



The science behind the report:

Start common classroom tasks faster and avoid distractions with Microsoft Windows 10

On November 17, 2016, we finalized the hardware and software configurations we tested. Updates for current and recently released hardware and software appear often, so unavoidably these configurations may not represent the latest versions available when this report appears. For older systems, we chose configurations representative of typical purchases of those systems. We concluded hands-on testing on December 5, 2016.

Appendix A: Detailed system configuration

The table below presents detailed information on the three systems we tested.

System	Lenovo N22 8056 (4GB RAM) with Windows 10	Lenovo N22 8056 (2GB RAM) with Windows 10	Lenovo N22 Chromebook 805F
Vendor and model	Lenovo® N22 8056	Lenovo N22 8056	Lenovo N22 Chromebook 805F
Processor	Intel® Celeron® processor N3050	Intel Celeron processor N3050	Intel Celeron processor N3050
Processor frequency (GHz)	1.6	1.6	1.6
Processor cores	2	2	2
Memory	4GB DDR3L SDRAM	2GB DDR3L SDRAM	4GB DDR3L SDRAM
Storage	64GB eMMC SSD	32GB eMMC SSD	16GB eMMC SSD
Battery type	3-cell Li-Ion	3-cell Lithium Polymer	3-cell Li-Ion
Battery capacity (Wh)	45	45	45
Display	11.6" (1,366 x 768)	11.6" (1,366 x 768)	11.6" (1,366 x 768)
Wireless	802.11 a/b/g/n/ac	802.11 a/b/g/n/ac	802.11 a/b/g/n/ac
Bluetooth®	Bluetooth 4.0 compatible	Bluetooth 4.0 compatible	Bluetooth 4.0 compatible
USB ports	1 x USB 3.0, 2 x USB 2.0	1 x USB 3.0, 2 x USB 2.0	1 x USB 3.0, 2 x USB 2.0
System weight (lbs.)	2.7	2.7	2.8
OS (version)	Windows 10 Pro (1607)	Windows 10 Pro (1607)	Chrome OS™ (54.0.2840.101)
Build/firmware	14393.447	14393.447	Google_Celes.7287.92.35

Appendix B: How we tested

We wanted a hardware reference platform in testing to ensure a fair comparison. We chose the Lenovo N22 as that reference platform as it was available in configurations with Windows 10 and Chrome OS at the time of this study. We tested two Windows 10 configurations with different RAM amounts as both were available for purchase; the Lenovo N22 Chromebook was only available with 4GB RAM at the time of purchase.

We conducted all tests on a private network throttled to 1Mbps upload and download to simulate a congested network that one might find in a public school. Testers used a stopwatch to measure time to complete tasks. We performed each task until we collected three consecutive runs at or below a variability threshold of 10 percent. We report the average of these three runs.

Both productivity web app platforms used the same files in our testing. For example, the 1.7MB .docx and 1.7MB Google Doc contained the same content.

Note: Khan Academy leveraged different video players in Microsoft Edge and Google Chrome™.

Testing on the laptops running Windows 10

Launching Word Online

1. Launch Microsoft Edge.
2. Navigate to <http://login.microsoftonline.com>
3. Enter an account email address and password.
4. Press Enter.
5. Simultaneously click Word and start the stopwatch.
6. When the page fully loads, stop the stopwatch.
7. Record the time.
8. Repeat the test until three consecutive results fall at or under the variability threshold.
9. Report the average of the three runs.

Opening an existing document in Word Online

1. Log into Office 365® online.
2. Launch OneDrive®.
3. Simultaneously click the name of the document and start the stopwatch.
4. When the page fully loads, stop the stopwatch.
5. Record the time.
6. Repeat the test until three consecutive results fall at or under the variability threshold.
7. Report the average of the three runs.

Launching Excel Online

1. Launch Microsoft Edge.
2. Navigate to <http://login.microsoftonline.com>
3. Enter an account email address and password.
4. Press Enter.
5. Simultaneously click Excel and start the stopwatch.
6. When the page fully loads, stop the stopwatch.
7. Record the time.
8. Repeat the test until three consecutive results fall at or under the variability threshold.
9. Report the average of the three runs.

Opening an existing workbook in Excel Online

1. Log into Office 365 online.
2. Launch OneDrive.
3. Simultaneously click the name of the document and start the stopwatch.
4. When the page fully loads, stop the stopwatch.
5. Record the time.
6. Repeat the test until three consecutive results fall at or under the variability threshold.
7. Report the average of the three runs.

Launching PowerPoint Online

1. Launch Microsoft Edge.
2. Navigate to <http://login.microsoftonline.com>
3. Enter an account email address and password.
4. Press Enter.
5. Simultaneously click PowerPoint and start the stopwatch.
6. When the page fully loads, stop the stopwatch.
7. Record the time.
8. Repeat the test until three consecutive results fall at or under the variability threshold.
9. Report the average of the three runs.

Opening an existing presentation in PowerPoint Online

1. Log into Office 365 online.
2. Launch OneDrive.
3. Simultaneously click the name of the document and start the stopwatch.
4. When the page fully loads, stop the stopwatch.
5. Record the time.
6. Repeat the test until three consecutive results fall at or under the variability threshold.
7. Report the average of the three runs.

Loading a lesson in Khan Academy

Note: You must already have an account and be logged in.

1. Launch Microsoft Edge.
2. Navigate to <https://khanacademy.org>
3. Click Start learning something new.
4. Select Precalculus.
5. Select Conic Sections.
6. Simultaneously click Intro to Conic Sections and start the stopwatch.
7. When the page and video fully load (and the play icon appears), stop the stopwatch.
8. Record the time.
9. Repeat the test until three consecutive results fall at or under the variability threshold.
10. Report the average of the three runs.

Opening a new 3D graphics project in GeoGebra

1. Launch Microsoft Edge.
2. Navigate to <http://geogebra.org>
3. At the top of the webpage, click GeoGebra Math Apps.
4. Simultaneously click 3D Grapher and start the stopwatch.
5. When the page fully loads, stop the stopwatch.
6. Record the time.
7. Repeat the test until three consecutive results fall at or under the variability threshold.
8. Report the average of the three runs.

Loading a simulation in PhET Build an Atom

1. Launch Microsoft Edge.
2. Navigate to <http://phet.colorado.edu>
3. In the Search box, start typing Build an Atom (simulation), and when the phrase appears, select it.
4. Simultaneously click the play button and start the stopwatch.
5. When the page fully loads, stop the stopwatch.
6. Record the time.
7. Repeat the test until three consecutive results fall at or under the variability threshold.
8. Report the average of the three runs.

Logging into Glogster

1. Launch Microsoft Edge.
2. Navigate to <http://glogster.com>
3. Click LOG IN.
4. Enter an account email address and password.
5. Simultaneously click Log in and start the stopwatch.
6. When the page fully loads, stop the stopwatch.
7. Record the time.
8. Log out of the website.
9. Repeat the test until three consecutive results fall at or under the variability threshold.
10. Report the average of the three runs.

Logging into Edmodo

1. Launch Microsoft Edge.
2. Navigate to <http://edmodo.com>
3. Click Login.
4. Enter an account email address and password.
5. Simultaneously click Login and start the stopwatch.
6. When the page fully loads, stop the stopwatch.
7. Record the time.
8. Log out of the website.
9. Repeat the test until three consecutive results fall at or under the variability threshold.
10. Report the average of the three runs.

Logging into Gmail

Note: You must already have an account and be logged in.

1. Launch Microsoft Edge.
2. Navigate to, but do not execute, <http://mail.google.com/>
3. Simultaneously press Enter and start the stopwatch.
4. When the page fully loads, stop the stopwatch.
5. Record the time.
6. Repeat the test until three consecutive results fall at or under the variability threshold.
7. Report the average of the three runs.

Testing on the Chromebook

Launching Google Docs

1. Open the list of Chromebook Apps.
2. Simultaneously click Docs and start the stopwatch.
3. When the page fully loads, stop the stopwatch.
4. Record the time.
5. Repeat the test until three consecutive results fall at or under the variability threshold.
6. Report the average of the three runs.

Opening an existing document

1. Open the list of Chromebook Apps.
2. Select Files. Select the desired file.
3. Simultaneously click Open and start the stopwatch.
4. When the page fully loads, stop the stopwatch.
5. Record the time.
6. Repeat the test until three consecutive results fall at or under the variability threshold.
7. Report the average of the three runs.

Launching Google Sheets

1. Open the list of Chromebook Apps.
2. Simultaneously click Sheets and start the stopwatch.
3. When the page fully loads, stop the stopwatch.
4. Record the time.
5. Repeat the test until three consecutive results fall at or under the variability threshold.
6. Report the average of the three runs.

Opening an existing workbook in Google Sheets

1. Open the list of Chromebook Apps.
2. Select Files.
3. Select the desired file.
4. Simultaneously click Open and start the stopwatch.
5. When the page fully loads, stop the stopwatch.
6. Record the time.
7. Repeat the test until three consecutive results fall at or under the variability threshold.
8. Report the average of the three runs.

Launching Google Slides

1. Open the list of Chromebook Apps.
2. Simultaneously click Slides and start the stopwatch.
3. When the page fully loads, stop the stopwatch.
4. Record the time.
5. Repeat the test until three consecutive results fall at or under the variability threshold.
6. Report the average of the three runs.

Opening an existing presentation in Google Slides

1. Open the list of Chromebook Apps.
2. Select Files.
3. Select the desired file.
4. Simultaneously click Open and start the stopwatch.
5. When the page fully loads, stop the stopwatch.
6. Record the time.
7. Repeat the test until three consecutive results fall at or under the variability threshold.
8. Report the average of the three runs.

Loading a lesson in Khan Academy

Note: You must already have an account and be logged in.

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3. Click Start learning something new.
4. Select Precalculus.
5. Select Conic Sections.
6. Simultaneously click Intro to Conic Sections and start the stopwatch.
7. When the page and video fully load (and the play icon appears), stop the stopwatch.
8. Record the time.
9. Repeat the test until three consecutive results fall at or under the variability threshold.
10. Report the average of the three runs.

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1. Launch Google Chrome.
2. Navigate to <http://geogebra.org>
3. At the top of the webpage, click GeoGebra Math Apps.
4. Simultaneously click 3D Grapher and start the stopwatch.
5. When the page fully loads, stop the stopwatch.
6. Record the time.
7. Repeat the test until three consecutive results fall at or under the variability threshold.
8. Report the average of the three runs.

Loading a simulation in PhET Build an Atom

1. Launch Google Chrome.
2. Navigate to <http://phet.colorado.edu>
3. In the Search box, start typing Build an Atom (simulation), and when the phrase appears, select it.
4. Simultaneously click the play button and start the stopwatch.
5. When the page fully loads, stop the stopwatch.
6. Record the time.
7. Repeat the test until three consecutive results fall at or under the variability threshold.
8. Report the average of the three runs.

Logging into Glogster

1. Launch Google Chrome.
2. Navigate to <http://glogster.com>
3. Click LOG IN.
4. Enter an account email address and password.
5. Simultaneously click Log in and start the stopwatch.
6. When the page fully loads, stop the stopwatch.
7. Record the time.
8. Log out of the website.
9. Repeat the test until three consecutive results fall at or under the variability threshold.
10. Report the average of the three runs.

Logging into Edmodo

1. Launch Google Chrome.
2. Navigate to <http://edmodo.com>
3. Click Login.
4. Enter an account email address and password.
5. Simultaneously click Login and start the stopwatch.
6. When the page fully loads, stop the stopwatch.
7. Record the time.
8. Log out of the website.
9. Repeat the test until three consecutive results fall at or under the variability threshold.
10. Report the average of the three runs.

Logging into Gmail

Note: You must already have an account and be logged in.

1. Simultaneously click the Google Mail desktop icon and start the stopwatch.
2. When the page fully loads, stop the stopwatch.
3. Record the time.
4. Repeat the test until three consecutive results fall at or under the variability threshold.
5. Report the average of the three runs.

Appendix C: Results

The table below presents our findings in detail. We ran each test three times and present the average.

Application (Windows)	Application (Chrome)	Test description	Timing results in seconds (using default browsers)		
			Chromebook	Windows 2GB	Windows 4GB
Word Online	Google Docs	Launch website/web app average	00:05.6	00:02.6	00:02.6
		Open existing document average	00:07.8	00:04.0	00:04.1
Excel Online	Google Sheets	Launch website/web app average	00:05.7	00:02.9	00:02.3
		Open existing document average	00:17.0	00:06.4	00:06.4
PowerPoint Online	Google Slides	Launch website/web app average	00:06.1	00:02.3	00:02.4
		Open existing document average	00:09.1	00:04.7	00:04.5
Khan Academy	Khan Academy	Load lesson average	00:11.0	00:03.0	00:07.0
GeoGebra	GeoGebra	Open new 3D graphics project average	00:02.8	00:02.2	00:02.2
PhET Build An Atom	PhET Build An Atom	Load simulation average	00:05.4	00:03.9	00:03.7
Glogster	Glogster	Log in website average	00:04.0	00:03.6	00:03.5
Edmodo	Edmodo	Log in website average	00:07.2	00:06.9	00:06.3
Gmail	Gmail	Log in Gmail average	00:18.4	00:13.1	00:12.9

Read the report at <http://facts.pt/3Vyc4Q>. ►

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