# AP Chemistry Summer Assignment

Welcome to AP Chemistry! You will quickly notice that things will be different than they were in Honors/Regular Chemistry. For one, there will be a lot more to memorize. For another, you need to manage many more types of calculations. This assignment will help us with some of the memorization, math skills, and basic topics that you will need so that we can hit the ground running when the school year begins. **Start the packet several weeks before school starts at the latest.** If you have questions, you can reach me at mjensen@stpaulsmd.org

**As you progress through this assignment use the following sources for help:**

- http://chemwiki.ucdavis.edu/
  http://www.kentchemistry.com/
  https://www.khanacademy.org/science/chemistry
  http://www.chemtutor.com/
  http://www.chemteam.info/
  http://www.chemguide.com
  https://www.youtube.com/user/tdewitt451

**Important Dates**

- Due Date: The packet pages 4-16 are due on the first day of school.
- **We will have a quiz on the first day of class.** The quiz will require you to write the chemical formulas of any compound consisting of ions from Tasks 3 and 4 below, and also calculate the molar masses.
- **The second class will also have a quiz.** The topic of this quiz is on metric conversions and mole conversions.
- These are the topics summarized and reviewed in this packet.
  - Nomenclature – Elements, polyatomic Ions, and compounds
  - Quantitative Skills – scientific notation, significant figures*, metric conversions, dimensional analysis**
  - Chemical Reactions - balancing equations, writing equations
  - Stoichiometry – Mole conversions from mass, gas at STP, solutions; multi-step mole conversions, empirical formula, full stoichiometry problems (all 3 states), mass percent of compounds**
  - Helpful diagrams, documents, and guides. You will not need to hand this in.

(* = not covered in Regular Chemistry, ** = not covered in Honors or Regular Chemistry)

**Task 1: Complete Attached Packet**

**Task 2: Memorize the names of the elements and their corresponding symbols**

- You need to know elements 1-56, plus Pt, Au, Hg, Pb, Rn, Fr, Ra, U, Pu
- Many of these elements you will already know
- Making flashcards is helpful!
- It's important to know these elements because the periodic table you are provided has only the symbols and not the names of the elements.
- You do not need the data of these elements (atomic number, relative atomic mass, etc) but you should be familiar with oxidation states (charges) of these including transition metals.

**Task 3: Memorize the ionic charges of the basic ions**

- **Think** about the valence electrons!
- **Think** about the common elements/ions in that group
  - Group 1 ions = +1
  - Group 2 ions = +2
  - Group 15 (5A) ions (N and P) = -3
  - Group 16 (6A) ions (O and S) = -2
  - Group 17 (7A)/ halogens = -1
  - Zn = +2
  - Ag = +1
  - Cu = +1 or +2
  - Fe = +2 or +3
  - Pb = +2 or +4
  - Sn = +2 or +4

**Task 4: Memorize the names, symbols, and charges of Polyatomic ions below:**

- Oxyanions – polyatomics containing oxygen, names end in *–ate* or *–ite*
- *-ate* is used for the most common form
- *-ite* is used for the form with the same charge, but one less oxygen
  - Example:
    - $NO_3^-$ = nitrate
    - $NO_2^-$ = nitrite
- Prefixes are also used
  - *Per-* indicates one more oxygen than the *–ate* form
  - *Hypo-* indicates one fewer oxygen than the *–ite* form
  - Example:
    - $ClO_4^-$ = perchlorate (b/c it has one more O than the –ate form)
    - $ClO_3^-$ = chlorate (b/c it is the most common)
    - $ClO_2^-$ = chlorite (b/c it has one less oxygen than – ate form)
    - $ClO^-$ = hypochlorite (b/c it has one less oxygen than –ite form)
  - F, Cl, Br, I all behave the same
    - Therefore, if chlorate is $ClO_3^-$, the bromate ion is…
    - $BrO_3^-$!!!!
    - Simply substitute one halogen for the other
    - If you learn the chlorate series, you also automatically know the bromate, iodate, and fluorate series
- Hydrogen can be added to -2 or -3 ions to make a "new ion"
  - $HPO_4^{2-}$ is hydrogen phosphate, $H_2PO_4^{1-}$ is dihydrogen phosphate (note the – charge went up 1 for each $H^+$ added)
  - $HCO_3^{1-}$ is hydrogen carbonate (bicarbonate)
  - $HSO_4^{1-}$ is hydrogen sulfate

| | | |
|---|---|---|
| +1<br>ammonium, $NH_4^+$ | | |
| -1<br>acetate, $C_2H_3O^-$ or $CH_3COO^-$<br>bromate, $BrO_3^-$<br>perchlorate, $ClO_4^-$<br>chlorate, $ClO_3^-$<br>chlorite, $ClO_2^-$<br>hypochlorite, $ClO^-$<br>cyanide, $CN^-$<br>hydrogen carbonate/bicarbonate, $HCO_3^-$<br>hydroxide, $OH^-$<br>iodate, $IO_3^-$<br>nitrate, $NO_3^-$<br>nitrite, $NO_2^-$<br>permanganate, $MnO_4^-$<br>thiocyanate, $SCN^-$ | -2<br>carbonate, $CO_3^{2-}$<br>chromate, $CrO_4^{2-}$<br>dichromate, $Cr_2O_7^{2-}$<br>oxalate, $C_2O_4^{2-}$<br>peroxide, $O_2^{2-}$<br>sulfate, $SO_4^{2-}$<br>sulfite, $SO_3^{2-}$ | -3<br>phosphate, $PO_4^{3-}$<br>phosphite, $PO_3^{3-}$<br>arsenate, $AsO_4^{3-}$ |

***Be able to name polyatomic ions using the rules above such as these below:***

$HPO_4^{-2}$ ______________________ $HSO_3^{-1}$ ______________________

$FO_3^{-1}$ ______________________ $HCO_3^{-1}$ ______________________

***Be able to write formulae for polyatomic ions using the rules above such as these below:***

Bromite ____________________ periodate ___________________

Dihydrogen phosphite_______________ hydrogen chromate ___________

Name:_______________________________________ Date:__________________

AP Chemistry Summer Assignment

## Quantitative Skills

**Significant Figures (Sig Figs)*** (Confused? Watch this: https://www.youtube.com/watch?v=7b60RZqut0U&t=22s AND See pages 17-18)

1. How many sig figs are in the following numbers?

   a. 790 ____________

   b. 0.0450 ____________

   c. 32.10 ____________

   d. 1001 ____________

   e. 0.0006 ____________

   f. 300. ____________

2. Solve the following problems. Round your answer to the correct number of sig figs (and use the correct unit on your answer) (Check pages 17-18).

   a) 825 cm x 32 cm x 0.248 cm ______________________

   b) $\frac{15.68\ g}{2.885\ mL}$ ______________________

   c) 1.20 g + 13.0 g + 10. g ______________________

   d) $\frac{(1.01\ g + 1.01\ g + 16.00\ g)}{1.0\ mL}$ ______________________

**Density*** (round your answers to correct number of sig figs and show all work with units)

3. A cube of ruthenium metal 1.5 cm on a side has a mass of 42.0 g. What is the density in $g/cm^3$? Will ruthenium metal float on water?

4. The density of bismuth metal is 9.8 $g/cm^3$. What is the mass of a sample of bismuth that displaces 65.8 mL of water?

**Metric Conversions** (round answers correctly and show work with units). You are responsible for the following prefixes: nano- ($10^{-9}$, n-), micro- ($10^{-6}$, μ-), milli- ($10^{-3}$, m-), kilo- ($10^{3}$, k-), Mega- ($10^{6}$, M-). Use scientific notation for any answers ≥1000 or ≤0.01. Use the correct number of significant figures.

5. Perform conversions to fill in all of the empty boxes. The first row is filled out.

| n- | μ- | m- | Base Unit | k- | M- |
|---|---|---|---|---|---|
| $1.62 \times 10^{10}$ nm | $1.62 \times 10^{7}$ μm | $1.62 \times 10^{4}$ ms | 16.2 m | 0.0162 km | $1.62 \times 10^{-5}$ Mm |
| | | | | 12 ks | |
| 5.44 nL | | | | | |
| | | | 2.0 L | | |
| | | 0.3100 ms | | | |
| | | | | | 0.056 Mg |
| | 20.1 μm | | | | |

**Dimensional Analysis***
See packet pages 19-21.

6. Make the following conversions, with correct number of significant figures in the answer:
   a) Convert 45.7 mL/s to kL/hr

   b) Convert 1.000 yr to seconds

   c) Convert 5 km to miles (1 km = 0.621 mi)

   d) Convert 80.0 km/hr to mm/s

   e) Convert 300. Atoms/s to moles/yr ($N_A = 6.022 \times 10^{23}$ atoms/mole)

f) I have 470 milligrams of table salt, which is the chemical compound NaCl. How many liters of NaCl solution can I make if I want the solution to be 0.90% NaCl? (9 grams of salt per 1000 grams of solution).

The density of the NaCl solution is 1.0 g solution/mL solution.

g) I have a bar of gold that is 7.0 in x 4.0 in x 3.0 in. The density of gold is 19.3 $g/cm^3$. The price of gold currently is $1,884.30 per ounce. How much is my gold bar worth?

h) The roof of a building is 0.2 $km^2$. During a rainstorm, 5.5 cm of rain was measured to besitting on the roof. What is the mass in kg of the water on the roof after the rainstorm? (Density of rainwater = 1g/mL).

i) The bromine content of the ocean is about 65 g of bromine per million g of sea water. Howmany mL of ocean must be processed to recover 500. mg of bromine, if the density of sea water is $1.0x10^3$ $kg/m^3$?

j) Light travels 186,000 miles / second. How long is a light year in meters? (1 light year isthe distance light travels in one year)

# Moles, Reactions, and Stoichiometry

## Percent Composition*

8. Calculate the percent composition of $Na_2SO_4$.

9. Calculate the percent composition of $C_{12}H_{22}O_{11}$ (sugar). (Give Percent of each element.) Show all work.

10. Calculate the percent composition the elements of hydroxyapatite, $Ca_5(PO_4)_3OH$ . Show all work.

## Mole Conversions

11. Complete the following conversions: (SHOW WORK, use correct # of sig figs)

a) 42.8 g of $KNO_3$ to moles

b) 4.1 g $NH_4OH$ to moles

c) 155.7 L of CO2 at STP to moles

d) 89.1 L of Ne at STP to moles

e) 0.018 L of a 3.0 M (M = mol/L or mol/dm$^3$) solution of HCl to moles HCl

f) 25 L of a 0.08 M solution of NaOH to moles NaOH

g) 1.21 x $10^{25}$ molecules of $CH_4$ to moles $CH_4$

h) 9.25 x $10^{26}$ formula units of CaCl2 to moles $CaCl_2$

i) 0.051 moles of $Na_2SO_4$ to mass of $Na_2SO_4$

j) 1.52 moles of $KNO_3$ to mass $KNO_3$

k) 1.08 x $10^{-3}$ moles of $H_2CO_3$ to mass $H_2CO_3$

l) 6.41 moles of $H_2$ gas to volume at STP

m) 0.08 moles of Ne gas to volume at STP

n) 4.0 moles of NaCl in 2.0 L, to molarity

o) 0.71 moles of KBr in 810 mL, to molarity

**Multi-Step Mole Conversions**

**12.** Complete the following conversions: (SHOW WORK, use correct # of sig figs)

a) If a 300 mL solution is desired at a concentration of 1.2 x $10^{-3}$ M, how many grams of $CaBr_2$ is needed?

b) You are preparing a solution of $K_2CO_3$. The desired volume and concentration is 1.5 L and 60 L. What is the mass of $K_2CO_3$ needed?

c) A balloon of He at STP takes up 300. L. How many He atoms are inside the balloon?

d) A bell jar at STP has a volume of 44.8 L, and contains an elemental gas with a mass of 64.0 g. What is the molar mass and identity of the gas?

e) 11.2 L of $CO_2$ at STP is pressurized into a soda bottle containing 2 L of soda. How many molecules of $CO_2$ are dissolved in the soda?

f) A student is hoping to collect 40.0 g of NaCl crystals from a 4.0 M stock solution. How much of the solution should they evaporate to get the desired quantity of crystals?

g) You notice that a tray of ice cubes left in the freezer has partially sublimated. It started out with 300.0 g of ice, and only 250.0 g of ice remains. What is the expected volume of sublimated $H_2O$ vapor at STP from this tray of ice?

**Empirical Formula (see pages 21-22)**

13. A compound contains, by mass, 40.0% C, 6.7% H, 53.3% O. Determine the empirical formula of the compound.

14. A compound contains, by mass, 42.9% C, 2.4% H, 16.7% N, and 38.1% O. Determine the empirical formula of the compound.

15. The mass of a sample of hydrated copper (II) chloride is 0.996 g before being heated, and 0.790 g after all water is driven off by heat. Determine the empirical formula of the hydrate. (This type of calculation will be in our first lab).

    a. Determine the mass of water in the hydrate sample.

    b. Determine the number of moles of $CuCl_2$ and $H_2O$.

    c. Compare the number of moles to estimate the mole ratio and determine the empirical formula.

**Chemical Reactions - Balancing**

16. Balance the following and equations.

a. _____ $KNO_3$ → _____ $KNO_2$ + _____ $O_2$

b. _____ $AgNO_3$ + ___ $K_2SO_4$ → _____ $Ag_2SO_4$ + _____ $KNO_3$

c. ____ $CH_3NH_2$ + ___ $O_2$ → _____ $CO_2$ + ____ $H_2O$ + ____ $N_2$

d. ____ $N_2O_5$ + _____ $H_2O$ → _____ $HNO_3$

e. _____ $Na$ + ___ $Zn(NO_3)_2$ → _____ $Zn$ + _____ $NaNO_3$

17. What are diatomic molecules? List the 7 diatomic elements.

18. Write a balanced chemical equation using correct chemical formulas and indicating states of matter (s, l, g, or aq) that describe the following observations. The first example is done for you:

a) A strip of magnesium metal is burned in the presence of oxygen to make a white ionic solid.

$2\ Mg_{(s)} + O_{2\ (g)} \rightarrow 2\ MgO_{(s)}$

b) Aqueous solutions of lead (II) nitrate and sodium iodide are mixed, resulting in a yellow precipitate of lead (II) iodide.

c) Potassium metal is added to water, resulting in the formation of a basic solution and a flammable gas.

d) Aluminum wire is added to an aqueous solution of copper (II) chloride, resulting in the formation of copper metal on the surface of the wire. The blue copper (II) chloride solution turns from blue to colorless.

e) Magnesium carbonate is heated and decomposes, leaving behind a metal oxide and gas that causes lime water to turn cloudy.

f) Butane ($C_4H_{10}$) from a lighter ignites in the presence of air.

# Stoichiometry

19. Using the following equation:

$$2\ NaOH + H_2SO_4 \rightarrow 2\ H_2O + Na_2SO_4$$

How many grams of sodium sulfate will be formed if you start with 200 grams of sodium hydroxide and you have an excess of sulfuric acid?

20. Using the following equation:

$$Pb(SO_4)_2 + 4\ LiNO_3 \rightarrow Pb(NO_3)_4 + 2\ Li_2SO_4$$

How many grams of lithium nitrate will be needed to make 250 grams of lithium sulfate, assuming that you have an adequate amount of lead (IV) sulfate to do the reaction?

21. Using the following equation: $Fe_2O_3 + 3\ H_2 \rightarrow 2\ Fe + 3\ H_2O$

Calculate the volume of $H_2$ gas at STP needed to fully react with 16.5 grams of $Fe_2O_3$. (hint: find the amount of moles of $H_2$ gas, then find the volume at STP this corresponds to)

22. Using the following equation: $HCl + NaOH \rightarrow H_2O + NaCl$

Determine the volume of 0.100 M NaOH needed to neutralize 100 mL 0.300 M HCl. (hint: find moles of HCl, then use stoich. to determine moles of NaOH)

**Practice Naming Compounds**

1. Provide names for the following ionic compounds:
   a. $AlF_3$ ______________________
   b. $Fe(OH)_2$ ______________________
   c. $Cu(NO_3)_2$ ______________________
   d. $Ba(ClO_4)_2$ ______________________
   e. $Li_3PO_4$ ______________________
   f. $Hg_2S$ ______________________
   g. $Cr_2(CO_3)_3$ ______________________
   h. $(NH_4)_2SO_4$ ______________________
2. Write the chemical formulas for the following compounds:
   a. Copper(I) oxide ______________________
   b. Potassium peroxide ______________________
   c. Iron(III) carbonate ______________________
   d. Zinc nitrate ______________________
   e. Sodium hypobromite ______________________
   f. Aluminum hydroxide ______________________
3. Give the name or chemical formula for each of the following molecular substances:
   a. $SF_6$ ______________________
   b. $XeO_3$ ______________________
   c. Dinitrogen tetroxide ______________________
   d. Hydrogen cyanide ______________________
   e. $IF_5$ ______________________
   f. Dihydrogen monoxide ______________________
   g. Tetraphosphorous hexasulfide ______________________
4. Give the name or chemical formula for the following compounds:
   a. Ammonium oxalate ______________________
   b. Manganese(III) dichromate ______________________
   c. $Ti(OH)_4$ ______________________
   d. $Ni(ClO_2)_3$ ______________________
   e. Dinitrogen pentoxide ______________________
   f. Aluminum oxide ______________________
   g. $Fe_2S_3$ ______________________

5. Name the following acids
   a. $H_2C_2O_4$ ______________________________
   b. $HBrO_3$ ______________________________
   c. HBr ______________________________
   d. $HNO_2$ ______________________________
   e. $H_2SO_4$ ______________________________
   f. HClO ______________________________
6. Write formulas for the following acids.
   a. hydrochloric acid ______________________________
   b. sulfuric acid ______________________________
   c. nitric acid ______________________________
   d. phosphoric acid ______________________________
   e. carbonic acid ______________________________
   f. acetic acid ______________________________

AP Chemistry Summer Review Part II: Uncertainty in Measurement and Calculations:

## 1. Exact Numbers:

*Counted numbers* and *definitions* do not involve any measurement and are considered as exact numbers with an infinite number of significant figures. Do not consider them when determining significant figures for your final answer.

*Definitions*: 1 week = 7 days.
1 mile = 5,280 feet
1 yard = 3 feet

*Counted*: 5 Players on the basketball court.
23 students in a room
25 pennies used by a class in an experiment.

## 2. Measured Numbers:

All ***measured numbers*** have some degree of uncertainty.

When recording measurements, ***record only the significant figures***. Record measurements to include one decimal estimate beyond the smallest increment on the measuring device.

Examples (consider a measuring instrument like a ruler):

- If smallest increment = 1m, then record measurement o 0.1m (i.e. 3.1***m***)
- If smallest increment = 0.1m, then record measurement to 0.01m (i.e. 5.67 ***m***)
- If smallest increment = 0.01m, then record measurement to 0.001m (i.e.12.675 ***m***)

c. Unless otherwise stated the uncertainty in the last significant figure *(the uncertain digit)*is assumed to be ±1 unit. Modern digital instruments and many types of volumetric glassware will state the level of uncertainty.

### 3. *Rules for counting Significant Figures.*

a.***Non-Zero Numbers***: Non-zero numbers are always significant.
b. ***Zeros:***

1: **Leading zeros** that come before the first non-zero number are ***never*** significant
2. **Captive zeros** (*sandwich zeros*) that fall between two non-zero digits are ***always*** significant.
3. **Ending zeros** that appear after the last non-zero digit are significant only when a decimal point appears somewhere in the number.

Examples:

| Number | 0.005 | 5005 | 5005.00 | 500. | 0.0050 |
|---|---|---|---|---|---|
| Sig Figs | 1 | 4 | 6 | 3 | 2 |

***c. Scientific Notation:*** Significant figures are recorded in the mantissa (*number 1 ≤ x < 10)*

Examples:

| Number | $3.0 \times 10^{3}$ | $5.998 \times 10^{5}$ | $6.00000 \times 10^{-23}$ | $0.5 \times 10^{4}$ |
|---|---|---|---|---|
| Sig Figs | 2 | 4 | 6 | 1 |

4. **Rules for Using Significant Figures in Calculations**

***(a)*** *Multiplication, Division, Powers and Roots*:-"*LEAST SIG.FIG RULE*"

1. The result should be reported to the same number of significant figures as the measured number having the ***least number of significant figures.***

2. Only consider the number of significant figures in each of the ***measured numbers! (not constants)***

*Example 1:*

$2.3 \times 5.78 = \text{Calculator returns } 13.294$

$2.3$ *has 2 sig.fig*

$5.78$ *has 3 sig.fig.*

$2.3 \times 5.78 = 13$ *The answer must be rounded to show 2 sig.fig*

*Example 2.*

$$\frac{1.67x10^{5} \times 0.00045}{2x10^{-23}} = \text{calculator returns } 2.505000000x10^{24}$$

$1.67x10^{5}$ *has 3 sig.figs*

*0.00045 has 2 sig.figs*

$2x10^{-23}$ *has 1 sig.fig*

$$\frac{1.67x10^{5} \times 0.00045}{2x10^{-23}} = 3x10^{24} \text{ (rounded to 1 sig.fig)}$$

*Example 3*

$\sqrt{2.3} = \text{calculator returns } 1.516575089$

*2.3 has 2 sig.figs*

$\sqrt{2.3} = 1.5$ *round answer to 2 sig.figs*

***(b)*** *Addition and Subtraction:* "*LEAST PRECISE DECIMAL RULE*"

1. The result should be reported with the same decimal precision as the measured numberhaving the uncertain digit in the ***least precise decimal place.***

2. Only consider the decimal precision in each of the ***measured numbers! (not constants)***

*Example 4: a – c*

*a.* $123cm + 5.35cm = 128cm$ (*rounded to* $10^{0}$)

*b.* $1.0001m + 0.0003m = 1.0004m$ (*rounded to* $10^{-4}$)

*c.* $1.002s - 0.998s = 0.004s$ (*rounded to* $10^{-3}$)

*Example 5: Watch for numbers ending with zero!*

$10 + 0.0110 = \text{calculator returns } 10.0110$

10 : *the uncertain digit appears in the* $10^{1}$ *place*

0.0110 : *the uncertain digit appears in the* $10^{-4}$ *place*

$10 + 0.0110 = 10$ *round answer to the* $10^{1}$ *place*

*Rationale*: The uncertainty in the measured number 10 is ±1. The uncertainty alone in the first number (10) is greater than the entire second number (0.0110).

## Unit Multiplication – Dimensional Analysis – Factor Labeling

**Units:**
In the world of mathematics numbers often exist as abstract and unit-less entities. However, in the world of physics and chemistry where numbers are based upon experimentation and measurement all numbers are based in a physical reality. ***As a result, every number consists of two important parts.*** The first is a **magnitude** and the second equally important part is a **unit**. It is the unit that gives physical, real-world meaning to the number. We never write one without the other!

**Examples:** Note that these are all "equivalence statements"!

12 ***inches*** in one ***foot***
365 ***days*** in one ***year***
*7* days in one ***week***
1.0 x $10^9$ ***bytes*** in one ***gigabyte***

**Derived Units and Calculations**
Many of the common units we use are actually derived units that result from performing mathematical operations on the basic units. ***When performing mathematical operations the units are treated and manipulated as if they were algebraic variables.*** Here are a few examples:

*Area* = (length -**m**) x (width -**m**) = $\mathbf{m^2}$

*Volume* = (length -**m**) x (width -**m**) x (height - **m**) = $\mathbf{m^3}$

*Velocity* = ( distance traveled – **m**)/(time -**s**) = **m/s**

*Density* = (mass – **g**)/(volume - **mL** ) = **g/mL**

**Unit Conversions**
It is often necessary to convert from one system of units to another. The most efficient way to do thisis using a process known as "*unit multiplication*", "*factor labeling*" or "*dimensional analysis*".

**"goal posting"**
One useful version of this method is called "goal posting". ***Step 1:*** Draw a "*goal post* "with the horizontal bar extending on each side. ***Step 2:*** Place the original number and unit to the left. Placethe final unit on the right. ***Step 3:*** Move the original unit (cm) from the top left (*numerator*) to the bottom of the conversion factor (*denominator*). Now there is no confusion about which form of the conversion factor you will use. If you have done this correctly the original units on the top (*cm*) will be cancelled by the same unit in the denominator of the conversion factor.

***Example:*** Consider a car traveling at ***35 m/s*** in the metric system. What would be the corresponding length in the English system (***miles / hour***)?

**Solution:** Note that velocity is a derived unit and has two units that must be converted: Length (Meters ➔ miles) and Time (seconds ➔ Hours).

***Step 1:*** The derived unit has consists of two different units – one in the numerator and one in the denominator. Place the numerator unit *together with the number* on the "top" of the goalpost. Placethe denominator units on the "bottom" of the goal post.

***Step 2:*** The top unit will be moved down and to the right, the bottom unit will be moved up and to the right.

| | | | | | |
|---|---|---|---|---|---|
| 35 m | 1.094 ***yds*** | 1 mile | 60 s | 60 minute | **78 miles** |
| ***s*** | 1 m | 1760 ***yds*** | 1 minute | 1 hour | **hour** |

Note that the only unit not cancelled in the numerator is miles. The only unit not cancelled in the **denominator** is hours. This gives us the final unit of miles/hour which the correct unit for the result.

If you need additional support in the form of video tutorials, check out the following:

https://www.youtube.com/watch?v=7N0lRJLwpPI
https://www.youtube.com/watch?v=LdZ00OFAfaQ

***https://www.youtube.com/watch?v=BKsPi-VXp5U***

### *Steps to Find Empirical & Molecular Formulas*

Remember this:

"Percent to mass, Mass to mole,

Divide by small, Make it whole"

**1.** Determine the mass in grams of each element present in the sample. **"Percent to mass"**

If the information in the problem is in terms of percent composition of each element ▫

a) assume you have 100 g of the sample to start with

b) The grams of each element (out of the 100 g sample) will just be the numericalvalue of its percent composition.

**EXAMPLE:** You have a sample that is 40.0% carbon, 6.73% hydrogen and the restoxygen. Find the empirical and molecular formulas.

Step 1: 40.0% + 6.73% = 46.73%. The percentage of oxygen is 100%-46.73% =

53.27%If I have 100 g of sample to start with, I have:

40.0 grams Carbon, 6.73 grams Hydrogen and 53.27 grams Oxygen

2. Calculate the number of *moles* of each element. **"Mass to mole"**

Step 2: Moles of Carbon = 40.0g C x 1 mol C/12.01g C = 3.331 mol C

Moles Hydrogen = 6.73g H x 1 mol H/1.01g = 6.663 mol H

Mole Oxygen = 53.27 g O x 1 mol O/16.0 g = 3.33 mol O

*DO NOT ROUND THESE NUMBERS. KEEP SEVERAL DECIMAL PLACES!*

3. Divide each by the smallest number of moles to obtain the *simplest whole number ratio.*

"Divide by small"

Step 3: The molar ratio of the elements in my compound is $C_{3.331}H_{6.663}O_{3.33}$. I want a whole number ratio, so I will divide all the subscripts by the smallest number of moles(3.331) to get:

$C_1H_2O_1$ → so my empirical formula is $CH_2O$

If your number after dividing are values like 2.07, 1.1 etc. then round to the nearest wholenumber. If they are values like 3.5, 2.333 etc., then go to step 4.

4. If whole numbers are not obtained* in step 3), multiply through by the smallest integer that will giveall whole numbers

"Make it whole"

Let's say that my empirical formula turned out to be $C_{2.333}H_4O_2$. 2.333 is not close enough to 2to round down to 2. But I can multiply my formula through by 3 to get this:

$C_7H_{12}O_6$

**Finding molecular formula:** If the molar mass of your empirical formula matches the molar massof the final compound (as stated in the problem) ▫ Hooray! You are done: your empirical formula ISyour molecular formula.

5. For my example in step 1, it says that the molecular weight (molar mass) of mycompound is 180.18 g/mol

My empirical formula is $CH_2O$ from step 3 has a molar mass of (12.01 + 2×1.01 + 16)g/mol = 30.03 g/mol. ***So my empirical formula is not my molecular formula.***

Now, divide molar mass of compound/molar mass of empirical formula:

180.18 g/mol ÷ 30.03 g/mol = 6

The molar mass of my compound is 6 times the molar mass of my empirical formula.Multiply the empirical formula subscripts by 6 to get the final molecular formula:

6($CH_2O$) = $\mathbf{C_6H_{12}O_6}$ The compound in my sample is glucose