Lesson 9: Describing Large and Small Numbers Using Powers of 10

Let's find out how to use powers of 10 to write large or small numbers.

9.1: Thousand Million Billion Trillion

1. Match each expression with its corresponding value and word.

expression
10^{-3}
10^{6}
10^{9}
10^{-2}
10^{12}
10^{3}

value
1,000,000,000,000
$\frac{1}{100}$
1,000
1,000,000,000
1,000,000
$\frac{1}{1,000}$

word
billion
milli-
million
thousand
centi-
trillion

2. For each of the numbers, think of something in the world that is described by that number.

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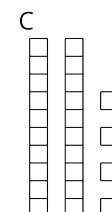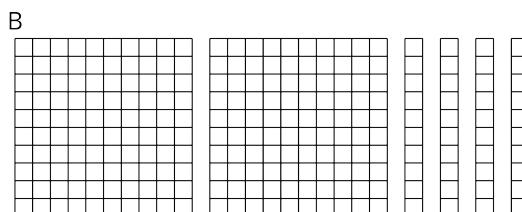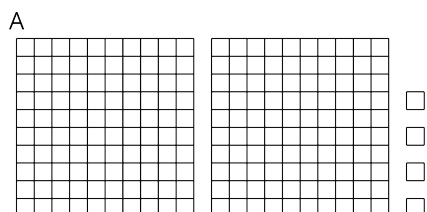
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9.2: Base-ten Representations Matching

1. Match each expression to one or more diagrams that could represent it. For each match, explain what the value of a single small square would have to be.

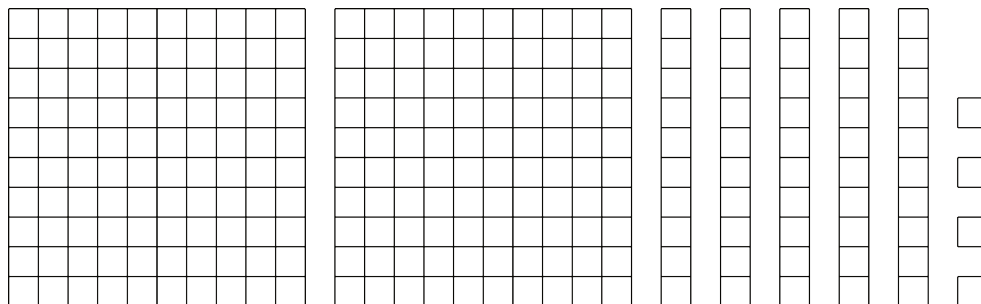   a. $2 \cdot 10^{-1} + 4 \cdot 10^{-2}$

    b. $2 \cdot 10^{-1} + 4 \cdot 10^{-3}$

    c. $2 \cdot 10^{3} + 4 \cdot 10^{1}$

    d. $2 \cdot 10^{3} + 4 \cdot 10^{2}$

A

B

C

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2. a. Write an expression to describe the base-ten diagram if each small square represents 10^{-4}. What is the value of this expression?

b. How does changing the value of the small square change the value of the expression? Explain or show your thinking.

c. Select at least two different powers of 10 for the small square, and write the corresponding expressions to describe the base-ten diagram. What is the value of each of your expressions?

9.3: Using Powers of 10 to Describe Large and Small Numbers

Your teacher will give you a card that tells you whether you are Partner A or B and gives you the information that is missing from your partner's statements. Do not show your card to your partner.

Read each statement assigned to you, ask your partner for the missing information, and write the number your partner tells you.

Partner A's statements:

1. Around the world, about _____ pencils are made each year.

2. The mass of a proton is _____ kilograms.

3. The population of Russia is about _____ people.

4. The diameter of a bacteria cell is about _____ meter.

Partner B's statements:

1. Light waves travel through space at a speed of _____ meters per second.

2. The population of India is about _____ people.

3. The wavelength of a gamma ray is _____ meters.

4. The tardigrade (water bear) is _____ meters long.

Are you ready for more?

A "googol" is a name for a really big number: a 1 followed by 100 zeros.

1. If you square a googol, how many zeros will the answer have? Show your reasoning.

2. If you raise a googol to the googol power, how many zeros will the answer have? Show your reasoning.

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Lesson 9 Summary

Sometimes powers of 10 are helpful for expressing quantities, especially very large or very small quantities. For example, the United States Mint has made over

$$500{,}000{,}000{,}000$$

pennies. In order to understand this number, we have to count all the zeros. Since there are 11 of them, this means there are 500 billion pennies. Using powers of 10, we can write this as:

$$500 \cdot 10^9$$

(five hundred times a billion), or even as:

$$5 \cdot 10^{11}$$

The advantage to using powers of 10 to write a large number is that they help us see right away how large the number is by looking at the exponent.

The same is true for small quantities. For example, a single atom of carbon weighs about

$$0.0000000000000000000000199$$

grams. We can write this using powers of 10 as

$$199 \cdot 10^{-25}$$

or, equivalently,

$$(1.99) \cdot 10^{-23}$$

Not only do powers of 10 make it easier to write this number, but they also help avoid errors since it would be very easy to write an extra zero or leave one out when writing out the decimal because there are so many to keep track of!

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