Lesson 16

Is a Smartphone Smart Enough to Go to the Moon?

Goal

Use scientific notation to compare quantities in context, and describe (orally) how using scientific notation helps with making comparisons between very large and very small quantities.

Learning Target

I can use scientific notation to compare different amounts and answer questions about real-world situations.

Lesson Narrative

In this culminating lesson, students use scientific notation as a tool for making comparisons. Students compare older computer hardware to newer computer hardware using various digital media as a form of measurement.

Students begin by comparing the storage, processor speed, and memory on various electronic devices to the 1966 Apollo Guidance Computer used to make the calculations that put humans on the moon. They then compare floppy drives to modern technology by measuring how many floppy drives it would take to store a high-definition film. Students must identify the essential features of the questions and reason quantitatively and abstractly in order to answer them in context.

Student Learning Goal

Let's compare digital media and computer hardware using scientific notation.

Access for Multilingual Learners

- MLR7: Compare and Connect (Activity 1)
- MLR8: Discussion Supports (Activity 2)

Access for Students with Diverse Abilities

- Representation (Activity 2)

Required Materials

Materials to Copy

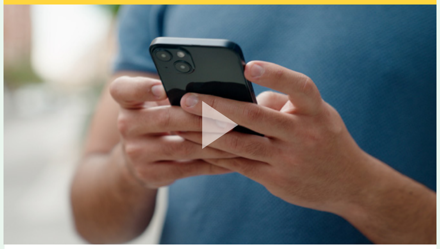
- Old Hardware New Hardware Handout (1 copy for every 2 students): Activity 1

Lesson Timeline

20 min	Activity 1
25 min	Activity 2

Inspire Math

Going Viral video



Go Online
Before the lesson, show this video to review the real-world connection.

ilclass.com/l/614244

Please log in to the site before using the QR code or URL.

Student Workbook


LESSON 16

Is a Smartphone Smart Enough to Go to the Moon?

Let's compare digital media and computer hardware using scientific notation.

1 Old Hardware, New Hardware

In 1966, the Apollo Guidance Computer was developed to make the calculations that would put humans on the Moon.

Your teacher will give you information for different devices from 1966 to 2023. Choose one device, and compare the specifications of that device with the 1966 Apollo Guidance Computer. If you get stuck, consider using scientific notation to help with the calculations.

For reference, storage is measured in bytes, processor speed is measured in hertz, and memory is measured in bytes. "Kilo" stands for 1,000, "mega" stands for 1,000,000, "giga" stands for 1,000,000,000, and "tera" stands for 1,000,000,000,000.

1. Which device did you choose?
2. How many times more information than the 1966 Apollo Guidance Computer can this device store?
3. How many times faster than the 1966 Apollo Guidance Computer is this device's processor speed?
4. How many times more memory than the 1966 Apollo Guidance Computer can this device store?

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Activity 1

Old Hardware, New Hardware

20 min

Activity Narrative

Students perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Students use scientific notation and choose units of appropriate size for measurements of very large or very small quantities.

Launch

Arrange students in groups of 2. Distribute one copy of the blackline master containing computer hardware specifications over time to each group, or display for all to see throughout the activity. Give students 15 minutes of quiet work time, and follow that with a brief whole-class discussion.

Student Task Statement

In 1966, the Apollo Guidance Computer was developed to make the calculations that would put humans on the Moon.

Your teacher will give you information for different devices from 1966 to 2023. Choose one device, and compare the specifications of that device with the 1966 Apollo Guidance Computer. If you get stuck, consider using scientific notation to help with the calculations.

For reference, storage is measured in bytes, processor speed is measured in hertz, and memory is measured in bytes. "Kilo" stands for 1,000, "mega" stands for 1,000,000, "giga" stands for 1,000,000,000, and "tera" stands for 1,000,000,000,000.

1. Which device did you choose?
2. How many times more information than the 1966 Apollo Guidance Computer can this device store?

   1977 Desktop:
   - Can store $\frac{28}{15}$ times as much as Apollo

   2001 Desktop:
   - Can store $2.\overline{6} \times 10^5$ times as much as Apollo

   2007 Smartphone:
   - Can store $5.\overline{3} \times 10^4$ times as much as Apollo.

   2016 Smartphone:
   - Can store $4.2\overline{6} \times 10^5$ times as much as Apollo.

   2020 Laptop:
   - Can store $1.\overline{3} \times 10^7$ times as much as Apollo.

   2023 Smartphone:
   - Can store $1.\overline{3} \times 10^7$ times as much as Apollo.

3. How many times faster than the 1966 Apollo Guidance Computer is this device's processor speed?

1977 Desktop:

- Processor is $\frac{1}{2}$ as fast as Apollo.

2001 Desktop:

- Processor is 550 times as fast as Apollo.

2007 Smartphone:

- Processor is 200 times as fast as Apollo.

2016 Smartphone:

- Processor is 4,400 times as fast as Apollo.

2020 Laptop:

- Processor is 6,000 times as fast as Apollo.

2023 Smartphone:

- Processor is 6,000 times as fast as Apollo.

4. How many times more memory than the 1966 Apollo Guidance Computer can this device store?

1977 Desktop:

- Has the same amount of memory as Apollo.

2001 Desktop:

- Has 32,000 times as much memory as Apollo.

2007 Smartphone:

- Processor is 200 times as fast as Apollo.

2016 Smartphone:

- Has 7.5×10^5 times as much memory as Apollo.

2020 Laptop:

- Has 2×10^6 times as much memory as Apollo.

2023 Smartphone:

- Has 2×10^6 times as much memory as Apollo.

Activity Synthesis

The purpose of this discussion is for students to share their results. Begin by inviting students to share which device they chose to compare to the 1966 Apollo Guidance Computer and how the specifications have changed over the years. Some questions for discussion are:

"Did anyone compare the same two devices but use a different strategy?"

"What do you notice about these results?"

Answers vary.

"What do you wonder about these results?"

Answers vary.

Access for Multilingual Learners (Activity 1, Synthesis)

MLR7: Compare and Connect. Invite groups to prepare a visual display that shows the strategy they used to compare the specifications of their chosen device to those of the 1966 Apollo Guidance Computer. Encourage students to include details that will help others interpret their thinking. Examples might include using specific language, different colors, shading, arrows, labels, notes, diagrams, or drawings. Give students time to investigate each others' work. During the whole-class discussion, ask students,

"What did the approaches have in common? How were they different?"

"What kinds of additional details or language helped you understand the displays?"

"Were there any additional details or language that you have questions about?"

Advances: Representing, Conversing

Access for Students with Diverse Abilities (Activity 2, Launch)

Representation: Access for Perception.
Ask students to read each problem statement aloud to their partner. Students who both listen to and read the information will benefit from extra processing time.
Supports accessibility for: Language, Attention

Student Workbook


2 A Bit More on Bytes

For each question, think about what information you would need to figure out an answer. Your teacher may provide some of the information you ask for. Write your answers using scientific notation.

1. Mai found a 1980's computer magazine with an advertisement for a machine with hundreds of kilobytes of storage! Mai was curious and asked, "How many kilobytes would my dad's new computer hold?"

2. The old magazine showed another ad for a 750-kilobyte floppy disk, a device used in the past to store data. How many gigabytes is this?

3. Mai is writing a 1-page essay for school on her computer. Estimate how many 1-page essays it would take for Mai to fill up a floppy disk. Explain or show your reasoning.

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Activity 2

A Bit More on Bytes

25 min

Activity Narrative

In this activity, students use scientific notation as a tool to understand the relative scale of different units. They practice modeling skills by identifying essential elements of the problems and gathering relevant information before computing.

Launch

Arrange students in groups of 2. Instruct students to first read through the problems and decide on what information they need to solve each problem. Give students an opportunity to ask for the information they need, and record relevant information for all students to see. Record information only when students have asked for it. Possible information students will ask for include:

- Mai's dad's computer holds 500 gigabytes of storage space.
- A kilobyte is 1,000 bytes, a megabyte is 1,000,000 bytes, and a gigabyte is 1,000,000,000 bytes.
- A 1-page document is approximately 1.5 kilobytes.
- A full-length, high-definition film is around 8 gigabytes and runs 2 hours.
- A person sleeps about 8 hours in a night.

Give students 15–20 minutes of work time, and follow that with a brief whole-class discussion.

Student Task Statement

For each question, think about what information you would need to figure out an answer. Your teacher may provide some of the information you ask for. Write your answers using scientific notation.

1. Mai found a 1980's computer magazine with an advertisement for a machine with hundreds of kilobytes of storage! Mai was curious and asked, "How many kilobytes would my dad's new computer hold?"

   500 million kilobytes

   Sample reasoning: Mai's dad's computer can hold 500 gigabytes, which is 500×10^9 bytes. A kilobyte is 10^3 bytes, so his computer holds $\frac{500 \times 10^9}{10^3}$ or 500×10^6 kilobytes.

2. The old magazine showed another ad for a 750-kilobyte floppy disk, a device used in the past to store data. How many gigabytes is this?

   0.00075 gigabytes

   Sample reasoning: A floppy drive holds 750 kilobytes, which is 750×10^3 bytes. As a fraction of a gigabyte (10^9 bytes), divide $\frac{750 \times 10^3}{10^9} = 750 \times 10^{-6} = 0.00075$.

3. Mai is writing a 1-page essay for school on her computer. Estimate how many 1-page essays it would take for Mai to fill up a floppy disk. Explain or show your reasoning.

   About 500 1-page essays

   Sample reasoning: Because $750 \div 1.5 = 500$.

4. Mai likes to go to the movies with her friends and knows that a high-definition film takes up a lot of storage space on a computer.

   Estimate how many floppy disks it would take to store a high-definition movie. Explain or show your reasoning.

   About 10,000 floppy disks

   Sample reasoning: Because $\frac{8 \times 10^9 \text{ bytes per movie}}{7.5 \times 10^5 \text{ bytes per floppy}} \approx 1 \times 10^4$ floppy disks.

5. How many seconds of a high-definition movie would one floppy disk be able to hold?

   0.72 seconds

   Sample reasoning: A 2-hour film is 120 minutes, which is 7,200 seconds. Therefore, $\frac{7.2 \times 10^3 \text{ seconds per movie}}{10^4 \text{ floppy disks per movie}} = 7.2 \times 10^{-1} = 0.72$ seconds.

6. If you fall asleep watching a movie streaming service, and it streams movies all night while you sleep, how many floppy disks of information would that be?

   About 40,000 floppy disks

   Sample reasoning: Eight hours is equivalent to 4 movies, which is 40,000 floppy disks.

Are You Ready for More?

Humans tend to work with numbers using powers of 10, but computers work with numbers using powers of 2. A “binary kilobyte” is 1,024 bytes instead of 1,000, because $1{,}024 = 2^{10}$. Similarly, a “binary megabyte” is 1,024 binary kilobytes, and a “binary gigabyte” is 1,024 binary megabytes.

1. Which is bigger, a binary gigabyte or a regular gigabyte? How many more bytes is it?

   A binary gigabyte is about 74 million more bytes (74 megabytes) than a regular gigabyte. A binary gigabyte is equal to 1,024 binary megabytes, which is equal to 1,024 binary kilobytes, which is equal to 1,024 bytes. So, a binary gigabyte is $1{,}024^3$ (or 1,073,741,824) bytes.

2. Which is bigger, a binary terabyte or a regular terabyte? How many more bytes is it?

   A binary terabyte is about 100 billion more bytes (100 gigabytes) than a regular terabyte. A binary terabyte is 1,024 times a binary gigabyte, so a binary terabyte would be $1{,}024^4$ (or 1,099,511,627,776) bytes.

Activity Synthesis

The purpose of this discussion is to reflect on how scientific notation can help make sense of real-world situations. Ask students:

“What was surprising or interesting when comparing different digital media and hardware?”

“How did scientific notation help to make these comparisons?”

Access for Multilingual Learners (Activity 2, Synthesis)

Speaking: MLR8: Discussion Supports.
As students explain what they noticed about the differences in digital media and hardware, press for details in students’ ideas by requesting that students challenge an idea, elaborate on an idea, or make explicit their process for calculating or comparing the values. Revoice student ideas to model mathematical language use in order to clarify, apply appropriate language, and involve more students. This will help students produce and make sense of the language needed to communicate their own ideas.
Design Principle(s): Support Sense-Making; Optimize Output (for explanation)

Student Workbook


2 A Bit More on Bytes

4 Mai likes to go to the movies with her friends and knows that a high-definition film takes up a lot of storage space on a computer.
Estimate how many floppy disks it would take to store a high-definition movie. Explain or show your reasoning

5 How many seconds of a high-definition movie would one floppy disk be able to hold?

6 If you fall asleep watching a movie streaming service, and it streams movies all night while you sleep, how many floppy disks of information would that be?

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