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.

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.

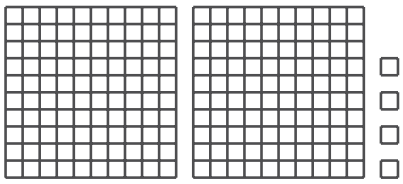
   a. $2 \cdot 10^{-1} + 4 \cdot 10^{-2}$

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

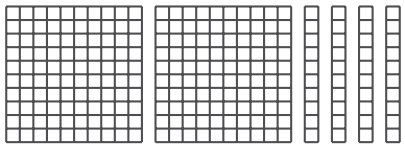
   c. $2 \cdot 10^{3} + 4 \cdot 10^{1}$

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

E



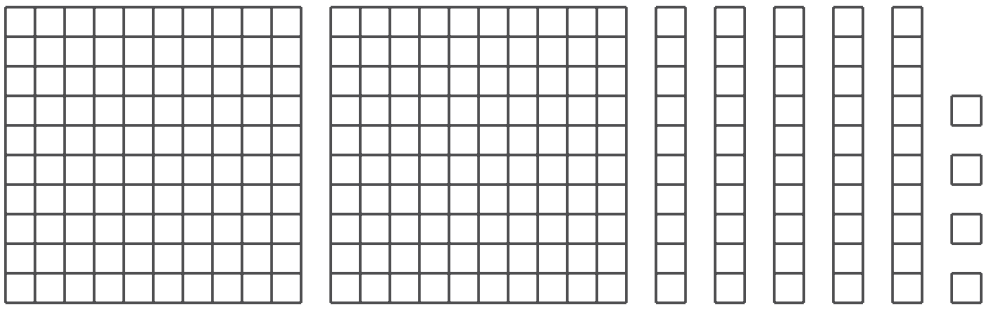
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2. a. Write an expression to describe the base-ten diagram if each small square represents 10^{-4}. What is the value of this expression?



b. Write an expression to describe the base-ten diagram if each small square represents 10^{-3}. What is the value of this expression?

c. Write an expression to describe the base-ten diagram if each small square represents 10^{6}. What is the value of this expression?

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

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.

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. To understand this number we can look at the number of zeros to know it is equivalent to 500 billion pennies. Since 1 billion can be written as 10^9, we can say that there are over $500 \cdot 10^9$ pennies.

Sometimes we may need to rewrite a number using a different power of 10. We can say that $500 \cdot 10^9 = 5 \cdot 10^{11}$. Since the factor 10^9 was multiplied by 100 to get 10^{11}, the factor of 500 was divided by 100 to keep the value of the entire expression the same.

The same is true for very small quantities. For example, a single atom of carbon weighs about 0.00000000000000000000000199 grams. If we write this as a fraction we get $\frac{199}{10,000,000,000,000,000,000,000,000}$. Using powers of 10, it becomes $199 \cdot 10^{-25}$, which is a lot easier to write!

Just as we did with large numbers, small numbers can be rewritten as an equivalent value with a different power of 10. In this example we can divide the factor 199 by 100 and multiply the factor 10^{-25} by 100 to get $1.99 \cdot 10^{-23}$.