10th Generation Intel® Core™ i5-10210U processor-powered Chromebook™†△

Intel Celeron® N4020 processor-powered Chromebook†△

Learn, play, and create with LEGO Education sets and Chromebooks powered by an Intel Celeron N4020 processor and an Intel Core i5-10210U processor

Games are more than just fun. From roughhousing and make-believe to video games, play behavior provides kids of all ages a sandbox to develop skills, practice perseverance, and claim foundational victories. In fact, UNICEF considers play "one of the most important ways" for children to gain and develop key skills.[1]

LEGO® Education building sets encourage learning through purposeful play. Users can create robotic playthings and set them to motion with the power of physics and code, making LEGO Education sets a promising avenue to explore for teachers, students, and even adult enthusiasts.

At Principled Technologies, we tested two LEGO Education sets with two Intel processor-powered Chromebooks:

- Intel Celeron N4020 processor-powered Acer® Chromebook 315
- Intel Core i5-10210U processor-powered Acer Chromebook Spin 713

In our experience, the LEGO Education sets were easy to set up and work with, and the Chromebooks each handled the LEGO apps responsively. Get a fuller introduction to the world of LEGO Education sets with Intel processor-powered Chromebooks by diving into this report.

†Acer Chromebook Spin 713 powered by a 10th Generation Intel Core i5-10210U processor and Acer Chromebook 315 powered by an Intel Celeron N4020 processor.
△See the **science behind this report** for detailed system configurations and benchmark results.

Complete SPIKE Prime tasks quickly with both Chromebooks†△

Complete MINDSTORMS EV3 tasks in up to
37% less time†△

Complete Linux tasks in up to
63% less time†△

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December 2020

This report features a fictional scenario to illustrate the hands-on testing we performed with each device and LEGO set. While the people we mention are imaginary, their stories reflect the real-world experiences we had during testing.

LEGO Education sets

LEGO offers a variety of kits that enable students and enthusiasts to explore STEAM (science, technology, engineering, art, and math) concepts by building LEGO creations and bringing them to life through motors, gears, and code. After creating a motorized object with gears and other simple machines, you can transmit code via Bluetooth or USB to the computer "hub" of your creation to make it move. We tested two of these kits with an Intel Celeron N4020 processor-powered Chromebook and an Intel Core i5-10210U processor-powered Chromebook.

LEGO Education SPIKE Prime

The LEGO Education SPIKE™ Prime Set is a learning tool for building STEAM skills. According to the LEGO website, SPIKE Prime combines LEGO building elements with a Scratch-based drag-and-drop coding language, helping to build a foundation for further computer science skills. SPIKE Prime introduces 11 brand-new LEGO elements, including a new wheel design, frames and base plates to support prototyping, and a new gear for additional angles.[2] To learn more, visit https://education.lego.com/en-us/meetspikeprime.

LEGO MINDSTORMS Education EV3 Core

An updated iteration of a design 22 years in the making,[3] LEGO MINDSTORMS® Education EV3 Core Set is a multidisciplinary building set for STEM education. Each kit supports up to two students, and includes video tutorials, lesson plans, and an e-learning program for educators. MINDSTORMS Education EV3 features the "EV3 Intelligent Brick," which LEGO describes as a compact, programmable computer that enables users to control motors and collect data from sensors.[4] To learn more, visit https://education.lego.com/en-us/products/lego-mindstorms-education-ev3-core-set/5003400#lego-mindstorms-education-ev3.

△See the **science behind this report** for detailed system configurations and benchmark results.

Learn, play, and create with LEGO Education sets and Chromebooks powered by an Intel Celeron N4020 processor and an Intel Core i5-10210U processor

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MINDSTORMS EV3

SPIKE Prime and MINDSTORMS for education

Learning from home during the pandemic has been challenging, but fictional siblings Kara and Anthony are getting by with support from their parents and each other. The siblings' parents invested in two LEGO Education sets to spark their imaginations and boost their engagement with learning. So far, it's worked like a charm, and the pair enjoy building and creating with the LEGO sets along with their school-issued Intel Celeron N4020 processor-powered Chromebooks even on the weekends.

During our tests, it was easy and straightforward for to get started with the LEGO Education sets. Each came with links to online videos that walked us through hardware setup and directed us to the Google Play Store or Chrome Web Store app that enables direct communication with each Education set's hub. The apps provided step-by-step instructions for powering on each set and connecting them to the Chromebook. With setup complete, you're free to create using starter lessons, advanced projects, or whatever your imagination thinks up.

With their Intel Celeron N4020 processor-powered Chromebooks, Kara and Anthony can easily interact with their LEGO Education SPIKE Prime and MINDSTORMS EV3 sets.

SPIKE Prime

ᐃSee the **science behind this report** for detailed system configurations and benchmark results.

Figure 1 shows the time required to complete certain tasks on each of the LEGO education sets. For example, with the siblings' Intel Celeron N4020 processor-powered Chromebook, it takes less than a second to create a new project in the Python coding language. Connecting to either set's hub takes just over two seconds, and downloading and running a complex program is also fast. However, some tasks could be even faster if the siblings had a Chromebook powered by an Intel Core i5-10210U processor.

Who knows what the future will hold for Kara and Anthony? Whether they become engineers, writers, bakers, teachers, or anything else—now, in the present, they are enjoying their time, expanding their minds, and building important skills as they tinker and play with their LEGO Education sets and Intel Celeron N4020 processor-powered Chromebooks.

Complete SPIKE Prime tasks quickly

With Chromebooks powered by an Intel Celeron N4020 and an Intel Core i5-10210U processor

Launch SPIKE LEGO education app

Create a new Python project in Chrome Web Store

Connect to hub via bluetooth in Chrome Web Store

Open obstacle course project

Download and run a complex program

22.2 sec

23.6 sec

Up to
7.5%
less time△

10th Generation Intel Core i5-10210U processor-powered Chromebook

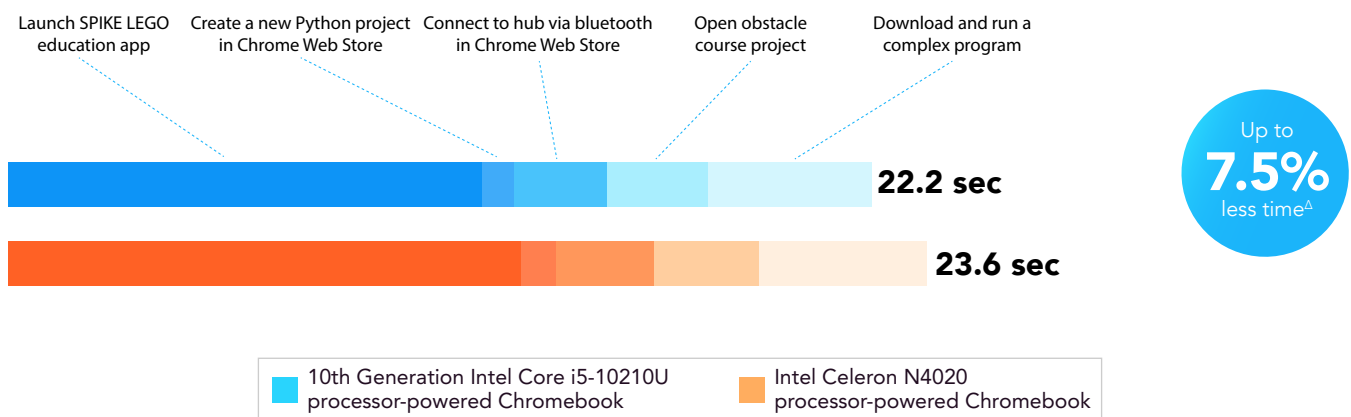**Intel Celeron N4020 processor-powered Chromebook**

Figure 1: Total time (in seconds) to complete a non-sequential group of tasks in the LEGO Education SPIKE Prime set app. Less time is better. Source: Principled Technologies.

△See the **science behind this report** for detailed system configurations and benchmark results.

Learn, play, and create with LEGO Education sets and Chromebooks powered by an Intel Celeron N4020 processor and an Intel Core i5-10210U processor

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MINDSTORMS for enthusiasts

Rachel is an accountant, an avid runner—and a huge LEGO enthusiast. The bright-colored building blocks have been a big part of her imagination ever since she got her first set for Christmas at age six.

Rachel has been having a ton of fun creating with her new LEGO MINDSTORMS EV3 set. The gentle learning curve of the MINDSTORMS software means that Rachel's limited coding knowledge isn't a barrier for engaging with the system. Plus, her Intel Core i5-10210U processor-powered Chromebook provides a smooth experience for interfacing with the MINDSTORMS kit.

^ΔSee the **science behind this report** for detailed system configurations and benchmark results.

Learn, play, and create with LEGO Education sets and Chromebooks powered by an Intel Celeron N4020 processor and an Intel Core i5-10210U processor

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The Intel Core i5-10210U processor-powered Chromebook may be better suited to enthusiasts like Rachel who wish to run more complex tasks. We found that this Chromebook needed less time to complete certain Linux-related tasks than the Intel Celeron N4020 processor-powered Chromebook. For example, the Intel Core i5-10210U processor-powered Chromebook saved 35 seconds when installing Linux® Beta for ChromeOS.

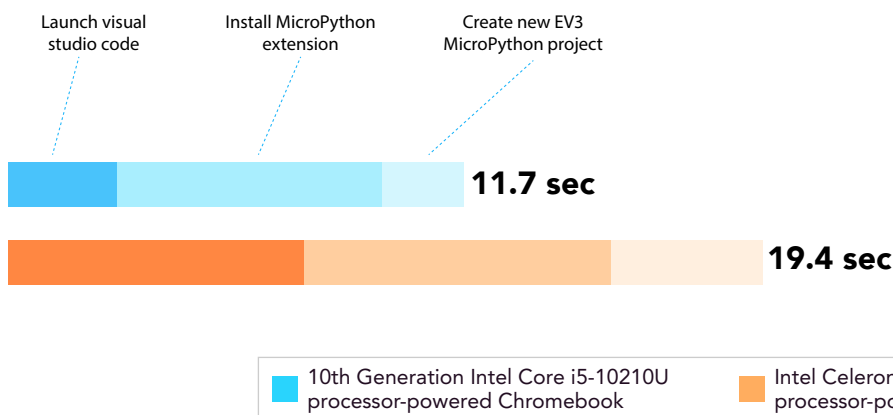## Complete MINDSTORMS EV3 tasks in less time
With an Intel Core i5 processor-powered Chromebook

Launch MINDSTORMS app · Create new program · Download and run complex program

18.4 sec

26.6 sec

Up to **37%** less time△

■ 10th Generation Intel Core i5-10210U processor-powered Chromebook   ■ Intel Celeron N4020 processor-powered Chromebook
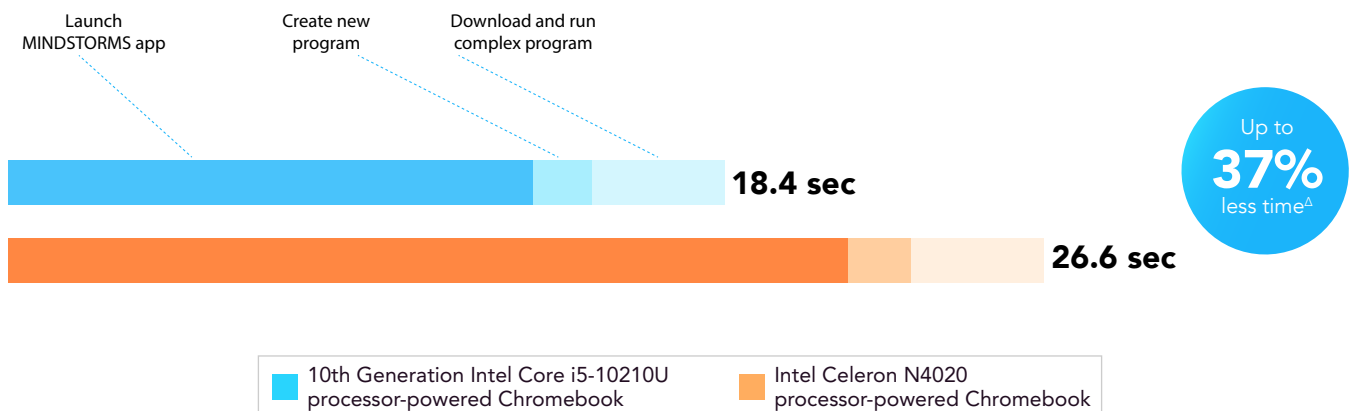
Figure 2: Total time (in seconds) to complete a non-sequential group of tasks in the MINDSTORMS EV3 app. Less time is better. Source: Principled Technologies.

△See the **science behind this report** for detailed system configurations and benchmark results.
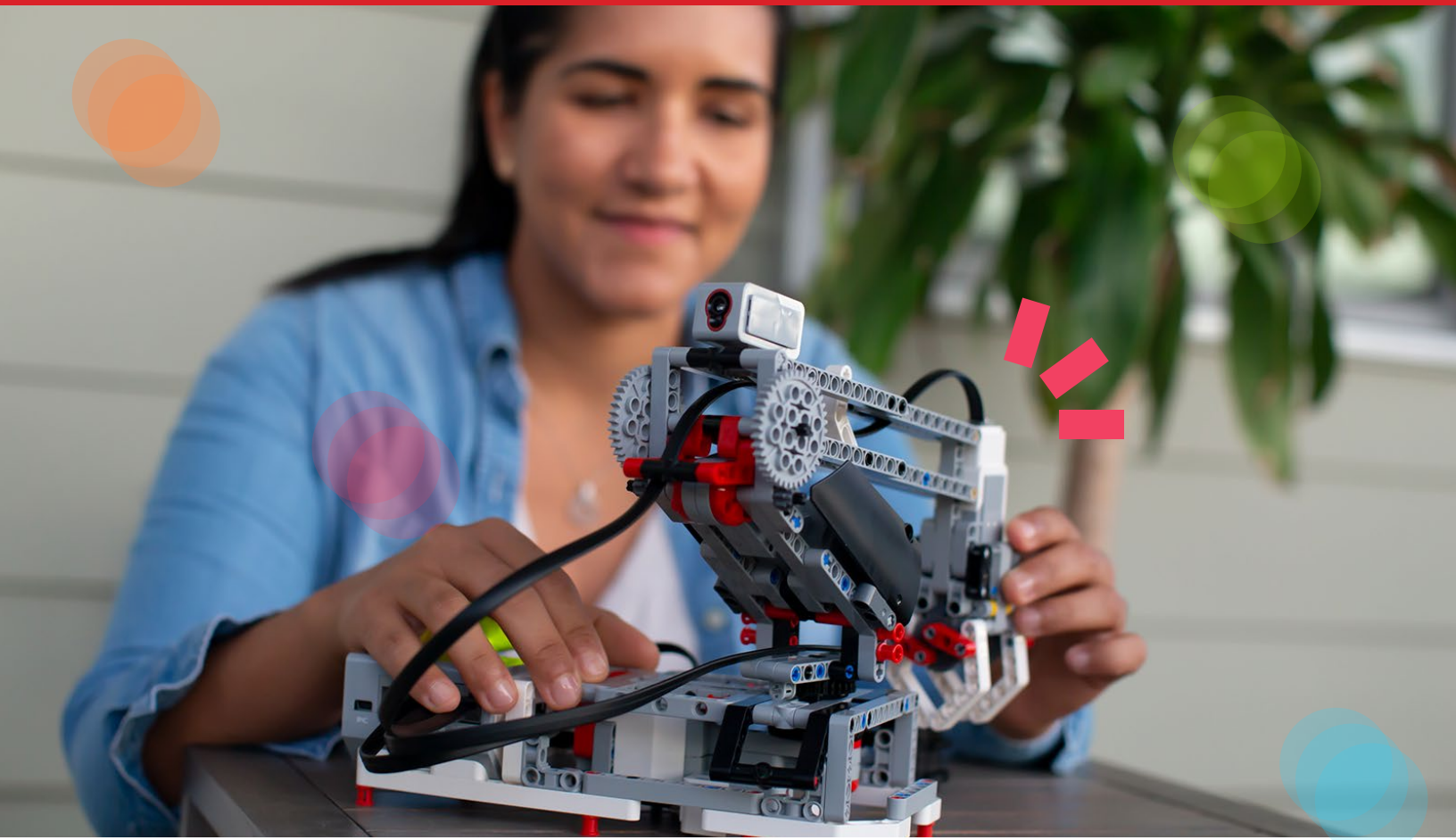
Installing Linux Beta is part of the process for using PyBricks, which is free and open-source software that enables users to run code directly on LEGO hubs rather than transmitting instructions via Bluetooth or USB. With her Intel Core i5-10210U processor-powered Chromebook, Rachel can perform these tasks quickly, as Figure 3 illustrates.

While she may not be an expert coder (yet!), Rachel is delighted with her LEGO MINDSTORMS EV3 set, and happy that her Intel Core i5-10210U processor-powered Chromebook provides a fast platform to engage with it.

Complete Linux-related tasks in less time
With an Intel Core i5 processor-powered Chromebook

Launch visual studio code

Install MicroPython extension

Create new EV3 MicroPython project

11.7 sec

19.4 sec

Up to
63%
less time△

■ 10th Generation Intel Core i5-10210U processor-powered Chromebook

■ Intel Celeron N4020 processor-powered Chromebook

Figure 3: Total time (in seconds) to complete a non-sequential group of tasks in the MINDSTORMS EV3 app and Visual Basic Studio (for tasks related to PyBricks Linux scripts). Less time is better. Source: Principled Technologies.

△See the **science behind this report** for detailed system configurations and benchmark results.

Learn, play, and create with LEGO Education sets and Chromebooks powered by an Intel Celeron N4020 processor and an Intel Core i5-10210U processor

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10th Generation Intel Core i5-10210U processor-powered Chromebook
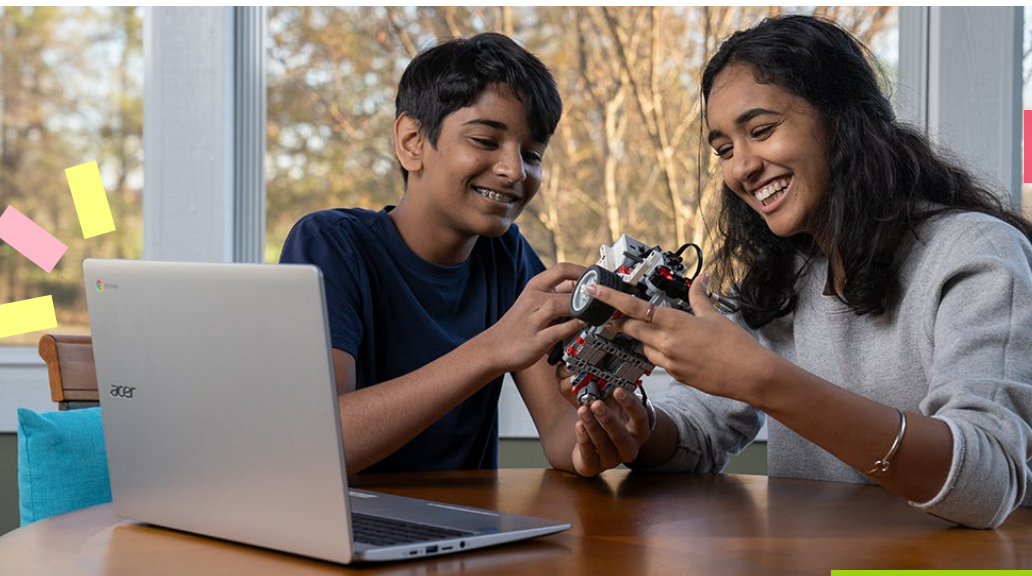
Intel Celeron N4020 processor-powered Chromebook

Conclusion

LEGO Education sets can provide children and adults alike with the opportunity to engage in skill-building play. We carried out a hands-on investigation of two LEGO Education sets—SPIKE Prime and MINDSTORMS EV3—to see how each interfaced with two Chromebooks: one powered by an Intel Celeron N4020 processor, and the other powered by an Intel Core i5-10210U processor. We found setup to be easy and straightforward, and both Chromebooks enabled us to quickly perform various tasks in each Education set's app. The Intel Core i5-10210U processor-powered Chromebook required less time to complete certain tasks in the MINDSTORMS EV3 app and certain tasks related to Linux scripts. We experienced no issues while using the Intel Celeron and Intel Core i5 processor-powered Chromebooks to perform these tasks.

For more information about the Chromebooks we tested, visit https://intel.com/Chromebooks.

△See the **science behind this report** for detailed system configurations and benchmark results.

Learn, play, and create with LEGO Education sets and Chromebooks powered by an Intel Celeron N4020 processor and an Intel Core i5-10210U processor

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1   UNICEF, "Learning through play: Strengthening learning through play in early childhood education programmes," accessed October 27, 2020,
    https://www.unicef.org/sites/default/files/2018-12/UNICEF-Lego-Foundation-Learning-through-Play.pdf

2   "LEGO Education SPIKE Prime Set," accessed October 27, 2020,
    https://education.lego.com/en-us/products/lego-education-spike-prime-set/45678#spike%E2%84%A2-prime

3   The first iteration of the MINDSTORMS set, LEGO Robotics Invention System, was released in 1998. https://brickset.com/sets/9719-1/Robotics-Invention-System.

4   "Bringing Best-in-Class STEM and Robotics Tools to the Classroom with LEGO MINDSTORMS Education EV3 for High School!" Accessed October 27, 2020,
    https://education.lego.com/en-us/middle-school/intro/mindstorms-ev3

We concluded our hands-on testing on October 27, 2020. 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 October 20, 2020 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

Table 1: Time in seconds to complete tasks in various apps.

Task	Acer® Chromebook Spin 713 with an Intel® Core™ i5-10210U processor	Acer Chromebook 315 with an Intel Celeron® N4020 processor	Intel Core i5-10210U processor powered Chromebook advantage
SPIKE™ Prime tasks			
Launching the LEGO® Education SPIKE app	12.2	13.2	Up to 7.5% less time
Creating a new Python project	0.8	0.9	
Connecting the hub via Bluetooth	2.4	2.5	
Opening the obstacle course project	2.6	2.7	
Downloading and running a complex program	4.2	4.3	
Total time	22.2	23.6	
MINDSTORMS® EV3 tasks			
Launching the MINDSTORMS EV3 app	13.5	21.6	Up to 37% less time
Creating a new program	1.5	1.6	
Downloading and running a complex program	3.4	3.4	
Total time	18.4	26.6	
Linux®-related tasks			
Launching Visual Studio Code	2.8	7.6	Up to 63% less time
Installing the MicroPython extension	6.8	7.9	
Creating a new MINDSTORMS EV3 MicroPython project	2.1	3.9	
Total time	11.7	19.4	

System configuration information

Table 2: The table below presents detailed information on the systems we tested.

System	Acer Chromebook Spin 713	Acer Chromebook 315
Processor	Intel Core i5-10210U	Intel Celeron N4020
Processor frequency (GHz)	1.6	1.10
Processor cores	4	2
Memory (GB)	8	4
Storage (GB)	128	64
Bluetooth	5	5
USB	2x USB 3.1 Type-C, 1x USB 3.1 Gen 1	2x USB 3.1 Type-C, 2x USB 3.1 Gen 1
Battery type	Lithium-Ion	Lithium-Ion
Battery capacity (Wh)	48	48
Display size (in.)	13.5	15.6
Display resolution	2256 x 1054	1366 x 768
OS (version)	85.0.4183.84	85.0.4183.84
System weight (lbs.)	3.02	4.19

How we tested

This document details the methodologies we will follow in testing the system.

Application testing

For each scenario, we downloaded, installed, and pinned the requisite apps to the Chrome shelf. For applications that required accounts or Google Authenticator, we created test profiles and logged in the users on each device. After one run of a given task, we reset the Chromebook and performed two additional runs.

SPIKE LEGO Education

Launching LEGO Education SPIKE

1. Install the LEGO Education SPIKE app from the Google Play Store.
2. Pin the app to the shelf.
3. Simultaneously start the timer, and click to launch the app.
4. Stop the timer when the app has fully loaded.

Creating a new Word Blocks project

1. Launch the app from the shelf.
2. From the home screen, click New Project.
3. Leave the default Word Blocks project type selected.
4. Simultaneously start the timer and click Create.
5. Stop the timer when the project editor has fully loaded.

Creating a new Python project

1. Launch the app from the shelf.
2. From the home screen, click New Project.
3. Click to select the Python project type. Simultaneously start the timer and click Create.
4. Stop the timer when the project editor has fully loaded.

Connecting the SPIKE hub via Bluetooth

1. Launch the app from the shelf.
2. Select and open the test project.
3. Power on the SPIKE hub.
4. After the startup chime completes, press and hold the Bluetooth button until it begins blinking.
5. Simultaneously start the timer and click the Connect button.
6. Stop the timer when the connection chime completes, and the device appears as connected in the project editor window.

Opening the Advanced Driving Base Assembly instructions

1. Launch the app from the shelf.
2. Click the Build tab from the navigation menu.
3. Simultaneously start the timer and click the Advanced Driving Base Assembly instructions.
4. Stop the timer when the first page of the instructions fully loads.

Opening the Obstacle Course project

1. Launch the app from the shelf.
2. Click the Units tab from the navigation menu.
3. Click the Training Trackers projects unit.
4. Scroll down to the bottom of the Lessons list to find The Obstacle Course lesson.
5. Simultaneously start the timer and click Start.
6. Stop the timer when the project editor and instruction video fully loads.

Downloading and running the Obstacle Course

1. Launch the app from the shelf.
2. Click the Units tab from the navigation menu.
3. Click the Training Trackers projects unit.
4. Scroll down to the bottom of the Lessons list to find The Obstacle Course lesson, and click Start.
5. Follow the lesson plans in steps 1 through 6, clicking the forward arrow to advance the instructions.
6. With the project code complete, simultaneously start the timer and click the Play icon.
7. Stop the timer when the motors connecting to the SPIKE hub begin spinning.

Downloading and running a complex program

1. Launch the app from the shelf.
2. From the home screen, click New Project.
3. Leave the default Word Blocks project type selected, and click Create.
4. Create the program and save the project. (For this task, we created a program with multiple repeating nested loops to create a large file size.)
5. Simultaneously start the timer and click the Play icon.
6. Stop the timer when the sound sequence begins playing from the SPIKE hub.

LEGO Education MINDSTORMS EV3

Launching the LEGO Education MINDSTORMS EV3 app

1. Install the LEGO Mindstorms Education EV3 app from the Google Chrome Web Store.
2. Pin the app to the shelf.
3. Simultaneously start the timer and click to launch the app.
4. Stop the timer when the app has fully loaded.

Connecting the MINDSTORMS EV3 hub via USB

1. Launch the app from the shelf.
2. From the home screen, click New Program.
3. Power on the EV3 hub.
4. Simultaneously start the timer and connect the EV3 hub via USB.
5. Stop the timer when the hub appears connect in the app.

Creating a new program

1. Launch the app from the shelf.
2. Simultaneously start the timer and click New Program.
3. Stop the timer when the program editor fully loads.

Downloading and running a simple project

1. Launch the app from the shelf.
2. From the home screen, click New Program.
3. Assemble the block code elements to play a sound when the program runs.
4. Simultaneously start the timer and click the download and run icon.
5. Stop the timer when sound playback begins on the EV3 hub.

Downloading and running a project with 10 sounds

1. Launch the app from the shelf.
2. From the home screen, click New Program.
3. Assemble the block code elements to play a series of 10 sounds when the program runs.
4. Simultaneously start the timer and click the download and run icon.
5. Stop the timer when the sound playback sequence begins on the EV3 hub.

Opening the Large Motor tutorial

1. Launch the app from the shelf.
2. Simultaneously start the timer and click Use a Large Motor.
3. Stop the timer when the Use a Large Motor webpage fully loads.

Downloading and running the Large Motor program

1. Launch the app from the shelf.
2. From the home screen, click the Use a Large Motor lesson.
3. Follow the instructions to arrange the block code elements to start the motor when the program runs.
4. Simultaneously start the timer and click the download and run icon.
5. Stop the timer when the motor connected to the EV3 hub begins spinning.

Downloading and running a complex program

1. Launch the app from the shelf.
2. From the home screen, click New Program.
3. Create the program and save the project. (For this task we created a program with multiple repeating nested loops to create a large file size.)
4. Simultaneously start the timer and click the Play icon.
5. Stop the timer when the sound sequence begins playing from the EV3 hub.

Launching Teacher Support

1. Launch the app from the shelf.
2. Simultaneously start the timer and click Teacher Support.
3. Stop the timer when the Teacher Support page fully loads.

Opening the User Guide PDF file

1. Launch the app from the shelf.
2. From the home screen, click Teacher Support.
3. From the Teacher Support page, simultaneously start the timer and click User Guide (pdf).
4. Stop the timer when the PDF file fully loads.

Opening the curriculum for engineering projects

1. Launch the app from the shelf.
2. From the home screen, click Teacher Support.
3. From the Teacher Support page, simultaneously start the timer and click Next Steps (pdf).
4. Stop the timer when the pdf file fully loads.

PyBricks – MINDSTORMS EV3 – Linux Beta for ChromeOS

Installing Linux Beta for ChromeOS

1. Open the Chromebook Settings window.
2. From the search bar, search for Linux, and click to select the search result.
3. Under the Linux (Beta) settings category, click Turn On.
4. Click Next.
5. Leave the default username and Disk size. Simultaneously start the timer and click Install.
6. Stop the timer when the Linux installation completes.

Launching Visual Studio Code

1. Launch the Linux terminal application.
2. Install the community build of Visual Studio Code from the following link: https://code.headmelted.com/
3. Pin the Linux app to the shelf.
4. Simultaneously start the timer and launch Visual Studio Code.
5. Stop the timer when the app has fully loaded.

Installing the MINDSTORMS EV3 MicroPython Extension

1. Launch the Visual Studio Code Linux app from the shelf.
2. Click the Extensions menu.
3. In the search bar, search for MINDSTORMS.
4. Simultaneously start the timer and click Install.
5. Stop the timer when the extension installation completes.

Creating a new MINDSTORMS EV3 MicroPython Project

1. Launch the Visual Studio Code Linux app from the shelf.
2. With the MINDSTORMS MicroPython project type selected, simultaneously start the timer and click New Project.
3. Stop the timer when the project editor fully loads.

This project was commissioned by Intel.

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