## "Summer" AP Chemistry Work

All of you will find AP chemistry to be challenging; some of you will find it to be down-right hard. There is a lot to cover and while we can do it we will all need to work very hard. You should expect this class to be SIGNIFICANTLY more difficult than your first chemistry class. This means that we cannot slow down if you don't understand a topic. You need to make sure that you are staying up with all assignments, and coming in for help if you need extra help.

We will "hit the ground running" when we start next year, there will be a test the first week of the course, so make sure you are prepared by doing the work assigned here. You can search the internet and find numerous websites and videos to help you. Also I will be available via email to help you if needed.

This is a college level course. As such, there is some basic knowledge that you should already have before beginning this class. You have done the required work in your Chemistry class, and this should be a relatively simple review (in other words, you have done all of this before, you just need to recall how to do it).

I will check my email all summer long. Please know that I too am on summer vacation, so I may not respond immediately. I do believe that there is strength in numbers, and I recommend you try and find a study buddy that works well with you as this will be the most powerful resource you can have for this class. If you have any questions or concerns, feel free to email me gourley@lisaacademy.org. I look forward to discovering the wonderful world of chemistry with you!

If you just look the answers up online, you are doing yourself a big disservice and will not get ahead in the long run because there will be a test over this material the first day. If you actually did the work you will be able to pass. If you didn't do the work on your own then you will fail and be dropped from the course.

There are several sites out there that offer good reviews of topics. A good website for a review and sample problems is on the Chem Team Webpage (http://www.chemteam.info/ChemTeamIndex.html ).

DUE DATE: You will need to turn in your "summer" work on the first day of the course. To get full credit, you will need to show all work, units, correct number of significant figures, and circle your answers. This class is the equivalent of college chemistry, therefore, a high level of work is expected from students in this class. We will also have a test over the summer material the first day of school. If you do not pass, you will be dropped from the course.

MATERIALS: You will need a non-graphing , scientific calculator and will be expected to bring it to every class period.

SUMMER ASSIGNMENT: This work is not meant to be anything more than review. Do not procrastinate until the last minute...it will probably not work out in your favor.

Part 1: Sign up for the Goggle classroom AP Chemistry page. The password is: 43vpa38
Answer the following questions in the feed: (1) Why are you taking this course? And (2) What do you hope/expect to get out of the course?

Part 2: Go to the AP Central, College Board website and familiarize yourself with the wealth of resources and information available about the AP Chemistry (and other AP subjects) exam. You may need to create a login and password to answer some of the questions below. Start at this website: http://apcentral.collegeboard.com

Answer these questions in complete sentences and submit them to me by Google classroom.

1. On what date did you gather the information below?
2. What is the date of the 2016/2017 AP Chemistry exam (the one you will take)? (it is possible that the new dates will not be posted so you can include the 2015/2016 dates)
3. What are the two major parts to the exam? What percent of your total score does each count?
4. What two types of problems will you be required to answer in the free response section?
5. Specifically where in the exam will you be allowed or not be allowed to use the following....
a. Calculator
b. Periodic table
c. Sheets with formulas and reduction potentials
6. Are there any examples of released questions available at the web site? Describe.

Part 3:- Memorize Charges of Common Ions. They will not give you an ion chart so it is essential that you have this done prior to school beginning. I suggest notecards and lots of practice.

Part 4: This work is a review of Chemistry topics. Please SHOW ALL WORK including setup, units AND answers with the proper number of significant digits for all calculation problems. Circle your final answer if it is a math problem.

Throughout this course - the rule will be no work, no units = NO CREDIT! Answers that are not within +/- 1 significant digits will be considered incorrect.

# Metric System /Scientific Notation/ Significant Figures/ Dimensional Analysis. 

1. For each of the following pieces of glassware, provide a sample measurement at arrow and discuss the number of significant figures and uncertainty.

2. A student performed an analysis of a sample for its calcium content and got the following results:
14.92\%, 14.91\%, 14.88\%, and 14.91\%

The actual amount of calcium in the sample is $15.70 \%$. What conclusion can you draw about the accuracy and precision of these results?
3. Calculate the percent error for the following measurements.
a. The density of an aluminum block determined in an experiment was $2.64 \mathrm{~g} / \mathrm{cm} 3$. (Accepted value $=\mathbf{2 . 7 0 ~ g / c m 3 ) ~}$
b. The experimental determination of iron in ore was $16.48 \%$. (Accepted value was $16.12 \%$ )
4. How many significant figures are in each of the following?
a. 12
b. 1098
c. 2001
d. $2.001 \times 10^{3}$
e. 100
f. 0.0000101
g. 1000.
h. $\mathbf{2 2 . 0 4 0 3 0}$
i. $1.00 \times 10^{3}$
5. Round of each of the following numbers to two significant figures, and write the answers in Scientific notation.
a. $\mathbf{0 . 0 0 0 3 1 2 5 4}$
b. $\mathbf{3 1}, \mathbf{2 5 4}, 000$
c. 35,900
d. $\mathbf{0 . 0 0 0 0 0 3 9 9}$
6. Use scientific notation to express the number 480 to
a. One significant figure
b. Two significant figures
c. Three significant figures
7. Perform the following mathematical operations, and express each result to the correct number of significant figures.
a. $97.381+4.2502+0.99195=$
b. $171.5+72.915-8.23=$
c. $0.102 \times 0.0821 \times 273.5=$
d. $(9.04-8.23+21.954+81.0) / 3.1416=$
8. Precious metals and gems are measured in troy weights in the English system:

24 grains = 1 pennyweight (EXACT)
20 pennyweights = 1 troy ounce (EXACT)
12 troy ounces $=1$ troy pound (EXACT)
1 grain $=0.0648$ gram
1 carat $=0.200$ gram
a. Diamonds are measured in carats. If a lucky girl receives a 5 carat diamond how many pennyweights is it?
b. What is the mass of $\mathbf{2 . 3}$ troy ounces of gold in grams?
c. The density of gold is $19.3 \mathrm{~g} / \mathrm{cm} 3$. What is the volume of a troy pound of gold?
9. Apothecaries (druggists) use the following set of measures:

20 grains ap = 1 scruple (EXACT)
3 scruples = 1 dram ap (EXACT)
8 dram ap = 1 oz. ap (EXACT)
1 dram ap $=3.888 \mathrm{~g}$
a. An aspirin table contains $5.00 \times 102 \mathrm{mg}$ of active ingredient. How many grains of active ingredient does it contain?
b. From (a) how many scruples?
c. What is the mass of 1.00 scruple in grams?
10. The world record for the hundred meter dash is 9.79 s . What is the corresponding speed in units of $\mathrm{m} / \mathrm{s}, \mathrm{km} / \mathrm{hr}, \mathrm{ft} / \mathrm{s}$, and $\mathrm{mi} / \mathrm{hr}$ ?
a. At this speed how long would it take to run a mile (5,820 ft)?
11. You're planning to buy a new car. One model that you're considering gets 32 miles per gallon of gasoline in highway travel. The one that your spouse likes gets 14 kilometers to the liter. Which car has the better gas mileage? ( 1 gal $=4 \mathrm{qt}$., $1.057 \mathrm{qt}=1 \mathrm{~L}$ )
13. You have a 1.0 cm 3 sample of lead and a 1.0 cm 3 sample of glass. You drop each in separate beakers of water. How do the volumes of water displaced by each sample compare? Explain.

Density of lead $=11.35 \mathrm{~g} / \mathrm{cm} 3$

Density of glass $=3.00 \mathrm{~g} / \mathrm{cm} 3$
16. The density of diamond is $3.51 \mathrm{~g} / \mathrm{cm} 3$. What is the volume of a 4.5 carat diamond? 1 carat $=0.200 \mathrm{~g}$
17. The volume of a diamond is found to be 2.8 mL . What is the mass of the diamond in carats? (See question \#16)
18. A sample containing 33.42 g of metal pellets is poured into a graduated cylinder initially containing 12.7 mL of water, causing the water level in the cylinder to rise to $\mathbf{2 1 . 6} \mathbf{~ m L}$. Calculate the density of the metal.
19. Two spherical objects have the same mass. One floats on water; the other sinks. Which object has the greater diameter? Explain your answer.

## Properties of Matter

20. What are some of the differences between a solid, a liquid, and a gas?
21. What is the difference between homogeneous and heterogeneous matter?
22. Classify each of the following as homogeneous or heterogeneous.
a. soil
b. the atmosphere
c. a carbonated soft drink
d. gasoline
e. gold
f. a solution of ethanol and water
23. Classify each of the following as a mixture or a pure substance. Of the pure substances, which are elements and which are compounds?
a. Water
f. Uranium
b. Blood
g. Wine
c. The oceans
h. Leather
d. Iron
i. Table salt ( NaCl )
e. Brass
24. Distinguish between physical and chemical changes.
25. List four indications that a chemical change (reaction) has occurred.
26. If you place a glass rod over a burning candle, the glass appears to turn black. What is happening to each of the following (physical change, chemical change, both, or neither) as the candle burns? Explain each answer
a. the wax
b. the wick
c. the glass rod
27. The properties of a mixture are typically averages of the properties of its components. The properties of a compound may differ dramatically from the properties of the elements that combine to produce the compound. For each process described below, state whether the material being discussed is most likely a mixture or a compound, and state whether the process is a chemical change or a physical change.
a. An orange liquid is distilled, resulting in the collection of a yellow liquid and a red solid.
b. A colorless, crystalline solid is decomposed, yielding a pale yellow-green gas and a soft, shiny metal.
c. A cup of tea becomes sweeter as sugar is added to it.

## ATOMS

1. Describe Dalton's atomic theory.
2. What discoveries were made by J.J. Thomson, Henri Becquerel, and Lord Rutherford? How did Dalton's model of the atom have to be modified to account for these discoveries?
3. What is the distinction between atomic number and mass number?
4. What is the difference between atomic mass and average atomic mass?
5. What is an isotope?
6. How many protons and neutrons are contained in the nucleus of each of the following atoms?
a. 22 Ti 42
b. $30 Z n 64$
c. 32 Ge 76
d. 36 Kr 86
e. 33As75
f. 19K41
7. Write the isotopic symbol for each of the isotopes below.
a. Atomic number $=8$, number of neutrons $=9$
b. The isotope of chlorine in which mass $=\mathbf{3 7}$
c. Atomic number $=\mathbf{2 7}$, mass $\mathbf{=} \mathbf{6 0}$
d. Number of protons $=\mathbf{2 6}$, number of neutrons $=31$
e. The isotope of I with a mass number of 131
f. Atomic number $=3$, number of neutrons $=4$
8. The element copper has naturally occurring isotopes with mass number of 63 and 65 . The relative abundance of the isotopes are $\mathbf{6 9 . 2 \%}$ for mass $=62.93 \mathrm{amu}$, and $\mathbf{3 0 . 8 \%}$ for mass $=$ 64.93 amu . Calculate the average atomic mass of copper.
9. An element consists of $1.40 \%$ of an isotope with mass $203.973 \mathrm{amu}, \mathbf{2 4 . 1 0 \%}$ of an isotope with mass $205.9745 \mathrm{amu}, \mathbf{2 2 . 1 0 \%}$ of an isotope with mass 206.9759 amu , and $52.40 \%$ of an isotope with mass 207.9766 amu . Calculate the average atomic mass and identify the element.
10. Distinguish between the terms family and period in connection to the periodic table. For which of these terms is the term group also used?
11. In the periodic table, what is the name of the following groups
a. Group (2)
b. Group (18)
12. An ion contains 50 protons, 68 neutrons, and 48 electrons. What is its symbol and charge?
13. Which of the following sets of elements are all in the same group in the periodic table?
a. $\mathrm{N}, \mathrm{P}, \mathrm{O}$
b. $\mathrm{C}, \mathrm{Si}, \mathrm{Ge}$
c. $\mathrm{Rb}, \mathrm{Sn}$
d. $\mathrm{Mg}, \mathrm{Ca}$
14. Identify each of the following elements:
a. A member of the same family as oxygen whose most stable ion contains 54
electrons
b. A member of the alkali metal family whose most stable ion contains 36 electrons
c. A noble gas with 18 protons in the nucleus
d. A halogen with 85 protons and 85 electrons
15. Would you expect each of the following atoms to gain or lose electrons when forming ions? What ion is the most likely in each case?
a. Na
b. Sr
c. $\mathbf{P}$
d. Ba
e. I
f. 0
g. AI
h. $S$
16. For each of the following ions, indicate the total number of protons and electrons in the ion. For the positive ions, predict the formula of the simplest compound formed between itself and oxide. For the negative ions predict the simplest compound formed between itself and aluminum.
a. $\mathrm{Fe}^{+2}$
b. $\mathrm{Fe}^{+3}$
c. $\mathrm{Ba}^{+2}$
d. $\mathrm{Cs}^{+1}$
e. $\mathrm{S}^{-2}$
f. $\mathrm{P}^{-3}$
g. $\mathrm{Br}^{-1}$
h. $\mathbf{N}^{-3}$
17. An element's most stable ion forms an ionic compound with bromine, having the formula $\mathrm{XBr}_{2}$. If the ion of element X has a mass number of $\mathbf{2 3 0}$ and 86 electrons, what is the identity of the element, and how many neutrons does it have?

# Writing Formulas and Naming Compounds - Do WITHOUT an ion chart! You need to have these memorized. 

1. Name each of the following compounds:
a. NaCl
b. $\mathrm{Rb}_{2} \mathrm{O}$
c. $\mathrm{FeBr}_{3}$
d. $\mathrm{Cr}_{2} \mathrm{O}_{3}$
e. $\mathrm{CaBr}_{2}$
f. CsF
g. CaS
h. $\mathrm{All}_{3}$
i. $\mathrm{Al}_{2} \mathrm{O}_{3}$
j. $\mathrm{ZnCl}_{2}$
k. $\mathrm{Li}_{3} \mathrm{~N}$
I. $\mathrm{Ag}_{2} \mathrm{~S}$
m. $\mathrm{KClO}_{4}$
n. $\mathrm{Al}_{2}\left(\mathrm{SO}_{4}\right)_{3}$
o. $\mathrm{BaSO}_{3}$
p. $\mathrm{KMnO}_{4}$
q. $\mathrm{Sr}_{3} \mathrm{P}_{2}$
r. $\mathrm{Ca}_{3}\left(\mathrm{PO}_{4}\right)_{2}$
s. $\mathrm{Pb}\left(\mathrm{NO}_{3}\right)_{2}$
t. $\mathrm{NaNO}_{2}$
u. $\mathrm{K}_{2} \mathrm{Cr}_{2} \mathrm{O}_{7}$
2. Name each of the following compounds:
a. $\mathrm{Nl}_{3}$
b. $\mathrm{PCl}_{3}$
c. $\mathrm{SO}_{2}$
d. $\mathrm{ICl}_{3}$
e. $S F_{2}$
f. $\mathrm{N}_{2} \mathrm{~F}_{4}$
g. $P_{2} S_{5}$
h. $\mathrm{N}_{2} \mathrm{O}_{4}$
3. Write the formula for each of the following compounds:
a. Cesium bromide
b. Barium sulfate
c. Chlorine trifluoride
d. Ammonium chloride
e. Beryllium oxide
f. Chlorine monoxide
g. Magnesium fluoride
h. Sulfur difluoride
i. Sulfur hexafluoride
j. Sodium dihydrogen phosphate
k. Silicon tetrachloride
I. Lithium nitride
m. Chromium (III) carbonate
n. Tin (II) fluoride
o. Ammonium acetate
p. Ammonium hydrogen sulfate
q. Cobalt (III) nitrate
r. Copper (I) sulfide
s. Potassium chlorate
t. Lithium tartrate

## Stoichiometry

1. Balance the following equations:
a. $\qquad$ CO + $\qquad$ $\mathrm{O}_{2} \rightarrow \mathrm{CO}_{2}$
b. $\qquad$ $\mathrm{N}_{2} \mathrm{O}_{5}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{O} \rightarrow$ $\qquad$ $\mathrm{HNO}_{3}$
c. $\qquad$
$\qquad$ $\mathrm{H}_{2} \mathrm{O} \rightarrow$ $\qquad$ $\mathrm{H}_{3} \mathrm{PO}_{4}+$ $\qquad$ HCl
d. $\qquad$ $\mathrm{CH}_{4}+$ $\qquad$ $\mathrm{Br}_{2} \rightarrow$ $\qquad$ $\mathrm{CBr}_{4}{ }^{+}$ $\qquad$ HBr
e. $\qquad$ $\mathrm{C}_{5} \mathrm{H}_{10} \mathrm{O}_{2}+\ldots \mathrm{O}_{2} \rightarrow$ $\qquad$ $\mathrm{CO}_{2}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{O}$
f. $\qquad$ $\mathrm{Cr}(\mathrm{OH})_{3}+$ $\qquad$ $\mathrm{HClO}_{4} \rightarrow$ $\qquad$ $\mathrm{Cr}\left(\mathrm{ClO}_{4}\right)_{3}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{O}$
g. $\qquad$ $\mathrm{KNO}_{3} \rightarrow$ $\qquad$ $\mathrm{KNO}_{2}+$ $\qquad$ $\mathrm{O}_{2}$
h. $\qquad$ $\mathrm{La}_{2} \mathrm{O}_{3}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{O} \rightarrow$ $\qquad$ $\mathrm{La}(\mathrm{OH})_{3}$
i. $\qquad$ $\mathrm{NCl}_{3}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{O} \rightarrow$ $\qquad$ $\mathrm{NH}_{3}+$ $\qquad$ HOCl
j. $\qquad$ $\mathrm{Mg}_{3} \mathrm{~N}_{\mathbf{2}}+$ $\qquad$ $\mathrm{HCl} \rightarrow \ldots \mathrm{MgCl}_{2}+$ $\qquad$ $\mathrm{NH}_{4} \mathrm{Cl}$
k. $\qquad$ $\mathrm{AgNO}_{3}+$ $\qquad$ $\mathrm{K}_{2} \mathrm{SO}_{4} \rightarrow$ $\mathrm{Ag}_{2} \mathrm{SO}_{4}+$ $\qquad$ $\mathrm{KNO}_{3}$
I. $\qquad$ $\mathrm{Al}(\mathrm{OH})_{3}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{SO}_{4} \rightarrow$ _ $\mathrm{Al}_{2}(\mathrm{SO} 4)_{3}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{O}$
m. $\qquad$ $\mathrm{CH}_{3} \mathrm{NH}_{2}+$ $\qquad$ $\mathrm{O}_{2} \rightarrow$ $\qquad$ $\mathrm{CO}_{2}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{O}+$ $\qquad$ $\mathrm{N}_{2}$
n. $\qquad$ $\left(\mathrm{NH}_{4}\right) 2 \mathrm{Cr}_{2} \mathrm{O}_{7} \rightarrow$ $\qquad$ $\mathrm{Cr}_{2} \mathrm{O}_{3}+$ $\qquad$ $\mathbf{N}_{\mathbf{2}}+$ $\qquad$ $\mathrm{H}_{2} \mathrm{O}$
2. Write balanced chemical equations to correspond to each of the following descriptions.
a. When solid potassium chlorate is heated it decomposes to form solid potassium chloride and oxygen.
b. Solid zinc metal reacts with sulfuric acid to form hydrogen gas and an aqueous solution of zinc sulfate.
c. When liquid phosphorous trichloride is added to water, it reacts to form aqueous phosphorous acid, and hydrochloric acid.
d. When hydrogen sulfide gas is passed over solid hot iron (III) hydroxide, the resultant reaction produces solid iron (III) sulfide and water vapor.
3. The molecular formula of aspartame, the artificial sweetener marketed as Nutrasweet, is $\mathrm{C}_{14} \mathrm{H}_{18} \mathrm{~N}_{2} \mathrm{O}_{5}$.
a. What is the molar mass of aspartame?
b. How many moles of aspartame are present in $\mathbf{3 7 6 9 . 4}$ grams of aspartame?
c. How many molecules of aspartame are present in $\mathbf{3 4 5 . 9}$ grams of aspartame?
d. How many oxygen atoms are present in $\mathbf{2 3 . 6}$ grams of aspartame?
4. How many moles of ammonium ions are in 0.557 g of ammonium carbonate?
5. What is the mass, in grams, of 0.0438 moles of iron (III) phosphate?
6. What is the mass, in grams, of $2.69 \times 1023$ molecules of aspirin, C9H8O4?
7. What is the molar mass of diazepam (Valium) if 0.05570 mol has a mass of 15.86 g ?
8. Determine the empirical formulas of the following compounds.
a. $\mathbf{1 0 . 4}$ \% C, $\mathbf{2 7 . 8}$ \% S, and $\mathbf{6 1 . 7 \% ~ C l}$
b. Monosodium glutamate (MSG), a flavor enhancer in certain foods, $35.51 \mathrm{~g} \mathrm{C}, 4.77 \mathrm{~g}$ H, $37.85 \mathrm{~g} \mathrm{O}, 8.29 \mathrm{~g} \mathrm{~N}, 13.60 \mathrm{~g} \mathrm{Na}$

## AP Chemistry - BACKGROUND NOTES

## INTRODUCTION: MATTER AND MEASUREMENT

Chemistry - study of the properties of materials and the changes that materials undergo
Matter - anything that has mass and occupies space
Atoms - building blocks of matter
Molecules - atoms combine to form these
A. Classifications of Matter

1. States of Matter
a. Gas (vapor)
i. Has no fixed volume or shape
ii. Takes the shape of its container
iii. Can be compressed or expanded
iv. Molecules are far apart and moving at high speeds
b. Liquid
i. Definite volume, Cannot be compressed
ii. Takes the shape of its container
iii. Molecules are much closer than in gas but still move rapidly (they can slide past each other)
c. Solid
i. Definite shape and volume, cannot be compressed
ii. Molecules are held tightly together, typically in definite arrangements
2. Pure Substances and Mixtures
a. Pure substance - matter that has a fixed composition and distinct properties i. Two Types
3. elements - substances that cannot be decomposed into simpler substances
4. compounds - composed of two or more elements chemically bonded together
b. Law of Constant Composition - (Joseph Proust) the makeup of compounds is always the same
c. Mixtures - combinations of two or more substances in which each substance retains its own chemical identity and properties
i. Properties can vary
5. example - adding sugar to coffee is a mixture, you can make it very sweet, add a little, or none at all
ii. Two Types
6. heterogeneous - different composition throughout a. rocks, sand, wood, chocolate chip cookies
7. homogeneous aka solutions- uniform composition throughout
d. air (gaseous solution), gasoline (liquid solution), brass (solid solution)
e. Separation of Mixtures
i. filtration - separating a solid component from a liquid component using a funnel and gravity
ii. distillation - separating liquid components utilizing different boiling points
iii. chromatography - separating substances by how they adhere to surfaces (used frequently for ink)
8. Properties of Matter
a. Physical properties - description of what something looks like
i. Ex - color, odor, density, melting point, boiling point, hardness
b. Chemical properties - how a chemical reacts with other chemicals
i. Ex - flammability, reactivity with other chemicals
9. Changes in Matter
a. Physical changes - physical appearance is changed
i. Ex - ripping up paper, melting wax, ALL CHANGES OF STATE (boiling, evaporating)
b. Chemical changes (reactions) - chemically transformed into a new substance
i. Ex - sodium metal reacts with chlorine gas to form salt

## B. Units of Measurement

1. Metric System/ Significant Figures/Dimensional Analysis
a. you should ALREADY know this -there are many good websites for review

## ATOMS, MOLECULES, IONS

A. The Atomic Theory of Matter

## HISTORY OF THE ATOM

- Democritus - first person to speculate that matter was mass of atoms, Greek philosopher
- Plato and Aristotle refuted this idea, atomic theory faded for many centuries
- John Dalton - came up with first atomic theory, English schoolteacher
- Each element is composed of extremely small particles called atoms.
- All atoms of a given element are identical; the atoms of different elements are different and have different properties (including different masses.)
- Atoms of an element are not changes into different types of atoms by chemical reactions; atoms are neither created nor destroyed in chemical reactions.
- Compounds are formed when atoms of more than one element combine; a given compound always has the same relative number and kind of atom.
- Dalton thought that atoms could not be broken down any further, this was expressed in the atomic model - Billiard Ball Model.

Laws from this time period

- Law of Constant Composition -
- Law of Conservation of Mass (LeChatelier) - matter and energy cannot be created or destroyed
- Law of Multiple Proportions - if elements combine to form more than one compound they must be different by whole numbers

Example - carbon monoxide, CO, carbon dioxide, CO2

- Cathode Rays - a high voltage electricity passed through partially evacuated tubes produced
- radiation and mass glass fluoresce, called cathode rays because they originated from the cathode
- Rays were deflected by electric and magnetic fields, suggesting that the rays were charged
- J.J. Thomson - observed that the rays were the same no matter what type of material was used, concluded that the rays were actually particles with mass, these particles were called electrons
- Able to calculate the charge to mass ratio of an electron, $1.76 \times 10^{8}$
- Coulombs/gram
- Came up with second atomic model - Plum-Pudding Model
- Robert Millikan - performed the oil drop experiment and determined the charge of an electron $\left(1.60 \times 10^{-19} \mathrm{C}\right)$ and then determined the mass of an electron $\left(9.11 \times 10^{-28} \mathrm{~g}\right)$
- Henri Becquerel - studied an ore of uranium called pitchblende and discovered the spontaneous emission of radiation called radioactivity
- Marie Curie and her husband, Pierre also studied this
- Ernest Rutherford - studied radiation and discovered three types of radiation: alpha $(\alpha)$, beta ( $\beta$ ), and gamma ( $\gamma$ )
- Utilizing alpha particles Rutherford performed the Gold Foil Experiment an determined that the atom had a nucleus and also discovered protons
- James Chadwick - discovered neutrons


## MODERN VIEW OF ATOMIC STRUCTURE

a. Atoms are made of protons, neutrons, and electrons
b. Electronic charge is measured in Coulombs (C)
i. Electrons have a charge of $-1.60 \times 10^{-19} \mathrm{C}$
ii. Protons have a charge of $+1.60 \times 10^{-19} \mathrm{C}$
iii. For simplicity we change this to $\mathbf{- 1}$ and $\mathbf{+ 1}$, but you should still know what the real value is
iv. Neutrons have no charge
c. Atoms are typically neutral, which means they have the same number of protons and electrons
d. Protons and neutrons are in the nucleus, electrons circle around
e. Vast majority of an atom's volume is the space where the electrons are
f. Isotopes - atoms of a given element that differ in the number of neutrons
g. Protons - all atoms of an element have the same number of protons in the nucleus, aka, atomic number
h. Mass number - number of protons + number of neutrons

Periodic Table

- You should know the general layout of periodic table (groups, rows, where the metals, nonmetals, and metalloids are)

Writing Chemical Formulas -there are many good websites to help you review
a. Covalent (aka Molecular) Compounds
i. Contain only nonmetals
ii. Prefixes are used to name them, first element only has a prefix if needed, second element ALWAYS has a prefix
$1=$ mono $2=\operatorname{di} 3=\operatorname{tri} 4=$ tetra $5=$ penta $6=$ hexa $7=$ hepta $8=$ octa 9
= nona 10 = deca
example: $\mathrm{CCl}_{4}=$ carbon tetrachloride $\mathrm{S}_{\mathbf{2}} \mathrm{O}=$ disulfur monoxide
b. Ionic Compounds
i. Composed of an cation (+) and an anion (-)
ii. Can contain polyatomic ions (ions that have more than one atom in them)
iii. Make sure you balance charges
iv. Use Roman numeral to indicate what charge multivalent metal have
c. Naming Acids
i. Two Types

Binary Acids - hydrogen and another elements

1. Hydro- $\qquad$ -ic acid ex. $\mathrm{H}_{2} \mathrm{~S}=$ hydrosulfuric acid
2. Oxy Acids - contain oxygen, need to look at anion
if anion ends in -ate ate goes to ic ex. $\mathrm{HNO}_{3}=$ nitrate $=$ nitric acid
if anion ends in -ite ite goes to ous ex. $\mathrm{HNO}_{2}=$ nitrite $=$ nitrous acid only exception is HCN = hydrocyanic acid

## STOICHIOMETRY: CALCULATIONS WITH CHEMICAL FORMULAS AND EQUATIONS

1. All chemical equations need to be written correctly and balanced appropriately
2. We will go over all of the types of chemical reactivity but below are some for review
a. Combustion - rapid reactions that produce a flame
b. Most common involve oxygen as a reactant
c. Often involve hydrocarbons (compounds that contain hydrogen and carbon) ex.
$\mathrm{C}_{3} \mathrm{H}_{8}$
d. Synthesis - when two or more reactants come together to form one product
e. Decomposition - one substance undergoes a reaction to form two or more products
3. Atomic and Molecular Weights
a. Atomic Mass Scale - is based off of Carbon-12, mass of carbon-12 = 12 amu
b. $\mathrm{Amu}=$ atomic mass unit, $1 \mathrm{~g}=6.022 \times 10^{23} \mathrm{amu}$
4. Average Atomic Masses
a. the masses listed on the periodic table are weighted averages based on the abundance in nature
5. Percent Composition from Formulas
a. part/whole X 100\%
b. used to determine how much of a compound is a particular kind of element
6. The Mole
a. used to convert between the microscopic and macroscopic
b. Avogadro's Number $=6.02 \times 10^{23}$
