COMPARING CHROMEBOOKS FOR CONSUMERS: INTEL CELERON VS. ARM

Experience more on an Intel® Celeron® processor-powered Chromebook™

130.8% more FPS while rendering in BioDigital Human™

57.2% more frames per second (FPS) playing Cracking Sands

Up to **18.6% less waiting** when multitasking

Up to **11.1% more FPS** while watching videos

15.6% more FPS during Google Hangouts™
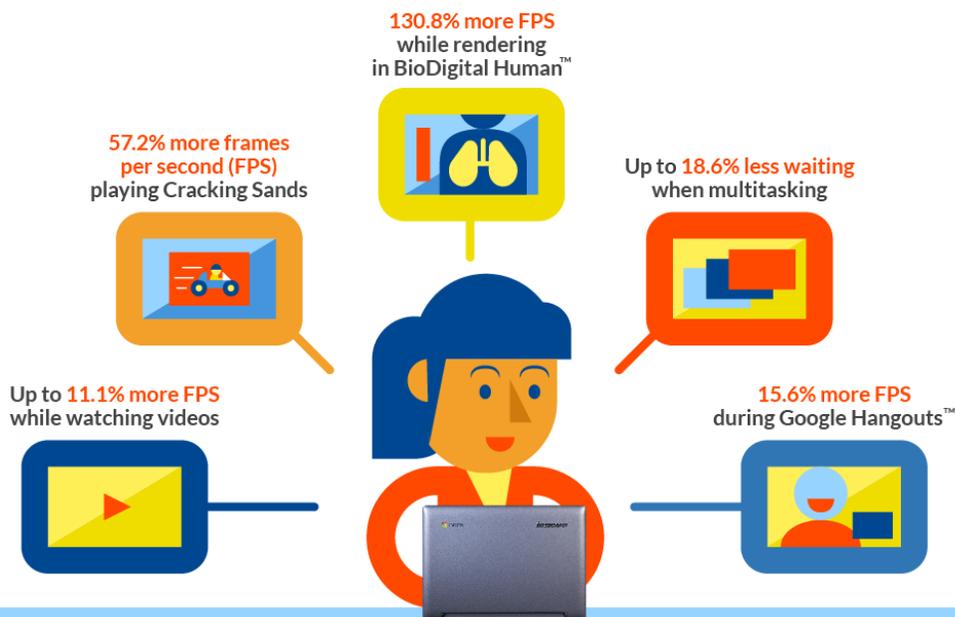
The Lenovo® N20p Chromebook powered by an Intel Celeron processor outperformed the ARM® based model and had a longer battery life.

If you've decided to get a Chromebook, it may not be immediately clear which model is right for you. Do you often switch back and forth from playing games to watching videos to chatting with friends in a Google Hangouts call? Do you want to spend less time opening and loading Web sites? Do you worry about battery life?

In our hands-on testing at Principled Technologies, we looked at an Intel Celeron processor-powered Chromebook and an ARM processor-based Chromebook. We put these two systems through consumer scenarios that included everyday tasks such as opening a Web site, watching a video, and chatting with a friend in a Google Hangouts call. We looked at different aspects of user experience—measuring frame rate, time to complete tasks, and battery life.

Which Chromebook is the better choice? We found that the Intel Celeron processor-powered Chromebook outperformed the ARM processor-based Chromebook, taking less time to complete tasks in four scenarios while lasting 34 minutes longer in our battery life test. The Intel Celeron processor-powered Chromebook also delivered more frames per second in a number of use cases, including playing a game, watching a video, working in BioDigital Human, and chatting in a Google Hangouts call. The Intel Celeron processor-powered Chromebook can deliver a better user experience by providing better performance without sacrificing battery life.

MAKING THE RIGHT CHROMEBOOK CHOICE

To help with choosing the right Chromebook, we looked at one with an Intel Celeron processor and one with the latest ARM processor. These two systems are comparable—they share the same display size, display resolution, and amount of storage. The Intel Celeron processor-powered Chromebook has half the amount of memory (2 GB) and a battery with a smaller capacity (3,144 mAh). We tested the two Chromebooks through scenarios that included common tasks such as playing a game and doing science homework. For more on how we tested, see Appendix B. For detailed results of our testing, see Appendix C, and for more information on these two systems, see Appendix A.

DOING SCIENCE HOMEWORK

Sophia opens her Chromebook and powers it on to do some science homework. She opens Gmail™ to double-check what her reading assignment is for the day, and goes to her Kno™ online textbook. She opens Google Drive™ and then opens a new document in Google Docs™ to take notes. She reads and takes notes for a while, and then comes upon something she doesn't know, so she searches Wikipedia® for it. She opens BioDigital Human app to work with a 3D model. When she reaches a stopping point with BioDigital Human, Sophia plays a Khan Academy® video about the types of muscles that her teacher shared with the class.

Doing science homework

Intel
ARM

16.6%
less waiting

86.0s

71.7s

1. Power on
2. Open Gmail
3. Open Kno textbook
4. Open Google Drive
5. Open new Google doc
6. Search Wikipedia
7. Load BioDigital Human
8. Play video on YouTube

130.8% more frames per second

11.1% more frames per second
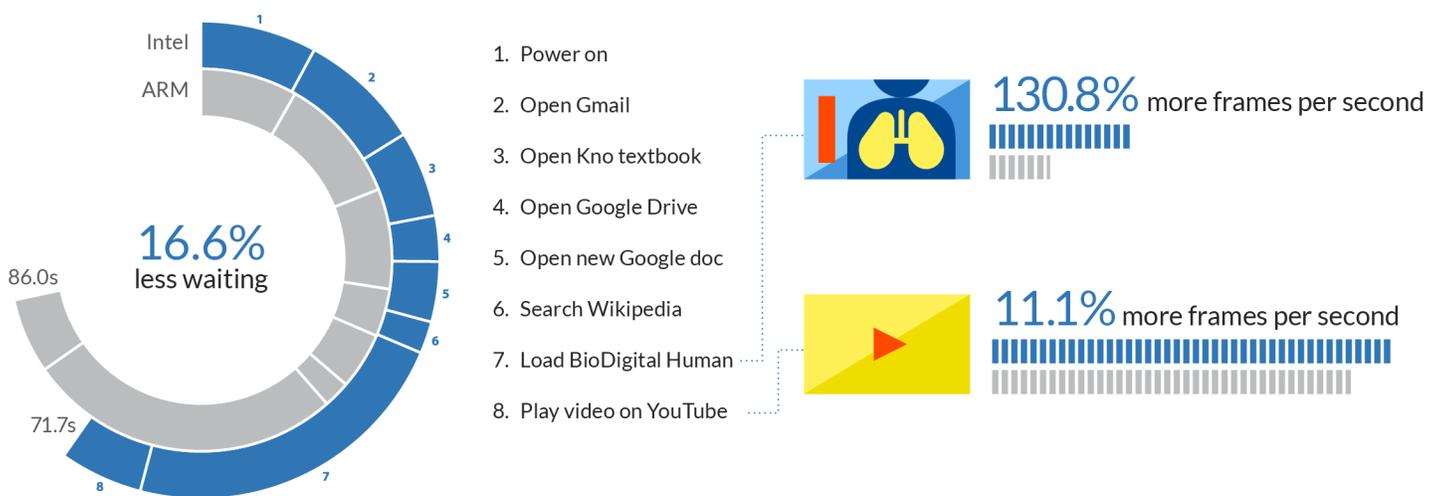
Figure 1: How the two Chromebooks compared while doing science homework. For frames per second, higher numbers are better. For time to complete tasks, lower numbers are better.

As Figure 1 shows, the Intel Celeron processor-powered Chromebook delivered 130.8 percent more frames per second than the ARM processor-based Chromebook when zooming in on the digestive system in BioDigital Human, and 11.1 percent more frames per second while playing the video. In addition to noticing the smoother zoom animation in BioDigital Human, Sophia would save more than 14 seconds when using the Intel Celeron processor-powered Chromebook instead of the ARM processor-based Chromebook.

HANGING OUT AT HOME

Olivia is using her Chromebook while watching an awards show on TV. She checks both Facebook and Twitter to see what her friends and people she is following are saying about the show. After seeing a few tweets about some breaking sports news, she goes to ESPN® and watches a video with some commentary about the story. She starts a game in Bejeweled® and then stops to answer a Google Hangouts call from her mom.

Hanging out at home

Intel
ARM

16.5%
less waiting

32.8s
39.3s

1. Open Facebook
2. Open Twitter
3. Open ESPN
4. Start a game of Bejeweled
5. Connect to a Google Hangout

6.9% more frames per second
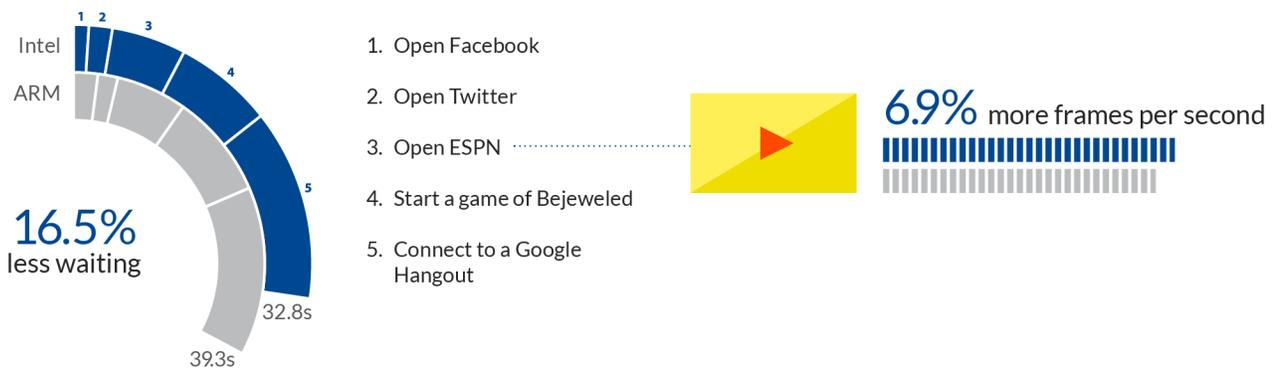
Figure 2: How the two Chromebooks compared while hanging out at home. For frames per second, higher numbers are better. For time to complete tasks, lower numbers are better.

As Figure 2 shows, the Intel Celeron processor-powered Chromebook outperformed the ARM processor-based Chromebook across the board, delivering 6.9 percent more frames per second while playing the video and taking less time to complete the tasks in the scenario.

PLANNING A HOUSEWARMING PARTY

Liam checks his email, and then opens Google Calendar™ to figure out what date he wants to have his housewarming party. He opens a Google Docs document and adds a few more items to the list of things he needs to get for the party. Somewhat unfamiliar with the area around his new house, Liam goes to Google Maps™ and searches for the nearest warehouse club. He opens Pandora® to listen to some music, and then starts playing his favorite racing game—Cracking Sands. He stops playing to answer a Google Hangouts call from his friend, who wants to see the new place.

Planning a housewarming party

1. Open Gmail
2. Open Google Calendar
3. Open Google Drive
4. Open existing Google doc
5. Open Google Maps
6. Search for a business in Google Maps
7. Start listening to Pandora
8. Launch Cracking Sands
9. Connect to a Google Hangout

Intel
ARM

8.8%
less waiting

66.9s
61.0s

57.2% more frames per second

15.6% more frames per second
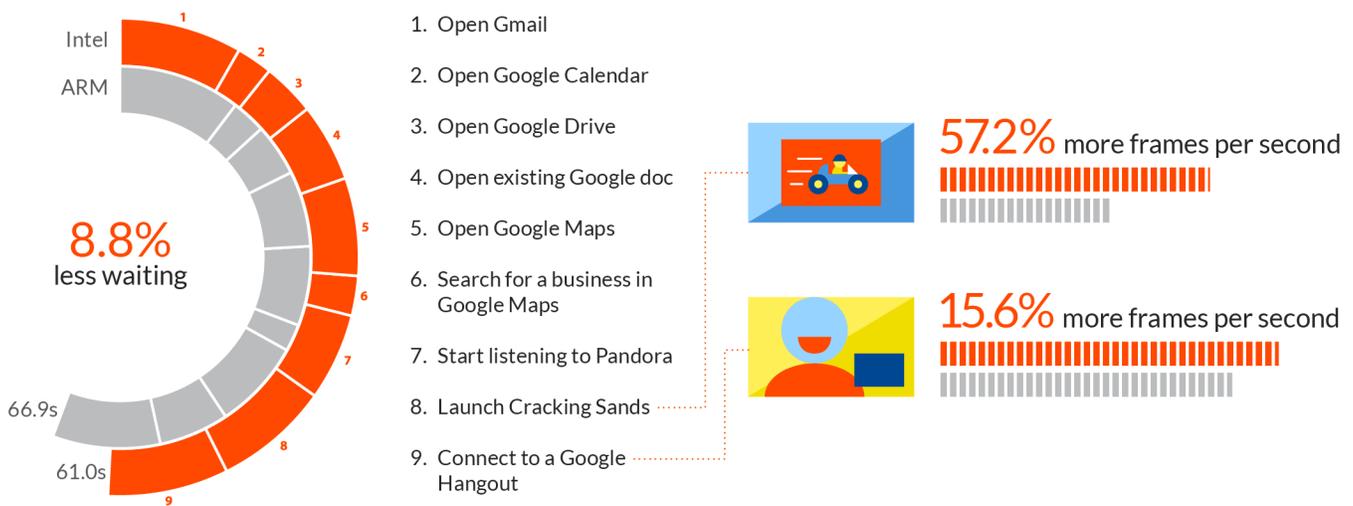
Figure 3: How the two Chromebooks compared while planning a housewarming party. For frames per second, higher numbers are better. For time to complete tasks, lower numbers are better.

As Figure 3 shows, the Intel Celeron processor-powered Chromebook delivered 57.2 percent more frames per second when playing Cracking Sands and 15.6 percent more frames per second during a Google Hangouts call. Liam would notice Cracking Sands running more smoothly on the Intel Celeron processor-powered Chromebook.

DRAFTING A FANTASY FOOTBALL TEAM

Jayden opens Gmail to look at the mock draft results, and jots down a couple players he and his friend want to target for their league. He opens Google Calendar to double-check the draft time, and then pulls up a spreadsheet of player action values that he had put together with his friend. He checks for any breaking stories on ESPN, and watches a video about a player dealing with an injury suffered in a preseason game.

After watching the video, he starts playing a podcast with thoughts on updated player rankings. When the draft room is open, Jayden joins the draft and then answers a Google Hangouts call from his friend.

Drafting a fantasy football team

1. Open Gmail
2. Open Google Calendar
3. Open Google Drive
4. Open existing Google spreadsheet
5. Open ESPN
6. Play ESPN video
7. Play audio podcast
8. Enter fantasy football draft
9. Connect to a Google Hangout
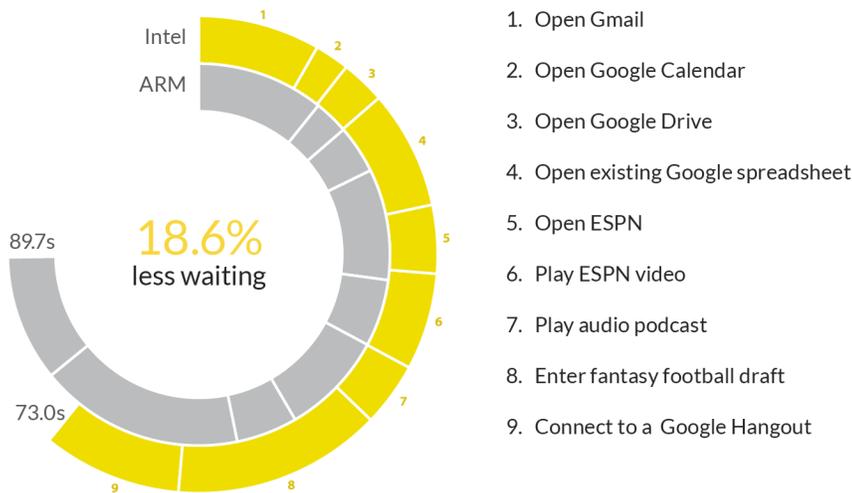
Figure 4: How the two Chromebooks compared while drafting a fantasy football team. For time to complete tasks, lower numbers are better.

As Figure 4 shows, the Intel Celeron processor-powered Chromebook would give Jayden a better experience when drafting his fantasy football team with his friend, saving him almost 17 seconds in comparison to the ARM processor-based Chromebook.

BATTERY LIFE WHILE BROWSING

Battery life matters—no one wants to worry about running out of a charge while in the middle of playing a game or watching a video. As Figure 5 shows, we found that the Intel Celeron processor-powered Chromebook lasted 34 minutes longer in our battery life test—9 hours and 33 minutes versus just under 9 hours for the ARM processor-based Chromebook.

6.3% longer battery life

| Intel | 9hr 33min |
| ARM | 8hr 59min |

Figure 5: The amount of time the two Chromebooks lasted unplugged while lightly browsing the Internet. Higher numbers are better.

THE BOTTOM LINE

Making the right Chromebook choice requires a bit of knowledge on performance and battery life. To help get that information to you, we tested two Chromebook models in common scenarios. We found the Intel Celeron processor-powered Chromebook provided a better user experience than the ARM processor-based Chromebook. The Intel Celeron processor-powered Chromebook delivered more frames per second in a number of use cases, including Google Hangouts calls, online video content, games, and education apps. We also found the Intel Celeron processor-powered Chromebook lasted longer in our battery life test and completed tasks in the four scenarios in less time than it took the ARM processor-based Chromebook.

APPENDIX A: DETAILED SYSTEM CONFIGURATION

Figure 6 presents detailed information on the two Chromebooks we tested.

System	Intel Celeron processor-powered Chromebook	ARM processor-based Chromebook
Vendor and model	Lenovo N20p 59418460	Samsung XE503C12-K01US
Processor	Intel Celeron N2830	Samsung Exynos® 5 Octa 5420
Processor frequency (GHz)	2.16	1.3 Quad + 1.9 Quad
Processor cores	2	4 + 4
Memory amount (GB)	2	4
Storage amount (GB)	16	16
Battery type	6 cell Li-Polymer	2 cell Li-Polymer
Battery capacity (mAh)	3,144	4,080
Display size and resolution	11.6" (1,366 × 768)	11.6" (1,366 × 768)
Wireless	802.11ac (802.11 a/b/g/n compatible)	802.11ac (802.11 a/b/g/n compatible)
Bluetooth®	4.0	4.0
USB ports	1 × USB 3.0 1 × USB 2.0	1 × USB 3.0 1 × USB 2.0
System weight	2.86 lbs.	2.65 lbs.
OS	Chrome OS™ version 36.0.1985.143	Chrome OS version 36.0.1985.143
Firmware	Google_Clapper.5216.199.5	Google_Peach_Pit.4482.94.0

Figure 6: Detailed configuration information for the two Chromebooks.

APPENDIX B: DETAILED TEST METHODOLOGY

Doing science homework

1. Simultaneously start the timer and power on the system.
2. When the login window appears, stop the timer, and record the result.
3. Enter the password, and press Enter.
4. Simultaneously start the timer and open Gmail from the shelf.
5. When all email messages and conversations are fully displayed, stop the timer, and record the result.
6. Press Ctrl+T to open a new Chrome™ tab.
7. Type `kno.com` and press Enter.
8. Select Course Manager.
9. Simultaneously start the timer and select the Campbell Biology textbook under My Stuff.
10. Simultaneously start the timer and open Google Drive from the apps list.
11. When the page is fully displayed, stop the timer, and record the result.
12. Select Create.
13. Simultaneously start the timer and select Document to open a new Google Docs document.
14. When the document is fully displayed, stop the timer, and record the result.
15. Press Ctrl+T to open a new Chrome™ tab.
16. Type `Wikipedia.org` and press Enter.
17. Type `muscles` into the search field, and simultaneously start the timer and press Enter.
18. When the Wikipedia page is fully displayed, stop the timer, and record the result.
19. Open the Chrome tab for the Kno textbook.
20. Open the Chrome tab for the document.
21. Simultaneously start the timer and open BioDigital Human from the apps list.
22. When the page is fully displayed and the human begins to rotate, stop the timer, and record the result.
23. Show the Digestive System.
24. To zoom in on the stomach and surround organs, double-click the stomach.
25. Take note of the lowest number of frames per second displayed in the counter during the zoom animation, and record the result.
26. Simultaneously start the timer and open YouTube™ from the shelf.
27. Click Watch Later.
28. Play the Khan Academy Three Types of Muscle video.
29. When the video begins playing, stop the timer, and record the result.
30. Start the timer.
31. Using a camera, capture the frames per second displayed in the counter at 20 seconds, 30 seconds, 40 seconds, 50 seconds, and 60 seconds.
32. Take the average of those five data points, and record the result.
33. Complete steps 1 through 32 two more times.

Hanging out at home

1. Open Google Chrome from the shelf, and type `facebook.com` in the omnibox.
2. Simultaneously start the timer and press Enter.

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3. When the page is fully displayed, stop the timer, and record the result.
4. Press Ctrl+T to open a new Chrome tab, and type `twitter.com` in the omnibox.
5. Simultaneously start the timer and press Enter.
6. When the page is fully displayed, stop the timer, and record the result.
7. Press Ctrl+T to open a new Chrome tab, and type `espn.go.com` in the omnibox.
8. Simultaneously start the timer and press Enter.
9. When the page is fully displayed, stop the timer, and record the result.
10. Simultaneously start the timer and select the play button to start the lead video.
11. Using a camera, capture the frames per second displayed in the counter at 20 seconds, 30 seconds, 40 seconds, 50 seconds, and 60 seconds.
12. Take the average of those five data points, and record the result.
13. Simultaneously start the timer and open Bejeweled from the apps list.
14. When the splash screen is fully displayed, stop the timer, and record the result.
15. On a Windows® client, start a new Google Hangouts call and send an invite to the test system.
16. On the test system, simultaneously start the timer and select Answer to join the call.
17. When the call is fully connected, stop the timer, and record the result.
18. Leave the call on the test system, and end the call on the Windows client.
19. Complete steps 1 through 18 two more times.

Planning a housewarming party
1. Simultaneously start the timer and open Gmail from the shelf.
2. When all email messages and conversations are fully displayed, stop the timer, and record the result.
3. Simultaneously start the timer and open Google Calendar from the apps list.
4. When the page is fully displayed, stop the timer, and record the result.
5. Simultaneously start the timer and open Google Drive from the apps list.
6. When the page is fully displayed, stop the timer, and record the result.
7. Simultaneously start the timer and open the existing Google Docs document from Google Drive.
8. When the document is fully displayed, stop the timer, and record the result.
9. Simultaneously start the timer and open Google Maps from the apps list.
10. When the map is fully drawn and the page is fully displayed, stop the timer, and record the result.
11. Type `Sam's Club Morrisville, NC` in the search box.
12. Simultaneously start the timer and press Enter.
13. When the map is fully redrawn and the page is fully displayed, stop the timer, and record the result.
14. Simultaneously start the timer and open Pandora from the apps list.
15. When the artist radio starts playing, stop the timer, and record the result.
16. Simultaneously start the timer and open Cracking Sands from the apps list.
17. When the splash screen is fully displayed, stop the timer, and record the result.
18. Maximize the Chrome browser window.
19. Select Single Race, and select Time Trial.
20. Simultaneously start the timer and select Start Race.
21. Using a camera, capture the frames per second displayed in the counter at 20 seconds, 30 seconds, 40 seconds, 50 seconds, and 60 seconds.

22. Take the average of those five data points, and record the result.
23. On the Windows client, start a new Google Hangouts call and send an invite to the test system.
24. On the test system, simultaneously start the timer and select Answer to join the call.
25. When the call is fully connected, stop the timer, and record the result.
26. Maximize the Google Hangouts call window.
27. Start the timer.
28. Using a camera, capture the frames per second displayed in the counter at 20 seconds, 30 seconds, 40 seconds, 50 seconds, and 60 seconds.
29. Take the average of those five data points, and record the result.
30. Leave the call on the test system, and end the call on the Windows client.
31. Complete steps 1 through 30 two more times.

Drafting a fantasy football team
1. Simultaneously start the timer and open Gmail from the shelf.
2. When all email messages and conversations are fully displayed, stop the timer, and record the result.
3. Simultaneously start the timer and open Google Calendar from the apps list.
4. When the page is fully displayed, stop the timer, and record the result.
5. Simultaneously start the timer and open Google Drive from the apps list.
6. When the page is fully displayed, stop the timer, and record the result.
7. Simultaneously start the timer and open the existing Google Sheets spreadsheet from Google Drive.
8. When the spreadsheet is fully displayed, stop the timer, and record the result.
9. Press Ctrl+T to open a new Chrome tab, and type `espn.go.com` in the omnibox.
10. Simultaneously start the timer and press Enter.
11. When the page is fully displayed, stop the timer, and record the result.
12. Select Fantasy & Games, select Football, and select Draft Kit.
13. Under Quick Links, open the fantasy video archives in a new tab.
14. Simultaneously start the timer and select the Cam Newton video under Quarterbacks.
15. Select the play button to start the video.
16. When the video begins playing, stop the timer, and record the result.
17. Start the timer.
18. Using a camera, capture the frames per second displayed in the counter at 20 seconds, 30 seconds, 40 seconds, 50 seconds, and 60 seconds.
19. Take the average of those five data points, and record the result.
20. In the search box in the top-right corner, type `fantasy focus football` and press Enter.
21. Select Audio to display audio podcasts.
22. Simultaneously start the timer and select the audio podcast from August 25, 2014.
23. When the audio podcast begins playing, stop the timer, and record the result.
24. Pause the audio podcast.
25. Press Ctrl+T to open a new Chrome tab.
26. Type `games.espn.go.com/ffl/mockdraftlobby` in the omnibox, and press Enter.
27. Select an available 10-team league with snake draft type.
28. Wait for the countdown timer to reach 00:00:00.

29. Simultaneously start the timer and select Launch Draft.

30. When the fantasy draft is fully displayed, stop the timer, and record the result.

31. On the Windows client, start a new Google Hangouts call and send an invite to the test system.

32. On the test system, simultaneously start the timer and select Answer to join the call.

33. When the call is fully connected, stop the timer, and record the result.

34. Complete steps 1 through 33 two more times.

Battery life while browsing

Setting up the test

1. Make sure the display will not automatically turn off during the test.
    a. Install the Keep Awake extension.
    b. To switch to the sun icon, click the icon in the top-right corner of the Chrome browser.
2. Open Google Chrome from the shelf, and bookmark the msn.com Web site.
3. Set the displays to as close as possible to 70 nits.
4. Plug the Chromebook chargers into a power strip.
5. Make sure the batteries are all 100 percent charged.
6. Place both Chromebooks next to the clock.

Running the test

1. Start the video camera.
2. Open Google Chrome from the shelf, and go to the bookmarked Web site.
3. Turn the power strip off, and note the time.
4. After both Chromebooks have fully discharged, review the video to determine when each Chromebook powered off.
5. Fully charge the Chromebooks.
6. Complete steps 1 through 5 two more times.

APPENDIX C: DETAILED RESULTS

Figure 7 presents the detailed results, with the time to complete tasks in the scenarios reported in seconds, and battery life while browsing reported in hours. We performed all tasks three times and used the median scores.

	Intel Celeron processor-powered Chromebook	ARM processor-based Chromebook
Scenario 1: Doing science homework		
Time to turn on system (lower is better)		
Run 1	00:09.50	00:09.76
Run 2	00:09.46	00:09.85
Run 3	00:09.46	00:09.88
Median	**00:09.46**	**00:09.85**
Time to open Gmail (lower is better)		
Run 1	00:09.95	00:12.92
Run 2	00:09.92	00:13.13
Run 3	00:10.06	00:12.91
Median	**00:09.95**	**00:12.92**
Time to open Kno.com textbook (lower is better)		
Run 1	00:06.95	00:10.13
Run 2	00:07.04	00:10.29
Run 3	00:06.99	00:10.15
Median	**00:06.99**	**00:10.15**
Time to open Google Drive (lower is better)		
Run 1	00:03.72	00:04.86
Run 2	00:03.84	00:04.79
Run 3	00:03.66	00:04.91
Median	**00:03.72**	**00:04.86**
Time to open new Google Docs document (lower is better)		
Run 1	00:04.90	00:05.76
Run 2	00:05.06	00:05.84
Run 3	00:04.87	00:05.69
Median	**00:04.90**	**00:05.76**
Time to search Wikipedia (lower is better)		
Run 1	00:02.61	00:02.73
Run 2	00:02.60	00:02.71
Run 3	00:02.56	00:02.71
Median	**00:02.60**	**00:02.71**
Time to load human in BioDigital Human (lower is better)		
Run 1	00:27.26	00:32.09
Run 2	00:27.30	00:32.24
Run 3	00:27.40	00:31.89
Median	**00:27.30**	**00:32.09**
Frames per second when viewing human in BioDigital Human (higher is better)		
Run 1	15.0	6.4
Run 2	15.4	6.9
Run 3	14.0	6.5
Median	**15.0**	**6.5**

	Intel Celeron processor-powered Chromebook	ARM processor-based Chromebook
Time to play Khan Academy video on YouTube (lower is better)		
Run 1	00:06.76	00:07.62
Run 2	00:06.81	00:07.68
Run 3	00:06.70	00:07.56
Median	**00:06.76**	**00:07.62**
Frames per second when playing Khan Academy video on YouTube (higher is better)		
Run 1	42.0	37.8
Run 2	42.1	38.3
Run 3	41.5	37.8
Median	**42.0**	**37.8**
Total time for eight tasks in the scenario	**01:11.68**	**01:25.96**
Scenario 2: Hanging out at home		
Time to open Facebook (lower is better)		
Run 1	00:01.22	00:02.58
Run 2	00:01.45	00:02.36
Run 3	00:01.23	00:02.44
Median	**00:01.23**	**00:02.44**
Time to open Twitter (lower is better)		
Run 1	00:01.93	00:02.01
Run 2	00:01.87	00:02.10
Run 3	00:01.91	00:02.03
Median	**00:01.91**	**00:02.03**
Time to open ESPN (lower is better)		
Run 1	00:06.01	00:07.18
Run 2	00:06.06	00:07.37
Run 3	00:06.26	00:07.14
Median	**00:06.06**	**00:07.18**
Frames per second when playing ESPN video (higher is better)		
Run 1	31.0	28.8
Run 2	30.7	28.2
Run 3	30.8	29.7
Median	**30.8**	**28.8**
Time to start game in Bejeweled (lower is better)		
Run 1	00:08.12	00:10.47
Run 2	00:08.05	00:10.67
Run 3	00:08.04	00:10.58
Median	**00:08.05**	**00:10.58**
Time to connect to Google Hangouts call (lower is better)		
Run 1	00:15.56	00:17.47
Run 2	00:15.42	00:16.72
Run 3	00:15.65	00:17.11
Median	**00:15.56**	**00:17.11**
Total time for five tasks in the scenario	**00:15.56**	**00:39.34**
Scenario 3: Planning a housewarming party		
Time to open Gmail (lower is better)		
Run 1	00:09.95	00:12.59
Run 2	00:09.92	00:12.30

	Intel Celeron processor-powered Chromebook	ARM processor-based Chromebook
Run 3	00:10.06	00:12.41
Median	**00:09.95**	**00:12.41**
Time to open Google Calendar (lower is better)		
Run 1	00:02.91	00:03.49
Run 2	00:02.93	00:03.49
Run 3	00:02.93	00:03.44
Median	**00:02.93**	**00:03.49**
Time to open Google Drive (lower is better)		
Run 1	00:04.40	00:05.31
Run 2	00:04.26	00:05.20
Run 3	00:04.31	00:05.43
Median	**00:04.31**	**00.05.31**
Time to open existing Google Docs document (lower is better)		
Run 1	00:06.43	00:07.66
Run 2	00:06.33	00:07.66
Run 3	00:06.35	00:07.66
Median	**00:06.35**	**00:07.66**
Time to open Google Maps (lower is better)		
Run 1	00:07.96	00:08.06
Run 2	00:07.90	00:07.97
Run 3	00:07.95	00:08.06
Median	**00:07.95**	**00:08.06**
Time to search for business in Google Maps (lower is better)		
Run 1	00:03.23	00:02.75
Run 2	00:03.32	00:02.94
Run 3	00:03.23	00:02.74
Median	**00:03.23**	**00:02.75**
Time to play artist radio on Pandora (lower is better)		
Run 1	00:07.08	00:08.88
Run 2	00:07.06	00:09.25
Run 3	00:07.21	00:09.10
Median	**00:07.08**	**00:09.10**
Time to launch Cracking Sands (lower is better)		
Run 1	00:09.36	00:07.20
Run 2	00:09.32	00:07.11
Run 3	00:09.39	00:07.12
Median	**00:09.36**	**00:07.12**
Frames per second when playing Cracking Sands (higher is better)		
Run 1	28.7	18.0
Run 2	28.3	18.8
Run 3	27.5	18.0
Median	**28.3**	**18.0**
Time to connect to Google Hangouts call (lower is better)		
Run 1	00:09.83	00:10.95
Run 2	00:10.00	00:10.82
Run 3	00:09.75	00:11.00
Median	**00:09.83**	**00:10.95**

	Intel Celeron processor-powered Chromebook	ARM processor-based Chromebook
Frames per second during Google Hangouts call (higher is better)		
Run 1	36.8	30.8
Run 2	35.6	31.6
Run 3	35.4	30.0
Median	**35.6**	**30.8**
Total time for nine tasks in the scenario	**01:00.99**	**01:06.85**
Scenario 4: Drafting a fantasy football team		
Time to open Gmail (lower is better)		
Run 1	00:09.90	00:12.98
Run 2	00:10.18	00:12.88
Run 3	00:09.88	00:12.90
Median	**00:09.90**	**00:12.90**
Time to open Google Calendar (lower is better)		
Run 1	00:02.81	00:03.40
Run 2	00:02.91	00:03.62
Run 3	00:02.78	00:03.49
Median	**00:02.81**	**00:03.49**
Time to open Google Drive (lower is better)		
Run 1	00:03.60	00:04.90
Run 2	00:03.67	00:04.86
Run 3	00:03.56	00:05.16
Median	**00:03.60**	**00:04.90**
Time to open existing Google Sheets spreadsheet (lower is better)		
Run 1	00:09.71	00:11.37
Run 2	00:09.66	00:11.28
Run 3	00:09.60	00:11.23
Median	**00:09.66**	**00:11.28**
Time to open ESPN (lower is better)		
Run 1	00:05.57	00:06.76
Run 2	00:05.40	00:06.82
Run 3	00:05.68	00:06.87
Median	**00:05.57**	**00:06.82**
Time to play ESPN video (lower is better)		
Run 1	00:07.87	00:10.56
Run 2	00:07.88	00:10.38
Run 3	00:08.08	00:10.53
Median	**00:07.88**	**00:10.53**
Time to play audio podcast (lower is better)		
Run 1	00:05.31	00:06.21
Run 2	00:04.96	00:06.19
Run 3	00:05.21	00:06.30
Median	**00:05.21**	**00:06.21**
Time to enter fantasy football draft (lower is better)		
Run 1	00:17.01	00:20.65
Run 2	00:17.30	00:20.77
Run 3	00:16.88	00:20.81
Median	**00:17.01**	**00:20.77**

	Intel Celeron processor-powered Chromebook	ARM processor-based Chromebook
Time to connect to Google Hangouts call (lower is better)		
Run 1	00:11.31	00:12.82
Run 2	00:11.57	00:12.88
Run 3	00:11.28	00:12.49
Median	**00:13.15**	**00:12.82**
Total time for nine tasks in the scenario	**01:12.95**	**01:29.72**
Battery life while browsing		
Battery life while browsing the Internet (higher is better)		
Run 1	09:36:00.00	08:55:00.00
Run 2	09:33:00.00	08:59:00.00
Run 3	09:24:00.00	09:17:00.00
Median	**09:33:00.00**	**08:59:00.00**

Figure 7: Detailed results.

ABOUT PRINCIPLED TECHNOLOGIES

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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

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Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.