DIMENSIONAL ANALYSIS (FACTOR LABEL METHOD)

Name ____________

Using this method, it is possible to solve many problems by using the relationship of one to another. For example, 12 inches = one foot. Since these two numbers represent the same value, the fractions 12 in/1 ft and 1 ft/12 in are both equal to one. When you multiply another number by the number one, you do not change its value. However, you may change its unit.

Example 1: Convert 2 miles to inches.

$$2 \text{ miles} \times \frac{5{,}280 \text{ ft}}{1 \text{ mile}} \times \frac{12 \text{ inches}}{1 \text{ ft}} = 126{,}720 \text{ in}$$

(Using significant figures, 2 mi = 100,000 in.)

Example 2: How many seconds are in 4 days?

$$4 \text{ days} \times \frac{24 \text{ hrs}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 345{,}600 \text{ sec}$$

(Using significant figures, 4 days = 300,000 sec.)

Solve the following problems. Write the answers in significant figures.

1. 3 hrs = ________ sec
2. 0.035 mg = ________ cg
3. 5.5 kg = ________ lbs
4. 2.5 yds = ________ in
5. 1.3 yrs = ________ hr (1 yr = 365 days)
6. 3 moles = ________ molecules (1 mole = 6.02×10^{23} molecules)
7. 2.5×10^{24} molecules = ________ moles
8. 5 moles = ________ liters (1 mole = 22.4 liters)
9. 100. liters = ________ moles
10. 50. liters = ________ molecules
11. 5.0×10^{24} molecules = ________ liters
12. 7.5×10^{3} mL = ________ liters

METRICS AND MEASUREMENT

Name ____________________

In the chemistry classroom and lab, the metric system of measurement is used, so it is important to be able to convert from one unit to another.

mega	kilo	hecto	deca	Basic Unit	deci	centi	milli	micro
(M)	(k)	(h)	(da)	gram (g)	(d)	(c)	(m)	(μ)
1,000,000	1000	100	10	liter (L)	.1	.01	.001	.000001
10^6	10^3	10^2	10^1	meter (m)	10^{-1}	10^{-2}	10^{-3}	10^{-6}

Factor Label Method

1. Write the given number and unit.
2. Set up a conversion factor (fraction used to convert one unit to another).
   a. Place the given unit as denominator of conversion factor.
   b. Place desired unit as numerator.
   c. Place a "1" in front of the larger unit.
   d. Determine the number of smaller units needed to make "1" of the larger unit.
3. Cancel units. Solve the problem.

Example 1: 55 mm = _____ m

55 ~~mm~~	1 m	= 0.055 m
	1000 ~~mm~~	

Example 2: 88 km = _____ m

88 ~~km~~	1000 m	= 88,000 m
	1 ~~km~~	

Example 3: 7000 cm = _____ hm

7000 ~~cm~~	1 ~~m~~	1 hm	= 0.7 hm
	100 ~~cm~~	100 ~~m~~	

Example 4: 8 daL = _____ dL

8 ~~daL~~	10 ~~L~~	10 dL	= 800 dL
	1 ~~daL~~	1 ~~L~~	

The factor label method can be used to solve virtually any problem including changes in units. It is especially useful in making complex conversions dealing with concentrations and derived units.

Convert the following.

1. 35 mL = __________ dL
2. 950 g = __________ kg
3. 275 mm = __________ cm
4. 1,000 L = __________ kL
5. 1,000 mL = __________ L
6. 4,500 mg = __________ g
7. 25 cm = __________ mm
8. 0.005 kg = __________ dag
9. 0.075 m = __________ cm
10. 15 g = __________ mg

SCIENTIFIC NOTATION

Name ____________________

Scientists very often deal with very small and very large numbers, which can lead to a lot of confusion when counting zeros! We have learned to express these numbers as pov of 10.

Scientific notation takes the form of $M \times 10^n$ where $1 \leq M < 10$ and "n" represents the number of decimal places to be moved. Positive n indicates the standard form is larger than zero whereas negative n would indicate a number smaller than zero.

Example 1: Convert 1,500,000 to scientific notation.

We move the decimal point so that there is only one digit to its left, a total of 6 places.

1,500,000 = 1.5×10^6

Example 2: Convert 0.000025 to scientific notation.

For this, we move the decimal point 5 places to the right.

0.000025 = 2.5×10^{-5}

(Note that when a number starts out less than one, the exponent is always negative.)

Convert the following to scientific notation.

1. 0.005 = ____________________
2. 5,050 = ____________________
3. 0.0008 = ____________________
4. 1,000 = ____________________
5. 1,000,000 = ____________________
6. 0.25 = ____________________
7. 0.025 = ____________________
8. 0.0025 = ____________________
9. 500 = ____________________
10. 5,000 = ____________________

Convert the following to standard notation.

1. 1.5×10^3 = ____________________
2. 1.5×10^{-3} = ____________________
3. 3.75×10^{-2} = ____________________
4. 3.75×10^2 = ____________________
5. 2.2×10^5 = ____________________
6. 3.35×10^{-1} = ____________________
7. 1.2×10^{-4} = ____________________
8. 1×10^4 = ____________________
9. 1×10^{-1} = ____________________
10. 4×10^0 = ____________________

SIGNIFICANT FIGURES

Name ____________________

A measurement can only be as accurate and precise as the instrument that produced it. A scientist must be able to express the accuracy of a number, not just its numerical value. We can determine the accuracy of a number by the number of significant figures it contains.

1) **All digits 1-9 inclusive are significant.**
   Example: 129 has 3 significant figures.
2) **Zeros between significant digits are always significant.**
   Example: 5,007 has 4 significant figures.
3) **Trailing zeros in a number are significant only if the number contains a decimal point.**
   Example: 100.0 has 4 significant figures.
   100 has 1 significant figure.
4) **Zeros in the beginning of a number whose only function is to place the decimal point are not significant.**
   Example: 0.0025 has 2 significant figures.
5) **Zeros following a decimal significant figure are significant.**
   Example: 0.000470 has 3 significant figures.
   0.47000 has 5 significant figures.

Determine the number of significant figures in the following numbers.

1. 0.02 _____
2. 0.020 _____
3. 501 _____
4. 501.0 _____
5. 5,000 _____
6. 5,000. _____
7. 6,051.00 _____
8. 0.0005 _____
9. 0.1020 _____
10. 10,001 _____

Determine the location of the last significant place value by placing a bar over the digit. (Example: $1.70\bar{0}$)

1. 8040 ____________________
2. 0.0300 ____________________
3. 699.5 ____________________
4. 2.000×10^2 ____________________
5. 0.90100 ____________________
6. 90,100 ____________________
7. 4.7×10^{-8} ____________________
8. 10,800,000. ____________________
9. 3.01×10^{21} ____________________
10. 0.000410 ____________________

CALCULATIONS USING SIGNIFICANT FIGURES

Name ____________

When multiplying and dividing, limit and round to the least number of significant figures in any of the factors.

> **Example 1:** 23.0 cm x 432 cm x 19 cm = 188,784 cm^3
> The answer is expressed as 190,000 cm^3 since 19 cm has only two significant figures.

When adding and subtracting, limit and round your answer to the least number of decimal places in any of the numbers that make up your answer.

> **Example 2:** 123.25 mL + 46.0 mL + 86.257 mL = 255.507 mL
> The answer is expressed as 255.5 mL since 46.0 mL has only one decimal place.

Perform the following operations expressing the answer in the correct number of significant figures.

1. 1.35 m x 2.467 m = ____________
2. 1,035 m^2 ÷ 42 m = ____________
3. 12.01 mL + 35.2 mL + 6 mL = ____________
4. 55.46 g − 28.9 g = ____________
5. .021 cm x 3.2 cm x 100.1 cm = ____________
6. 0.15 cm + 1.15 cm + 2.051 cm = ____________
7. 150 L^3 ÷ 4 L = ____________
8. 505 kg − 450.25 kg = ____________
9. 1.252 mm x 0.115 mm x 0.012 mm = ____________
10. 1.278 x 10^3 m^2 ÷ 1.4267 x 10^2 m = ____________

TEMPERATURE AND ITS MEASUREMENT

Name ____________________

Temperature (which measures average kinetic energy of the molecules) can be measured using three common scales: Celsius, Kelvin and Fahrenheit. We use the following formulas to convert from one scale to another. Celsius is the scale most desirable for laboratory work. Kelvin represents the absolute scale. Fahrenheit is the old English scale which is never used in lab.

$$°C = K - 273 \qquad K = °C + 273$$

$$°F = \frac{9}{5}°C + 32 \qquad °C = \frac{5}{9}(°F - 32)$$

Complete the following chart. All measurements are good to 1° C or better.

	°C	K	°F
1	0° C		
2			212° F
3		450 K	
4			98.6° F
5	-273° C		
6		294 K	
7			77° F
8		225 K	
9	-40° C		

PERCENTAGE ERROR

Name ______________

Percentage error is a way for scientists to express how far off a laboratory value is from the commonly accepted value.

The formula is:

$$\%\ \text{error} = \left| \frac{\text{Accepted Value} - \text{Experimental Value}}{\text{Accepted Value}} \right| \times 100$$

→ absolute value

Determine the percentage error in the following problems.

1. Experimental Value = 1.24 g
   Accepted Value = 1.30 g

   Answer: ___________

2. Experimental Value = 1.24×10^{-2} g
   Accepted Value = 9.98×10^{-3} g

   Answer: ___________

3. Experimental Value = 252 mL
   Accepted Value = 225 mL

   Answer: ___________

4. Experimental Value = 22.2 L
   Accepted Value = 22.4 L

   Answer: ___________

5. Experimental Value = 125.2 mg
   Accepted Value = 124.8 mg

   Answer: ___________