## AP Chemistry - Summer Assignment

## This assignment is due on the first day of school. You must show all your work in all problems.

AP Chemistry is a science course that will demand an exceptional knowledge of algebra-based mathematics, trigonometry, and geometry. In addition, we will be working constantly with elements and compounds and you must be able to comfortably write names and formulas for a wide variety of substances. There are several purposes to this summer assignment. First, it is a review of major topics you covered in your first chemistry course. These are topics I expect you to master in the first couple weeks of school and starting over the summer prepares you for that goal. Second, to familiarize yourself with a lot of the fundamental knowledge that will be used daily in class.

## Google Classroom:

Join the summer assignment google classroom using the code: lyktzas. I will post some reference videos and course materials for you to review as well as some recommended due dates so you do not save the entire assignment for the last day of summer. You can also send me questions and I will reply back to you as I am able.

Things to know about AP Chemistry:

1. Ignore your grade. If you focus on the content, do your work on time, ask questions as often as needed, you will do well.
2. Conceptual knowledge is the critical for success. We will cover concept after concept and to truly do well in the class, you need to be ready to apply that knowledge in different ways as the question being asked will always be different than you expect.
a. This means you need to be involved in the course and study regularly. If you do so, you can build upon your knowledge and gain a deeper understanding of the concepts. Topics covered at the beginning of the year will continue to be used throughout the course.
3. Outside resources are your friend. When told to read a chapter of the book, or watch a video, you need to do it. I will provide numerous resources for you so if one is not making sense, try another one. Take notes while reading or watching videos to review later. Study the diagrams, graphs, and equations as well.
a. When you are in college, taking effective notes is the key to success. Every course and every teacher is different so find a method that works best for you, but take notes!
b. Find your own resources! The internet is full of information and you can find dozens of people all explaining the same topic. If you do find something especially useful, send it to me and I can share it with the rest of the class.
4. Do not spend an exceptionally long time on one problem. The AP test is timed as well as the exams in class. If you get stuck on a problem, skip it. Often time future problems may provide hints or reminders on how to solve your problem.
5. Work together as a class. Help each other out, bounce ideas off each other, problem solve together. Find a study group, share quizlets, share videos with each other. Use class time effectively. Socializing with your friends may be fun, but you will have more work to do later.
6. Do not cram. This is not a memory based course. You will need to be able to pull multiple topics together to solve one problem. Keeping up with the material and constantly using it helps keep everything fresh and easy to recall. Learn how to solve a problem and not just memorize the steps from one example.

There are several ways this course is different from the chemistry course you have already taken.

1. You must be able to find charges and write formulas of common simple ions and various polyatomic ions on demand. Unlike regular chemistry, familiarity with the formulas of many more polyatomic ions will be expected from AP chemistry students. You are also expected to know the names and formulas of common acids and bases. Proficiency in recognizing transition metals, and proper use of roman numerals is also expected.
2. You must have proficiency in using prefixes in the names of binary covalent compounds. You also need to memorize the formulas of the seven diatomic elements for use in writing chemical equations, and to be able to write formulas of some common covalent compounds.
3. The AP periodic table is different from the one used in regular chemistry. The AP periodic table has no element names (only symbols and atomic number and atomic masses), no period number info, and no family names. You are expected to know element names and symbols and their relative positions in the table to explain trends.
4. You are expected to be able to differentiate between different types of chemical reactions, predict expected products, and be able to balance chemical equations.

## Common Elements

Since the AP periodic table does not include names, only symbols of elements, you should have common element names memorized. Pay special attention to symbols/names that are similar as well as symbols who do not match the name. Phases are also included for those elements who are not solid at room temperature.

A1 Aluminum
Ar Argon (g)
As Arsenic

B Boron
$\mathrm{Ba} \quad$ Barium
Be Beryllium
Bi Bismuth
Br Bromine* (1)
C Carbon
Cd Cadmium
Ca Calcium
Cl Chlorine* (g)
Co Cobalt
$\mathrm{Cr} \quad$ Chromium
Cs Cesium

F Fluorine* (g)
Fr Francium
Ga Gallium
Ge Germanium

H Hydrogen* (g)
He Helium (g)
I Iodine*
In Indium
Ir Iridium
$\mathrm{Kr} \quad$ Krypton (g)
Li Lithium

Mg Magnesium
Mn Manganese
N Nitrogen* (g)
Ne Neon (g)
Ni Nickel

O Oxygen* (g)
Os Osmium
P Phosphorus**
Pd Palladium
$\mathrm{Pt} \quad$ Platinum
$\mathrm{Pu} \quad$ Plutonium
$\mathrm{Ra} \quad$ Radium
Rb Rubidium
Rn Radon (g)
S Sulfur**
Se Selenium
Si Silicon
Sr Strontium
Th Thorium
Ti Titanium
U Uranium
Xe $\quad$ Xenon (g)
Zn Zinc
**************
Ag Silver
Au Gold
Cu Copper
Fe Iron
$\mathrm{Hg} \quad$ Mercury (1)
K Potassium
Na Sodium
Pb Lead
Sb Antimony
$\mathrm{Sn} \quad$ Tin
W Tungsten
(l) $=$ Liquid
(g) $=$ Gas

* $=$ Diatomic
$* *=$ Polyatomic elements $\left(\mathrm{P}_{4}, \mathrm{~S}_{8}\right)$
pg. 3


## Monatomic and Polyatomic Ions

You will need to be able to write formulas and names for ionic compounds. I suggest making flashcards to study and memorize these.


| FORMULAS AND NAMES OF COMMON METAL |  |
| :--- | :--- |
| IONS WITH MORE THAN ONE IONIC CHARGE |  |
| Formula | Name |
| $\mathrm{Cu}^{1+}$ | Copper (I) |
| $\mathrm{Cu}^{2+}$ | Copper (II) |
| $\mathrm{Fe}^{2+}$ | Iron (II) |
| $\mathrm{Fe}^{3+}$ | Iron (III) |
| $\mathrm{Hg}_{2}^{2+}$ | Mercury (I)* |
| $\mathrm{Hg}^{2+}$ | Mercury (II) |
| $\mathrm{Pb}^{2+}$ | Lead (II) |
| $\mathrm{Pb}^{4+}$ | Lead (IV) |
| $\mathrm{Sn}^{2+}$ | Tin (II) |
| $\mathrm{Sn}^{4+}$ | Tin (IV) |
| $\mathrm{Cr}^{2+}$ | Chromium (II) |
| $\mathrm{Cr}^{3+}$ | Chromium (III) |
| $\mathrm{Mn}^{2+}$ | Manganese (II) |
| $\mathrm{Mn}^{3+}$ | Manganese (III) |
| $\mathrm{Co}^{2+}$ | Cobalt (II) |
| $\mathrm{Co}^{3+}$ | Cobalt (III) |
| $\mathrm{Ag}^{+}$ | Silver |
| $\mathrm{Zn}^{2+}$ | Zinc |

# Tips for Memorizing Ions 

## Monatomic Ions: From the periodic table

## Cations:

These ions are broken into two groups:

1. Main group metals:

- Charges determined from location on periodic table
- Ions keep element name, just add "ion" (sodium ion, calcium ion)
a. All group 1 elements lose 1 electron to form an ion with a $1+$ charge
b. All group 2 elements lose 2 electrons to form an ion with a $2+$ charge
c. All group 13 metals lose 3 electrons to form an ion with a $3+$ charge

2. Transition (and other) metals:

- These elements cannot be predicted based on a pattern in the table. Many of these also form more than one type of ion so their charge is denoted by a roman numeral in parentheses immediately after the name of the element (eg. Iron (III) = $\mathrm{Fe}^{3+}$ )
a. Silver and zinc have only one possible charge and therefore do not use roman numerals since there is no discrepancy. Silver is always $\mathrm{Ag}^{+}$and zinc is always $\mathrm{Zn}^{2+}$.
b. Mercury (I) ion is diatomic and will always appear as $\mathrm{Hg}_{2}{ }^{2+}$. Mercury (II) remains as $\mathrm{Hg}^{2+}$.


## Anions:

- These ions belong to non-metals
- Ions get "-ide" suffix on element name (chloride ion, oxide ion, phosphide ion)
a. All group 17 elements (halogens) gain 1 electron to form a 1 - charge
b. All group 16 nonmetals gain 2 electrons to form a 2- charge
c. All group 15 nonmetals gain 3 electrons to form an ion with a 3 - charge


## Polyatomic Ions: Tips to memorize

1. Memorize the "-ate" ions (sulfate, nitrate, etc)
2. The suffix "-ite" means the ion has the same charge, but one less oxygen (sulfate $=\mathrm{SO}_{4}{ }^{2-}$, sulfite $=\mathrm{SO}_{3}{ }^{2-}$ )
3. The prefix "hypo-" means "under" or "too little". "Нуро-" is added to "-ite" ions indicating one additionally less oxygen
4. The prefix "per-" comes from "hyper" meaning "above" or "too much". "Per-" is added to "-ate" ions indicating one additional oxygen

| Hypochlorite | Chlorite | Chlorate | Perchlorate |
| :---: | :---: | :---: | :---: |
| $\mathrm{ClO}^{-}$ | $\mathrm{ClO}_{2}^{-}$ | $\mathrm{ClO}_{3}^{-}$ | $\mathrm{ClO}_{4}^{-}$ |

pg. 5
5. The prefix "bi-" usually means "two" and in some antiquated way, it applies here, but that is left over from an old naming system. Instead, think of "bi-" meaning "add hydrogen". At the same time the charge is reduced by one since the added hydrogen has a $1+$ charge. $\left(\right.$ carbonate $=\mathrm{CO}_{3}{ }^{2-}$, bicarbonate $\left.=\mathrm{HCO}_{3}{ }^{-}\right)$

## Naming Molecules and Compounds

There are two ways to name compounds based on what type of compound it is.

1. Ionic Compounds: Combine name of cation and anion. The cation is always listed first.

- Main group metals use just their element name
- Transition metals use roman numerals to indicate charge (Iron (III) oxide)
- Hydrogen and ammonium are non-metal cations $\left(\mathrm{H}^{+}, \mathrm{NH}_{4}^{+}\right)$
- Monatomic anions use "-ide" suffix, polyatomic anions use name listed

2. Covalent compounds: Covalent bonding with non-metals only

- Prefixes used to specify subscript
- Elements usually listed by increasing electronegativity
- First element keeps element name, second element uses "ide-" suffix
- NO "mono-" prefix on first element, only second

| Mono- | 1 |
| :--- | :--- |
| Di- | 2 |
| Tri- | 3 |
| Tetra- | 4 |
| Penta- | 5 |
| Hexa- | 6 |
| Hepta- | 7 |
| Octa- | 8 |
| Nona- | 9 |
| Deca- | 10 |

## Solubility and Activity Series

Knowledge of the solubility rules and activity series is necessary to predict whether a reaction will occur during double and single replacement reactions. These do not need to be memorized.

| Ion | Solubility |
| :--- | :--- |
| Group 1 <br> (including H) | All soluble. |
| $\mathrm{NH}_{4}^{+}$ | All soluble. |
| $\mathrm{NO}_{3}{ }^{-}, \mathrm{ClO}_{3}{ }^{-}$, <br> $\mathrm{ClO}_{4}^{-}, \mathrm{C}_{2} \mathrm{H}_{3} \mathrm{O}_{2}^{-}$ | All soluble. |
| $\mathrm{Br}^{-}, \mathrm{I}^{-}, \mathrm{Cl}^{-}$ | Soluble except $\mathrm{Ag}^{+}, \mathrm{Hg}^{2+}$, and $\mathrm{Pb}^{2+}$. |
| $\mathrm{SO}_{4}^{-2}$ | Soluble except $\mathrm{Ca}^{2+}, \mathrm{Ba}^{2+}, \mathrm{Sr}^{2+}, \mathrm{Hg}^{2+}, \mathrm{Pb}^{2+}$, and $\mathrm{Ag}^{+}$. |
| $\mathrm{CO}_{3}^{-2}, \mathrm{SO}_{3}^{-}$ <br> $\mathrm{CrO}_{4}$, <br> $\mathrm{PO}_{4}$ | Insoluble except for alkali metals (Group 1) and $\mathrm{NH}_{4}{ }^{+}$. |
| $\mathrm{PO}_{4}^{-3}$ | Insoluble except for alkali metals (Group 1) and $\mathrm{NH}_{4}{ }^{+}$. |
| $\mathrm{OH}^{-}, \mathrm{S}^{2-}$ | Insoluble except for alkali metals (Group 1), $\mathrm{NH}_{4}^{+}, \mathrm{Ca}^{2+}, \mathrm{Ba}^{2+}$, and $\mathrm{Sr}^{2+}$. |

## Activity Series

Most Reactive

| Lithium | Li | Fluorine | F |
| :--- | :--- | :--- | :--- |
| Potassium | K | Chlorine | Cl |
| Barium | Ba | Bromine | Br |
| Strontium | Sr | Iodine | I |
| Calcium | Ca |  |  |
| Sodium | Na |  |  |
| Magnesium | Mg |  |  |
| Aluminum | Al |  |  |
| Manganese | Mn |  |  |
| Zinc | Zn |  |  |
| Iron | Fe |  |  |
| Cobalt | Co |  |  |
| Nickel | Ni |  |  |
| Tin | Sn |  |  |
| Lead | Pb |  |  |
| Hydrogen | H |  |  |
| Copper | Cu |  |  |
| Silver | Ag |  |  |
| Mercury | Hg |  |  |
| Gold | Au |  |  |

Least Reactive

## Significant Figures

Always use the correct number of significant figures in your answers, whether it is scientific notation or regular notation.

## Significant Figures Rules:

Bold\&underline $=$ significant figure
Strikethreugh $=$ not significant

1. Non-zero digits are always significant Eg. $\mathbf{3 2 2 . 7}$
2. Zeroes between non-zero numbers are significant. Eg. $3 \underline{\mathbf{0}} 2 . \underline{\mathbf{0}} 7$
3. Zeroes at the beginning of a number are never significant. Eg. $0.0 \oplus 32$
4. Zeroes at the end of a number are significant IF there is a decimal point. Eg. 32ㅁ. is significant, but $32 \theta$ is not. Also $0.0032 \underline{\mathbf{0 0}}$ or $32 \underline{\mathbf{0}} \mathbf{0}$ are significant.

## Addition/Subtraction Rule:

Answers should be rounded to the value place of the number whose last sig fig is in the highest value place.
$35.4 \underline{\mathbf{8}}+2 . \underline{4}=37.88$ which would round to $37 . \underline{9}$
The last digit of the $1^{\text {st }}$ number (8) is in the $100^{\text {th }}$ place while the last digit of the $2^{\text {nd }}$ number (4) is in the $10^{\text {th }}$ place. Since the $10^{\text {th }}$ place is the higher place value, we round to the $10^{\text {th }}$ place.
$4,3 \underline{\mathbf{3}} 0-210 . \underline{\mathbf{5}}=4,119.5$ which would round to $4,1 \underline{\mathbf{2}} 0$
The last digit of the $1^{\text {st }}$ number (3) is in the 10 's place while the last digit of the $2^{\text {nd }}$ number (5) is in the $10^{\text {th }}$ place. Since the 10 's place is the higher place value, we round to the 10 's place.

## Multiplication/Division Rule:

Answer should be rounded so that it has the same total number of significant figures as the number with the least total number of significant figures.
$\underline{\mathbf{2 0 . 8 2}} * 0.0 \underline{\mathbf{4 2}}=0.87444$ which would round to $0 . \underline{\mathbf{8 7}}$
The first number has 4 total sig figs while the second number only has 2 total sig figs. Since the least total number of sig figs is 2 , we round to the first two significant digits.

7,890. $/ \underline{\mathbf{8 . 6 4 8 6}}=912.28638$ which would round to $\underline{\mathbf{9 1 2 . 3}}$
The first number has 4 total sig figs (since there is a decimal) while the $2^{\text {nd }}$ number has 5 total sig figs. Since the least total number of sig figs is 4 , we round to the first 4 significant digits.

## Metric Measurements and Conversions

You should be comfortable using and converting the following metric prefixes. Using proper symbols for units, variables, prefixes, etc is important as the wrong symbol could change the entire meaning. These symbols are CaSe SeNsItIvE, capital and lower case letters mean different things.

Complete the following table:

| Metric Prefix | Symbol | Power |
| :---: | :---: | :---: |
| Tera- |  |  |
| Giga- |  |  |
| Mega- |  |  |
| Kilo- | k | $10^{3}$ |
| Base Unit | ----- | $10^{0}$ |
| Centi- |  |  |
| Milli- |  |  |
| Micro- |  |  |
| Nano- |  |  |
| Pico- | p | $10^{-12}$ |

## Significant Figures, Metric Conversions, and Scientific Notation

1. Round each of the following numbers to four significant figures. Write the answer in decimal form AND scientific notation.
a. 300.235800
b. 456,500
c. $5,799.823$
d. 0.006580221
2. Complete the following calculations. Round all answers to the correct number of sig figs.
a. $1.24056+75.80$
b. 37.05-75
c. 890,000 * 112.3
d. $78,132 / 2.50$
3. Convert the following units. Solve each problem using dimensional analysis showing all your work. Every number every time must have a unit and the answer must be expressed with proper significant figures.
a. Convert $4,200 \mathrm{mg}$ to kg

$$
4,200 \mathrm{mg} \cdot \frac{10^{-3} \mathrm{~g}}{1 \mathrm{mg}} \cdot \frac{1 \mathrm{~kg}}{10^{3} \mathrm{~g}}=0.0042 \mathrm{~kg}
$$

b. 50.0 m to mm
c. 25 cL to kL
d. 0.00332 Mg to kg
e. 457.3 nm to m
f. $\quad 39.2 \mathrm{~m} / \mathrm{s}$ to miles per hour

## Review Problems

1. Fill in the following table, assume each row represent a neutral atom

- Nuclear notation:

Mass Number
Atomic Number Element ${ }^{\text {Charge }}$

$$
\text { Ex: }{ }_{238}^{92} U
$$

- Mass number $=$ protons + electrons
- Atomic number = protons
- Electrons $=$ Protons **For neutral atoms only. **Electrons do NOT equal atomic number. Electrons equal protons and protons equal atomic number

| Nuclear <br> Notation | Protons | Neutrons | Electrons | Mass <br> Number |
| :---: | :--- | :--- | :--- | :--- |
| ${ }^{38} K$ |  |  |  |  |
| ${ }_{19}{ }^{3}$ | 25 | 30 |  |  |
|  |  | 64 | 48 |  |
|  |  |  | 56 | 137 |
|  | 82 |  |  | 207 |

2. Describe where the following elements are located on the periodic table and two element examples:
a. Alkaline earth metals
b. Halogens
c. Alkali metals
d. Noble gasses
e. Metalloids
f. Rare earth metals
g. Transition metals
h. Non-metals
3. Write the formula of the common ion derived from each of the following atoms:
a. Li
d. N
g. Mg
b. S
e. Al
h. Xe
c. I
f. Cs
i. Br
4. Give the name for each of the following ionic compounds:
a. $\mathrm{AlF}_{3}$
b. $\mathrm{Fe}(\mathrm{OH})_{2}$
c. $\mathrm{Cu}\left(\mathrm{NO}_{3}\right)_{2}$
d. $\mathrm{Ba}\left(\mathrm{ClO}_{4}\right)_{2}$
e. $\mathrm{Li}_{3} \mathrm{PO}_{4}$
f. $\mathrm{Hg}_{2} \mathrm{~S}$
g. $\mathrm{Ca}\left(\mathrm{C}_{2} \mathrm{H}_{3} \mathrm{O}_{2}\right)_{2}$
h. $\left(\mathrm{NH}_{4}\right)_{2} \mathrm{SO}_{4}$
5. Write the chemical formula for each of the following compounds:
a. Copper (I) oxide
e. Silver carbonate
b. Potassium peroxide
f. Mercury (I) bromide
c. Aluminum hydroxide
g. Iron (III) chlorite
d. Ammonium sulfite
h. Lead (II) nitrate
6. Fill in the blanks in the following table:

| Cation | Anion | Formula | Name |
| :--- | :--- | :--- | :--- |
|  |  |  | Magnesium bicarbonate |
|  |  | $\mathrm{SrCl}_{2}$ |  |
| $\mathrm{Fe}^{3+}$ | $\mathrm{NO}_{2}{ }^{-}$ |  |  |
|  |  |  | Manganese (II) chlorate |
|  |  | $\mathrm{SnBr}_{4}$ |  |
| $\mathrm{Co}^{2+}$ | $\mathrm{PO}_{4}{ }^{3-}$ |  |  |
| $\mathrm{Hg}_{2}{ }^{2+}$ | $\mathrm{I}^{-}$ |  |  |
|  |  | $\mathrm{CuCO}_{3}$ | Lithium nitride |
|  |  |  |  |
| $\mathrm{Al}^{3+}$ | $\mathrm{S}^{2-}$ |  |  |

7. Give the name or chemical formula, as appropriate, for each of the following acids:
a. $\mathrm{HBrO}_{3}$
d. Hypochlorous acid
b. HBr
e. Chloric acid
c. $\mathrm{H}_{3} \mathrm{PO}_{4}$
f. Sulfuric acid
8. Give the name or chemical formula, as appropriate, for each of the following molecular compounds:
a. Dinitrogen tetroxide
d. $\mathrm{XeO}_{3}$
b. $\mathrm{SF}_{6}$
e. Dihydrogen sulfide
c. $\mathrm{IF}_{3}$
f. Tetraphosphorous hexasulfide
9. Give the name or chemical formula, as appropriate, for the following. Types of naming are mixed, make sure you can determine how to name each when the type is not specified.
a. Sodium hypochlorite
d. Iron (III) oxide
b. $\mathrm{Cr}_{2}\left(\mathrm{CO}_{3}\right)_{3}$
e. Nitrogen Dioxide
c. CO
f. $\mathrm{K}_{2} \mathrm{CrO}_{4}$
10. Determine the molar mass of each of the following compounds.
a. $\mathrm{N}_{2} \mathrm{O}_{3}$
c. Iron (II) carbonate
b. $\mathrm{Ca}\left(\mathrm{NO}_{3}\right)_{2}$
d. Disilicon hexabromide
11. Balance the following equations:
a. $\mathrm{NaH}_{2} \mathrm{PO}_{4} \rightarrow \mathrm{NaPO}_{3}+\mathrm{H}_{2} \mathrm{O}$
b. $\mathrm{Ca}(\mathrm{OH})_{2}+\mathrm{CO}_{2} \rightarrow \mathrm{Ca}\left(\mathrm{HCO}_{3}\right)_{2}$
c. $\mathrm{SrBr}_{2}+\left(\mathrm{NH}_{4}\right)_{2} \mathrm{CO}_{3} \rightarrow \mathrm{SrCO}_{3}+\mathrm{NH}_{4} \mathrm{Br}$
d. $\mathrm{Mn}_{2} \mathrm{O}_{3}+\mathrm{Al} \rightarrow \mathrm{Al}_{2} \mathrm{O}_{3}+\mathrm{Mn}$
e. $\mathrm{S}+\mathrm{N}_{2} \mathrm{O} \rightarrow \mathrm{SO}_{2}+\mathrm{N}_{2}$
f. $\mathrm{N}_{2}+\mathrm{H}_{2} \rightarrow \mathrm{NH}_{3}$
g. $\mathrm{AgNO}_{3}+\mathrm{FeCl}_{3} \rightarrow \mathrm{Fe}\left(\mathrm{NO}_{3}\right)_{3}+\mathrm{AgCl}$
h. $\mathrm{Fe}_{2}\left(\mathrm{SO}_{4}\right)_{3}+\mathrm{KOH} \rightarrow \mathrm{K}_{2} \mathrm{SO}_{4}+\mathrm{Fe}(\mathrm{OH})_{3}$
i. $\mathrm{Al}_{2}\left(\mathrm{SO}_{4}\right)_{3}+\mathrm{KOH} \rightarrow \mathrm{Al}(\mathrm{OH})_{3}+\mathrm{K}_{2} \mathrm{SO}_{4}$
j. $\mathrm{C}_{7} \mathrm{H}_{16}+\mathrm{O}_{2} \rightarrow \mathrm{CO}_{2}+\mathrm{H}_{2} \mathrm{O}$

For each of the following problems, show your work and circle your final answer with proper units. Remember that the first step to any stoichiometry problem is to make sure your equation is balanced!
12. How many atoms are present in 3.14 g of copper?
13. How many moles of cobalt atoms are there in $6.50 \times 10^{9}$ cobalt atoms?
14. How many moles of oxygen are necessary to react completely with 4 mol of propane $\left(\mathrm{C}_{3} \mathrm{H}_{8}\right)$ ?

$$
\mathrm{C}_{3} \mathrm{H}_{8}+\mathrm{O}_{2} \rightarrow \mathrm{CO}_{2}+\mathrm{H}_{2} \mathrm{O}
$$

15. The fermentation of glucose, $\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}$, produces ethyl alcohol, $\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{OH}$, and carbon dioxide as shown here:

$$
\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6} \rightarrow 2 \mathrm{C}_{2} \mathrm{H}_{5} \mathrm{OH}+2 \mathrm{CO}_{2}
$$

a. How many moles of $\mathrm{CO}_{2}$ are produced when 0.300 mol of $\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}$ fully reacts?
b. How many grams of glucose are needed to form 2.00 g of ethyl alcohol?
c. How many molecules of $\mathrm{CO}_{2}$ form when 2.00 g of $\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{OH}$ are produced?
16. Nitrogen gas and hydrogen gas react to produce ammonia $\left(\mathrm{NH}_{3}\right)$.
a. What volume of hydrogen gas is necessary to react completely with 5.0 L of nitrogen gas to produce ammonia at STP?
b. What volume of ammonia is produced in this reaction?
17. The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate and citric acid $\left(\mathrm{H}_{3} \mathrm{C}_{6} \mathrm{H}_{5} \mathrm{O}_{7}\right)$

$$
3 \mathrm{NaHCO}_{3}+\mathrm{H}_{3} \mathrm{C}_{6} \mathrm{H}_{5} \mathrm{O}_{7} \rightarrow 3 \mathrm{CO}_{2}+3 \mathrm{H}_{2} \mathrm{O}+\mathrm{Na}_{3} \mathrm{C}_{6} \mathrm{H}_{5} \mathrm{O}_{7}
$$

In an experiment, 2.50 g of sodium bicarbonate and 5.00 g of citric acid are allowed to react.
a. Which reactant is the limiting reagent? You must show work to support your answer.
b. How many grams of carbon dioxide are formed? What is the volume of this gas (in liters) if we assume STP?
c. How much of the limiting reagent is left when the reaction is complete?
d. How much of the excess reagent is left after the reaction is complete?
18. Calculate the percent yield for the reaction below if 75.0 g of phosphorus reacts with excess chlorine gas and produce 111.0 g of phosphorus trichloride during the lab.

$$
\mathrm{P}_{4}+6 \mathrm{Cl}_{2} \rightarrow 4 \mathrm{PCl}_{3}
$$

19. Calculate the molarity of each of the following solutions:
a. 29.0 g of ethanol $\left(\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{OH}\right)$ in 545 mL of solution
b. 15.4 g of sucrose $\left(\mathrm{C}_{12} \mathrm{H}_{22} \mathrm{O}_{11}\right)$ in 74.0 mL of solution
20. Predict the outcomes of the single replacement reactions below by using the activity series. Then balance the equations. Use NR for no reaction.
a. $\mathrm{Cu}+\mathrm{HCl} \rightarrow$
b. $\mathrm{I}_{2}+\mathrm{NaBr} \rightarrow$
c. $\mathrm{Mg}+\mathrm{CuSO}_{4} \rightarrow$
d. $\mathrm{Cl}_{2}+\mathrm{KBr} \rightarrow$
e. $\mathrm{K}+\mathrm{Mg}\left(\mathrm{NO}_{3}\right)_{2} \rightarrow$
21. Characterize the following compounds as soluble or insoluble in water:
a. $\mathrm{Ca}_{3}\left(\mathrm{PO}_{4}\right)_{2}$
b. $\mathrm{Mn}(\mathrm{OH})_{2}$
c. $\mathrm{AgClO}_{3}$
d. $\mathrm{K}_{2} \mathrm{~S}$
e. $\mathrm{CaCO}_{3}$
f. $\mathrm{ZnSO}_{4}$
g. $\mathrm{Hg}\left(\mathrm{NO}_{3}\right)_{2}$
h. $\mathrm{HgSO}_{4}$
i. $\mathrm{NH}_{4} \mathrm{ClO}_{4}$
