PREPARATORY MATH SKILLS LAB

Lab $P^{M}_{S}11$

MATH ACTIVITY

Conducting Mathematical Operations with Numbers Expressed in Power-of-ten Form

MATH SKILLS LAB OBJECTIVE

When you complete this activity, you should be able to multiply or divide numbers expressed in power-of-ten form.

MATERIALS

For this activity, you'll need a pencil, paper and a calculator.

In a previous math skills lab exercise, you changed decimal numbers to power-of-ten numbers. The exponent of 10 determines the placement of the decimal when converting back to decimal numbers.

This math lab will explain how to multiply and divide numbers written in power-of-ten form. Table 1 from your previous lab can serve as a guide to check your work. Therefore, Table 1 is repeated here.

TABLE 1: DECIMAL NUMBER AND POWER-OF-TEN EQUIVALENTS

Decimal Number	Power of Ten	Explanation
1,000,000	1×10^6 or 10^6	$10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^6$
100,000	1×10^5 or 10^5	$10 \times 10 \times 10 \times 10 \times 10 = 10^5$
10,000	1×10^4 or 10^4	$10 \times 10 \times 10 \times 10 = 10^4$
1,000	1×10^3 or 10^3	$10 \times 10 \times 10 = 10^3$
100	1×10^2 or 10^2	$10 \times 10 = 10^2$
10	1×10^1 or 10^1	$10^1 = 10$ (usually written without exponent)
1	1×10^0 or 10^0	$10^0 = 1$ (by definition, any number to zero power equals 1)
0.1	1×10^{-1} or 10^{-1}	$\frac{1}{10} = 10^{-1}$
0.01	1×10^{-2} or 10^{-2}	$\frac{1}{10 \times 10} = \frac{1}{100} = 10^{-2}$
0.001	1×10^{-3} or 10^{-3}	$\frac{1}{10 \times 10 \times 10} = \frac{1}{1{,}000} = 10^{-3}$
0.0001	1×10^{-4} or 10^{-4}	$\frac{1}{10 \times 10 \times 10 \times 10} = \frac{1}{10{,}000} = 10^{-4}$
0.00001	1×10^{-5} or 10^{-5}	$\frac{1}{10 \times 10 \times 10 \times 10 \times 10} = \frac{1}{100{,}000} = 10^{-5}$
0.000001	1×10^{-6} or 10^{-6}	$\frac{1}{10 \times 10 \times 10 \times 10 \times 10 \times 10} = \frac{1}{1{,}000{,}000} = 10^{-6}$

The following rule applies to *multiplying* power-of-ten numbers.

Rule 1: When multiplying power-of-ten numbers, the first factors (decimal parts) of each number are multiplied. But the ***EXPONENTS*** of 10 are ***ADDED ALGEBRAICALLY.*** The result is a ***product of the first factors*** times (×) a certain ***power of ten.***

Example 1: $(3.2 \times 10^4) \times (1.5 \times 10^2) = \underbrace{(3.2 \times 1.5)}_{\text{1st factors}} \times \underbrace{10^{4+2}}_{\text{Power of Ten}}$

$= 4.8 \times 10^6$

Note: $10^4 \times 10^2 = 10^6$.

Example 2: $(3.2 \times 10^{-3}) \times (1.5 \times 10^2) = \underbrace{(3.2 \times 1.5)}_{\text{1st factors}} \times \underbrace{10^{-3+2}}_{\text{Power of Ten}}$

$= 4.8 \times 10^{-1}$

Note: $10^{-3} \times 10^2 = 10^{-1}$.

The following rules apply to *dividing* power-of-ten numbers.

Rule 2: Whenever 10 has a power with a negative sign, such as 10^{-1} or 10^{-2}, it's equal to the number "one" divided by 10 with the same power and a positive sign. For example:

$$10^{-1} = \frac{1}{10^1} = \frac{1}{10}$$

$$10^{-2} = \frac{1}{10^2} = \frac{1}{10 \times 10} = \frac{1}{100}$$

$$10^{-3} = \frac{1}{10^3} = \frac{1}{10 \times 10 \times 10} = \frac{1}{1000}$$

Rule 3: When dividing power-of-ten numbers, the first factors of each number are divided. But the ***EXPONENTS*** of 10 in the denominator are ***SUBTRACTED ALGEBRAICALLY*** from those in the numerator. The result is a number equal to the ***quotient of the first factors*** times (×) a certain ***power of ten.*** ["Subtracted algebraically" means that the sign of the number must be considered. For instance, 7 – (+3) = 7 – 3 = 4, but 7 – (–3) = 7 + 3 = 10.]

Example 1: $\dfrac{8.4 \times 10^9}{2.1 \times 10^4} = \underbrace{\dfrac{8.4}{2.1}}_{\text{1st Factors}} \times \underbrace{10^{9-4}}_{\text{Power of Ten}} = 4.0 \times 10^5$

Note: $\dfrac{10^9}{10^4} = 10^{9-4} = 10^5$

Example 2: $\dfrac{8.4 \times 10^7}{2.1 \times 10^{-3}} = \underbrace{\dfrac{8.4}{2.1}}_{\text{1st Factors}} \times \underbrace{10^{7-(-3)}}_{\text{Power of Ten}} = 4 \times 10^{10}$

Note: $\dfrac{10^7}{10^{-3}} = 10^{7-(-3)} = 10^{7+3} = 10^{10}$

PRACTICE EXERCISES

Problem 1: *MULTIPLY* the following numbers in exponential form. First group the "first factors" and powers of ten. Multiply first factors together. Then *add* exponents of ten *ALGEBRAICALLY.*

$(5.5 \times 10^{3})\,(2 \times 10^{4}) =$ _____

$(2.2 \times 10^{-3})(2.5 \times 10^{4}) =$ _____

$(9 \times 10^{5})\,(4 \times 10^{-2}) =$ _____

Problem 2: *DIVIDE* the following numbers in exponential form. First group the first factors and powers of ten. Divide the first factors. Then *subtract* the exponents of ten in the denominator *ALGEBRAICALLY* from those in the numerator.

$\dfrac{3.6 \times 10^{5}}{1.2 \times 10^{3}} =$ _____ × _____

$\dfrac{9.6 \times 10^{8}}{8 \times 10^{-4}} =$ _____ × _____

$\dfrac{10.5 \times 10^{-3}}{5 \times 10^{-3}} =$ _____ × _____