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CONCEPT: MULTIPLICATION AND DIVISION

When you multiply values in scientific notation you ___________ the coefficients and ___________ the exponents.

$$(A \times 10^{x}) \cdot (B \times 10^{y}) =$$

When you divide values in scientific notation you ___________ the coefficients and ___________ the exponents.

$$\frac{(A \times 10^{x})}{(B \times 10^{y})} =$$

After multiplying and/or dividing remember that for the coefficient will have the _____________________________.

EXAMPLE 1: Using the method discussed above, determine the answer when the following values are multiplied.

$$(2.134 \times 10^{5}) \cdot (1.6 \times 10^{-3}) \cdot (3.07 \times 10^{6})$$

EXAMPLE 2: Using the methods discussed above, determine the answer for the following mixed operations question.

$$\frac{(7.33 \times 10^{8}) \cdot (9.89 \times 10^{-1})}{(6.12 \times 10^{11})}$$

CONCEPT: ADDITION AND SUBSTRACTION

When you add or subtract values in scientific notation they must have the same exponents. The coefficients add or subtract, but the exponents ___________________________.

$$\begin{array}{r} A \times 10^{x} \\ - B \times 10^{x} \\ \hline (A - B) \times 10^{x} \end{array} \qquad \begin{array}{r} A \times 10^{x} \\ + B \times 10^{x} \\ \hline (A + B) \times 10^{x} \end{array}$$

- If the exponents are not the same then we transform the ________________ value so that they do.
- Remember when adding or subtracting values that the final answer must have the ____________________.

EXAMPLE 1: Using the method discussed above, determine the answer to the following question.

$$\begin{array}{r} 8.17 \times 10^{8} \\ + 1.25 \times 10^{9} \\ \hline \end{array}$$

EXAMPLE 2: Using the method discussed above, determine the answer to the following question.

$$\begin{array}{r} 9.08 \times 10^{-11} \\ - 1.17 \times 10^{-12} \\ - 3.35 \times 10^{-13} \\ \hline \end{array}$$

CONCEPT: POWERS AND ROOT FUNCTIONS

When we raise a value in scientific notation to a particular power we raise the coefficient to that power, but then we _____________ the exponent and the power.

$$(3.0 \times 10^{-2})^3 =$$

When we take a value in scientific notation to the nth root we raise the coefficient to the reciprocal power and we _____________ the exponent portion by that reciprocal power value.

$$\sqrt[3]{6.0 \times 10^9} =$$

EXAMPLE: Using the method discussed above, determine the answer to the following question.

$$(7.5 \times 10^{-3})^5 \cdot \sqrt[4]{(8.6 \times 10^{21}}$$

CONCEPT: LOGARITHMIC FUNCTIONS

The logarithmic base 10 form represents the exponent that 10 must be raised in order to obtain that specific number. For example:

$$10^1 = 10 \qquad \log 10 = 1$$

$$10^4 = 10,000$$

$$10^{-1} = 0.10$$

$$10^0 = 1$$

EXAMPLE 1: Without using a calculator, determine the answer to the following questions.

$\log 1.0 \times 10^{-7}$ $\qquad$ $\log 1000$

EXAMPLE 2: Without using a calculator, determine the answer to the following questions.

$\log 1.0 \times 10^{5}$ $\qquad$ $\log 0.0001$

CONCEPT: INVERSE LOGARITHMIC FUNCTIONS

The inverse or anti logarithmic function can be seen as the opposite of the logarithmic function.

$$\log x = y \qquad \text{inv}\log y = 10^{y} = x$$

So applying this logic the example below would go as follows:

$$\log 100 = 2 \qquad \text{inv}\log 2 =$$

EXAMPLE: The Henderson-Hasselbalch equation is a useful equation for the determination of the pH of a buffer. With its equation, shown below, determine the ratio of conjugate base to weak acid when the pH = 4.17 and pKa = 3.83.

$$\text{pH} = \text{pKa} + \log \frac{\text{conjugate base}}{\text{weak acid}}$$

a) – 0.469

b) 0.457

c) 2.19

d) 1.0×10^{-8}

CONCEPT: NATURAL LOGARITHMIC FUNCTIONS

The natural logarithm, sometimes shortened to just ln, of a value is the exponent to which *e* must be raised to determine that number. For example:

$$\ln 1000 = 6.908$$

This means that *e*, the inverse of the natural logarithm, had to be said to 6.908 in order to obtain 1000.

The inverse of the natural logarithm again symbolized by the variable *e* can be seen as the opposite of the natural logarithm ln.

$$\ln x = y \qquad \text{inv} \ln y = e^y = x$$

So applying this logic the example below would go as follows:

$$\ln 2 = 0.693 \qquad \text{inv} \ln 0.693$$

EXAMPLE: Based on your understanding of natural logarithmic functions solve for the missing variable in the following question:

$$\ln[x] = -(2.13 \times 10^{-1})(12.3) + \ln[1.25]$$

CONCEPT: MATHEMATICAL RELATIONSHIPS USING LOGARITHMS

When dealing with the logarithmic form or the natural logarithmic form it is important to remember the following relationships.

MULTIPLICATION

$\log(a \cdot b) =$

$\ln(a \cdot b) =$

DIVISION

$\log \frac{a}{b} =$

$\ln \frac{a}{b} =$

RAISED TO A POWER

$\log a^x =$

$\ln a^x =$

TAKEN TO THE nth ROOT

$\log \sqrt[x]{a} =$

$\ln \sqrt[x]{a} =$

EXAMPLE: Solve the following without the use of a calculator. If log 3 = 0.48 and log 2 = 0.30, what would be the value of log 12?

CONCEPT: THE QUADRATIC FORMULA

The quadratic formula is used for algebraic equations that contain an x variable raised to the second power: ___________________________.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

The quadratic formula is most commonly used for questions dealing with chemical equilibrium.

Although the presence of the $\pm$ sign gives two possible values for x, only one of them will be significant and used as the answer.

EXAMPLE: Using the quadratic formula solve for x when given the following algebraic expression:

$$4x = -2.13 \times 10^{-4} + \frac{1.75 \times 10^{-5}}{x}$$