



MATH NEWS



LAFAYETTE
PARISH SCHOOL SYSTEM

Grade 8, Module 1, Topic B

8th Grade Math

Module 1: Integer Exponents and Scientific Notation

Math Parent Letter

This document is created to give parents and students a better understanding of the math concepts found in Eureka Math (© 2013 Common Core, Inc.) that is also posted as the Engage New York material which is taught in the classroom. Module 1 of Eureka Math (Engage New York) builds on exponential notation with integer exponents and transforming expressions in order to perform operations including numbers in scientific notation as well as judging the magnitude of a number.



Focus Area Topic B:

Magnitude and Scientific Notation

Words to Know:

Scientific Notation - the representation of a number as the product of a decimal (or whole number) and a power of 10, where the decimal number (or whole number), d , satisfies the property that it is at least 1, but smaller than 10, or in symbolic notation, $1 \leq d < 10$. For example, the scientific notation for 192.7 is 1.927×10^2 .

Order of Magnitude- the exponent in the power of 10 when that number is expressed in scientific notation. For example, the order of magnitude of 192.7 is 2, because when 192.7 is expressed in scientific notation as 1.927×10^2 , 2 is the exponent of 10^2 . *Sometimes we also include the number 10 in the definition of order of magnitude* and say that the order of magnitude of 192.7 is 10^2 .

What does it mean to say 10^n where n is an integer?

- ❖ 10^n is a large number for positive integers n .
- ❖ 10^n is a small number for negative integers n .

Examples: $10^6 = 1,000,000$ is a large number while $10^{-6} = 0.000001$ is a small number.



How is magnitude used as a measurement?

Magnitude can be thought of as “how big” or “how small” a number is especially when comparing numbers.

Understanding magnitude requires an understanding of integer powers of 10. While comparing numbers using magnitude, we are in essence finding the next largest power of 10 to determine how many times bigger or smaller one number is than the other.

Focus Area Topic B:

Magnitude and Scientific Notation

Example: John said that 0.009 is bigger than 0.01. Use powers of 10 to show that he is wrong.

Answer: 0.009 can be written as $\frac{9}{1000} = \frac{9}{10^3} = 9 \times 10^{-3}$ and 0.01 can be written as $\frac{1}{100} = \frac{1}{10^2} = 1 \times 10^{-2}$. Since 0.009 has a smaller power of ten, 0.009 is closer to zero and smaller than 0.01.

Question: What is the smallest power of 10 that will exceed 875,147?

Answer: 10^6 since it has 6 digits. The largest 6 digit number is 999,999, so the next power of 10 is 10^6 which is 1,000,000.

Question: Approximately how many times greater is 7,687,374 than 875,147?

Answer: 7,687,374 is approximately 10 times bigger than 875,147.

Explanation: The smallest power of 10 that is greater than 7,687,375 is 10^7 (note that the exponent is equal to the number of digits in 7,687,375), and 10^6 can be used to approximate 875,147. So, $\frac{10^7}{10^6} = 10^{(7-6)} = 10^1 = 10$.

Can we be more precise?

While 10^6 can be used to estimate 875,147, it is not very precise since 1,000,000 is not a close approximation, nor is 10^7 a precise approximation for 7,687,375 since $10^7 = 10,000,000$. In an attempt to be more precise but still make simple calculations, we can use ...

$900,000 = 9 \times 10^5$ to approximate 875,147 and $8,000,000 = 8 \times 10^6$ to approximate 7,687,375.

So, $\frac{8 \times 10^6}{9 \times 10^5} = \frac{8}{9} \times \frac{10^6}{10^5} \approx 0.889 \times 10^1 \approx 8.89$. Now we can see with more precision that 7,687,375 is almost 9 times greater than 875,147. This approximation method allows us to make quick comparisons with very large or very small numbers.



Problem: The average American household spends \$4,000 per year on gasoline. If there are 1×10^8 households, what is the total amount of money spent on gasoline by American households in one year?

Answer: \$400 billion
or 4×10^{11} dollars

$$\begin{aligned}
 &4000 = 4 \times 10^3 \\
 &(4 \times 10^3) \times (1 \times 10^8) \\
 &\quad \swarrow \quad \searrow \\
 &(4 \times 1)(10^3 \times 10^8) \\
 &4 \times 10^{11} = 400,000,000,000
 \end{aligned}$$

Focus Area Topic B:

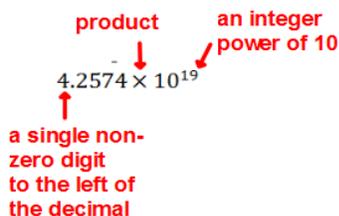
Magnitude and Scientific Notation

Writing Numbers in Scientific Notation

There are a few basic characteristics of numbers written in scientific notation.

- It is a product of a decimal number (or whole number) and an integer power of 10.
- The decimal number (or whole number) must be between 1 and 10. It can be 1, but it cannot be 10 since there should only be one non-zero digit left of the decimal.

Example: 42,574,000,000,000,000 can be written as 4.2574×10^{19} which is in scientific notation.



Example: One hydrogen atom is approximately 0.000000000000000000000000017 kilograms. In scientific notation this number is 1.7×10^{-27} kg.

Adding or Subtracting Numbers in Scientific Notation

In order to add or subtract numbers written in scientific notation, the *order of magnitude* of the numbers must be equal. Just like with adding “like terms” or adding fractions, we must be adding things that are “alike” or the same size.

Example:

$$(3.52 \times 10^8) + (9 \times 10^6)$$

$$(3.52 \times 10^2 \times 10^6) + (9 \times 10^6)$$

$$(352 \times 10^6) + (9 \times 10^6)$$

$$(352 + 9) \times 10^6$$

$$361 \times 10^6$$

$$3.61 \times 10^2 \times 10^6$$

$$3.61 \times 10^8$$

Decompose 10^8 in order to make order of magnitude equal

Associative Property

The order of magnitude must be equal to add the “decimal parts.”

Scientific Notation allows for one non-zero digit left of the decimal

Use exponent rules to simplify

Subtraction follows the same guidelines only you will be subtracting the “decimal parts” of the numbers.

Why do we use Scientific Notation?

- To express very small or very large numbers
- Standardizing the notation allows us to get a sense of numbers’ order of magnitude when comparing them
- To sensibly and efficiently record and convey the results of measurements



Multiplying Numbers in Scientific Notation

Since Associative and Commutative Properties hold for multiplication, we can reorder and associate the “decimal parts” and the powers of 10.

$$(8.2 \times 10^6)(2.4 \times 10^7)$$

$$(8.2 \times 2.4)(10^6 \times 10^7)$$

$$19.68 \times 10^{(6+7)}$$

$$19.68 \times 10^{13}$$

$$1.968 \times 10^1 \times 10^{13}$$

$$1.968 \times 10^{(1+13)}$$

$$1.968 \times 10^{14}$$

Reorder using Commutative and Associative Properties to use exponent rules to simplify the powers of 10

Scientific notation requires one non-zero digit to the left of the decimal.

Dividing Numbers in Scientific Notation

$$\frac{1.898 \times 10^{30}}{5.986 \times 10^{24}}$$

$$\frac{1.898}{5.986} \times \frac{10^{30}}{10^{24}}$$

$$0.3170 \dots \times 10^{(30-24)}$$

$$0.3170 \dots \times 10^6 \approx 0.32 \times 10^6$$

$$0.32 \times 10 \times 10^5$$

$$3.2 \times 10^5$$

Simplify the division of powers of 10 using exponent rules

Decompose 10^6 in order to convert the quotient into scientific notation since there should only be one non-zero digit left of the decimal.

Choice of Units

Since scientific notation is used to convey measurements, there are occasions when an arbitrary new unit can be defined out of convenience in order to compare measurements. A single lesson in this topic is devoted to creating a choice of units. A couple of examples include gigaelectronvolt as a unit of mass and light-year as a unit of distance. Students are asked to define their own units given a set of measurements. Rest assured that there are many correct “choices.” Once a unit has been chosen and clearly defined, the calculations are dependent on that new unit, and there will only be one correct calculation for a measurement conversion.

Interpreting Scientific Notation Using Technology

Sometimes operations with very large or very small numbers cannot be completed with precision on a calculator, so we can convert these numbers as a sum which may be written in scientific notation or a product using powers of 10. By using distributive, commutative, and associative properties, we can then simplify to complete the calculations.

Example

$$5,634,942,137 \times 52$$

$$(5,634,000,000 + 942,137) \times 52$$

$$((5634 \times 10^6) + 942,137) \times 52$$

$$(5634 \times 10^6)(52) + 942,137(52)$$

$$(5634 \times 52) \times 10^6 + 48,991,124$$

$$292,968 \times 10^6 + 48,991,124$$

$$292,968,000,000 + 48,991,124$$

$$293,016,991,124$$