from the shelf.
2. When the app fully loads, stop the timer.

Launching a new Google Meet meeting

1. From the Google Meet main screen, click New meeting.
2. Simultaneously start the timer and click Start an instant meeting.
3. When the meeting invite code appears and the webcam loads, stop the timer.
4. For the remainder of our timings, we joined a four-way video meeting, and minimized the app.

Google Drive

Opening a PDF preview from Google Drive

1. From the Google Meet chat window, simultaneously start the timer and click the link to the test PDF.
2. When the PDF preview fully loads in the web browser, stop the timer.

Google Sheets

Opening a shared Excel file with Google Drive

1. From the Google Meet chat window, simultaneously start the timer and click the link to the test .csv file via Google Drive.
2. When the Google Sheets spreadsheet fully loads, stop the timer.

Creating a chart in Google Sheets

1. From Google Sheets, select the range of data, and click Insert.
2. Simultaneously start the timer and click Chart.
3. When the chart fully loads into the document, stop the timer.

Google Slides

Opening a shared Google Slides presentation

1. From the Google Meet chat window, simultaneously start the timer and click the link to the Google Slides test document via Google Drive.
2. When the Slides presentation fully loads, stop the timer.

Copying and pasting a graph from Google Sheets into a Google Slides presentation

1. Navigate to the Google Sheets test document tab.
2. Select and copy the bar graph.
3. Navigate to the first slide of the Google Slides presentation.
4. Simultaneously start the timer and paste the bar graph into the first slide.
5. When the bar graph fully loads, stop the timer.

Scenario #2

Google System: Unarchiving Photos

Unzipping 280 photos from the desktop

1. From the Files application, navigate to the test archive location.
2. To open the test archive using the default system viewer, double-click the archive.
3. Select the contents of the test archive, and click and drag the contents to an empty folder.
4. Simultaneously start the timer and unclick the dragged content.
5. When the copying files dialog completes, stop the timer.

Adobe Lightroom

Importing 280 photos

1. From the app shelf, launch Adobe Lightroom.
2. From the Adobe Lightroom home page, click the blue import photos icon.
3. Sort by Device Folders. To select the unarchived test photos, click the checkbox next to the folder name.
4. Simultaneously start the timer and click Add.
5. When the import dialog completes, stop the timer.

Batch-processing 280 photos with a filter preset

1. From the Adobe Lightroom home page, click the collection containing the test photos.
2. Click the first image.
3. Click the Adjustments icon.
4. To apply auto-adjustments, click Auto.
5. Click the menu button in the top right, and select Copy Settings.
6. Leave the default Copy Settings, and click OK.
7. To return to the collection view, click the back arrow.
8. Long-click the first photo to select it.
9. Click the menu button in the top right, and select Select All.
10. Click the menu button in the top right again, and select Paste Settings.
11. Simultaneously start the timer and click Apply.
12. When the processing dialog closes, and "Changes applied to 140 photos" appears, stop the timer.

Exporting 280 photos

1. From the Adobe Lightroom home page, click the collection containing the test photos.
2. Click to select the first image.
3. From the dropdown menu, click Select All images.
4. With all images selected, click the Share icon.
5. From the Share dialog box, click Export As...
6. Leave the default settings. Simultaneously start the timer and click the checkmark icon.
7. When the export dialog completes, stop the timer.

Adobe Photoshop Express

Creating a nine-image collage

1. From the app shelf, launch Adobe Photoshop Express from the shelf.
2. Click the Collage icon in the bottom right.
3. Click to select the nine test images.
4. Simultaneously start the timer and click the next arrow.
5. When the collage fully loads, stop the timer.

Other app tasks

Zoom

Sharing a Google Sheets spreadsheet from Google Drive

1. From the chat window, simultaneously start the timer and click the link to the shared Google Sheets document.
2. Stop the timer when the Google Drive preview has fully loaded.

Minecraft: Education Edition

Launching Minecraft: Education Edition

1. Simultaneously start the timer and launch the Minecraft: Education Edition app from the shelf.
2. When the app fully loads, stop the timer.

Loading the Hour of Code 2019 demo

1. From the shelf, launch Minecraft: Education Edition.
2. Click Try A Demo Lesson.
3. Click to check Accept Terms, and click Play.
4. When the Demo Experience loads, click Start Lesson.
5. From the Demo Lessons, simultaneously start the timer and click Hour of Code 2019.
6. When the game fully loads, stop the timer.

Parallels Desktop for Chrome OS

Installing Parallels Desktop for Chrome OS and creating the base Windows 10 image

1. Ensure the device under test is eligible for Chrome Enterprise enrollment and meets the minimum requirements for installing Parallels Desktop for Chrome OS. You can find more information on minimum requirements at the Parallels website: <https://www.parallels.com/products/desktop/chrome/>
2. You need a Google Workspace account to deploy and license the Parallels Desktop for Chrome OS application. Ensure the requisite licenses are applied to the correct Organization Unit in the Google Workspace Admin console.
3. Log into the device under test with the Chrome Enterprise admin account. With the correct Organization Unit settings applied, the Parallels Desktop application will be automatically downloaded on initial setup.
4. Download a Windows 10 .iso from the Microsoft website and transfer it to the device under test's Downloads folder.
5. To launch the crosh Terminal, launch Google Chrome, and press Ctrl + Alt + T.
6. Create the Windows 10 VM:

```
vmc create -p PvmDefault win10.iso
```
7. When the command completes, start the virtual machine:

```
vmc start PvmDefault
```
8. The Windows 10 installation media will launch in the virtual machine window. Follow the wizard to install Windows 10, and install the applications for the base image. For our testing, we installed the Microsoft Office suite.
9. When creation of the Windows 10 base image is complete, shut down the virtual machine.
10. From the crosh Terminal, export the newly created virtual machine:

```
vmc export -d PvmDefault PvmDefault.zip
```
11. The virtual machine will export to a .zip file in the device's Downloads folder and include a hash. For our environment, we uploaded the .zip file to our user's Google Drive.
12. From the Google Workspace Admin Console, Navigate to Devices → Chrome → Settings → Users & Browsers, click on the User & Browser Settings Tab, and scroll to the Parallels Desktop section.
13. Enter the URL to the shared .zip file containing the exported virtual machine, and enter the SHA-256 hash generated in the device's Downloads folder.
14. Log out, and log back into the device with the Chrome Enterprise test account.
15. After initial setup is complete, open the Parallels Desktop application.
16. The Windows 10 virtual machine image will be automatically downloaded and installed on the test user's account.

Launching the Windows Virtual Machine

1. Simultaneously start the timer and click the Parallels Desktop app icon from the shelf.
2. When the Windows virtual machine boots to the desktop, stop the timer.

Microsoft Excel: Opening an Excel Spreadsheet

1. From the Windows virtual machine, navigate to the folder containing the test Excel document.
2. Right-click the document, and simultaneously start the timer and click Open.
3. When the Excel document has fully loaded, stop the timer.

Microsoft Excel: Creating a bar chart from a range

1. From the Windows virtual machine, open the test Excel document.
2. Click to select a range of data.
3. From the Excel ribbon menu, click Insert → Recommended Charts.
4. Click the All Charts tab.
5. Select the Clustered Column chart.
6. Simultaneously start the timer and click OK.
7. When the bar chart has fully loaded, stop the timer.

Microsoft Excel: Running an Excel macro to export range as PDF

1. From the Windows virtual machine, open the test Excel document.
2. From the Excel ribbon menu, click View → Macros.
3. Enter a name for the macro, and click Create.
4. From the macro editor window, export the selected range to PDF:

```
Sub SaveSelectedRangeAsPdf
Selection.ExportAsFixedFormat Type:=xlTypePDF, OpenAfterPublish:=True
End Sub
```

5. Save the macro, and return to the Excel application window.
6. Click to select the range of data.
7. From the Excel ribbon menu, click View, Macros.
8. Select the test Macro.
9. Simultaneously start the timer and click Run.
10. When the PDF opens in the web browser, stop the timer.

Benchmark testing

WebXPRT 3

Running WebXPRT 3

1. Power on the device, and log in.
2. Allow the device to idle for 10 minutes to clear any background startup activity.
3. Open the default web browser, and navigate to <https://www.principledtechnologies.com/benchmarkxpert/webxpert/>.
4. Click Run WebXPRT 3.
5. Click Continue.
6. Click Start.
7. When the test completes, record the score.

Speedometer 2.0 - BrowserBench

Running Speedometer 2.0

1. Power on the device, and log in.
2. Allow the device to idle for 10 minutes to clear any background startup activity.
3. Open the default web browser, and navigate to <https://browserbench.org/Speedometer2.0/>.
4. Click Start Test.
5. When the test completes, record the score.

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