

DIMENSIONAL ANALYSIS (FACTOR LABEL METHOD)

Name _____

Using this method, it is possible to solve many problems by using the relationship of one unit 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

$$\frac{55 \text{ mm}}{1000 \text{ mm}} \times \frac{1 \text{ m}}{1 \text{ m}} = 0.055 \text{ m}$$

Example 2: 88 km = ____ m

$$\frac{88 \text{ km}}{1 \text{ km}} \times \frac{1000 \text{ m}}{1 \text{ m}} = 88,000 \text{ m}$$

Example 3: 7000 cm = ____ hm

$$\frac{7000 \text{ cm}}{100 \text{ cm}} \times \frac{1 \text{ hm}}{100 \text{ hm}} = 0.7 \text{ hm}$$

Example 4: 8 dL = ____ dL

$$\frac{8 \text{ dL}}{1 \text{ dL}} \times \frac{10 \text{ L}}{10 \text{ dL}} = 800 \text{ dL}$$

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 powers 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 a large number. Negative n indicates a number between zero and one.

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.

$$1,500,000 = 1.5 \times 10^6$$

Example 2: Convert 0.000025 to scientific notation.

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

$$0.000025 = 2.5 \times 10^{-5}$$

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

Convert the following to scientific notation.

1. $0.005 =$ _____

6. $0.25 =$ _____

2. $5,050 =$ _____

7. $0.025 =$ _____

3. $0.0008 =$ _____

8. $0.0025 =$ _____

4. $1,000 =$ _____

9. $500 =$ _____

5. $1,000,000 =$ _____

10. $5,000 =$ _____

Convert the following to standard notation.

1. $1.5 \times 10^3 =$ _____

6. $3.35 \times 10^{-1} =$ _____

2. $1.5 \times 10^{-3} =$ _____

7. $1.2 \times 10^{-4} =$ _____

3. $3.75 \times 10^{-2} =$ _____

8. $1 \times 10^4 =$ _____

4. $3.75 \times 10^2 =$ _____

9. $1 \times 10^{-1} =$ _____

5. $2.2 \times 10^5 =$ _____

10. $4 \times 10^0 =$ _____

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 _____

6. 5,000. _____

2. 0.020 _____

7. 6,051.00 _____

3. 501 _____

8. 0.0005 _____

4. 501.0 _____

9. 0.1020 _____

5. 5,000 _____

10. 10,001 _____

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

1. 8040 _____

6. 90,100 _____

2. 0.0300 _____

7. 4.7×10^{-8} _____

3. 699.5 _____

8. 10,800,000. _____

4. 2.000×10^2 _____

9. 3.01×10^{21} _____

5. 0.90100 _____

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: $23.0 \text{ cm} \times 432 \text{ cm} \times 19 \text{ cm} = 188,784 \text{ cm}^3$

The answer is expressed as $190,000 \text{ cm}^3$ 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: $123.25 \text{ mL} + 46.0 \text{ mL} + 86.257 \text{ mL} = 255.507 \text{ mL}$

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. $1.35 \text{ m} \times 2.467 \text{ m} =$ _____
2. $1,035 \text{ m}^2 + 42 \text{ m} =$ _____
3. $12.01 \text{ mL} + 35.2 \text{ mL} + 6 \text{ mL} =$ _____
4. $55.46 \text{ g} - 28.9 \text{ g} =$ _____
5. $.021 \text{ cm} \times 3.2 \text{ cm} \times 100.1 \text{ cm} =$ _____
6. $0.15 \text{ cm} + 1.15 \text{ cm} + 2.051 \text{ cm} =$ _____
7. $150 \text{ L}^3 + 4 \text{ L} =$ _____
8. $505 \text{ kg} - 450.25 \text{ kg} =$ _____
9. $1.252 \text{ mm} \times 0.115 \text{ mm} \times 0.012 \text{ mm} =$ _____
10. $1.278 \times 10^3 \text{ m}^2 + 1.4267 \times 10^2 \text{ m} =$ _____

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: _____

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.

$$\begin{aligned}{}^{\circ}\text{C} &= \text{K} - 273 & \text{K} &= {}^{\circ}\text{C} + 273 \\{}^{\circ}\text{F} &= \frac{9}{5}{}^{\circ}\text{C} + 32 & {}^{\circ}\text{C} &= \frac{5}{9}({}^{\circ}\text{F} - 32)\end{aligned}$$

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

	${}^{\circ}\text{C}$	K	${}^{\circ}\text{F}$
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		