<u>AP CHEMISTRY SUMMER ASSIGNMENT</u>

This AP Chemistry course is designed to be the equivalent of the general chemistry course usually taken during the first year of college. For most students, the course enables them to undertake, as a freshman, second year work in the chemistry sequence at their institution or to register in courses in other fields where general chemistry is a prerequisite.

The following assignment includes material from Chapter 1 and parts of Chapter 2 in the textbook and encompasses basic skills and concepts such as the classification of matter, units of measurement, significant figures, and dimensional analysis, as well as an introduction to the Periodic Table. You are responsible for understanding this information. This summer assignment also contains 25 numbered questions that you should answer on separate pieces of paper. While the majority of your responses should come from information outlined within this document, you may also utilize the internet or other sources as needed. The questions themselves are red and italicized, while the point value assigned to each question is bold and in parentheses after the question. The summer assignment will be graded as a 50 point assignment at the beginning of the school year. In August, the remainder of Chapter 2 will be discussed before testing on Chapters 1 and 2 shortly after. One of the first topics will be nomenclature, which entails writing chemical formulas when given the name and naming compounds when given the formula. In addition to completing the written assignment, you should *memorize the list of common polyatomic ions* from name to formula/charge and vice versa. You can *ignore the accompanying list of transition metal charges* for now.

As mentioned before, this is a college level course so I hope you are prepared to work hard. Sophomores without the experience of a first year of high school chemistry, and students who studied it at the Advanced level, will need to work even harder. There is simply not enough time in the year to cover each and every detail you will ultimately be held accountable for on the AP Exam, so homework will consist of independent reading as well as practice problems. This course has the potential to be a very valuable part of your high school learning experience in terms of developing exceptional study habits and organizational skills, as well as mastering the content.

I look forward to meeting you all and having a great year. If you need to contact me during the summer, you can email me at gracz@wmrhsd.org. Please attempt to solve all problems independently first and resort to messaging me only after exhausting all other options. Good luck!

-Mr. Racz

CLASSIFICATION OF MATTER

Chemistry is the study of matter. Everything is made of matter, so chemistry is the study of everything. Matter is classified in the following manner:

- **Pure substances** have distinct properties and composition that does not vary
  - **Elements** are made of one type of atom (nitrogen, gold)
  - **Compounds** are two or more atoms chemically combined (salt, water)

- **Mixtures** are combinations of two or more substances that retain their own properties
  - **Homogeneous mixtures** or **solutions** are uniform throughout (salt water, air)
  - **Heterogeneous mixtures** have variable composition (sand, trail mix)

Mixtures can be separated into their components be taking advantage of differences in properties. Some common examples include **filtration**, **distillation**, and **chromatography**.

1. *Define the following six terms on a separate piece of paper and provide at least two examples of each: physical/chemical property, intensive/extensive property, physical/chemical change* **(6)**

The three states of matter (solid, liquid, gas) vary primarily in the speed of and distance between the particles. You should already know which phases have definite shape and/or volume.

UNITS OF MEASUREMENT

Scientific measurements are made using the metric system. The **SI units** (*Système International d'Unités*) were designated by international agreement in 1960 and consist of the following:

Physical Quantity	Name of Unit	Abbreviation
mass	kilogram	kg
length	meter	m
time	second	s or sec
temperature	Kelvin	K
amount of substance	mole	mol
electric current	ampere	A or amp
luminous intensity	candela	cd

Other units such as *volume* $(\text{length})^3$ and *speed* (length/time) are derived from SI units. **Derived units** such as *density* (mass/volume) and *molar mass* (mass/amount) are often used to relate different types of physical quantities. You'll see much more of this later.

2. *What is the mass of 15.0 mL of a substance if its density at a given temperature is 5.5 g/mL?* **(1)**
3. *How many moles are in 50.5 g of a sample if its molar mass is 16.00 g/mol?* **(1)**

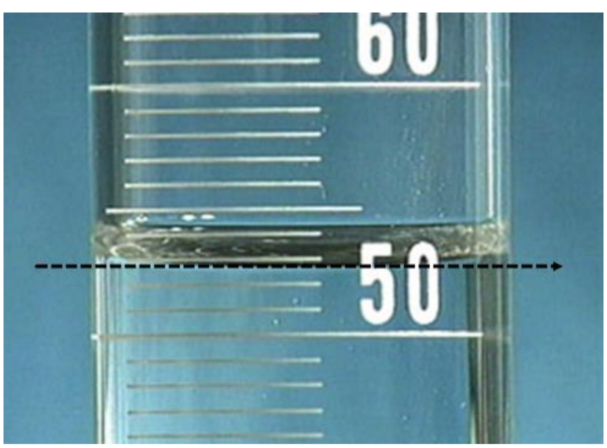
Metric prefixes are based on factors of ten and are decimal fractions or multiples of various units. While some are more common than others, you should memorize the following:

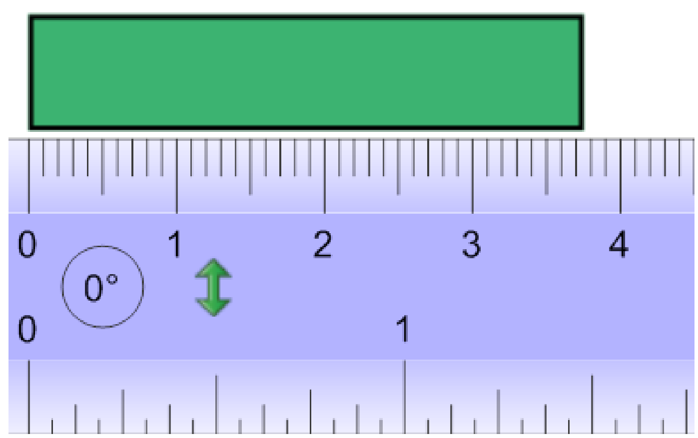
Prefix	**Abbreviation**	**Meaning**
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	k	10^{3}
Deci	d	10^{-1}
Centi	c	10^{-2}
Milli	m	10^{-3}
Micro	µ	10^{-6}
Nano	n	10^{-9}
Pico	p	10^{-12}
Femto	f	10^{-15}

4. *How many meters are in 3.35 x 10^{4} micrometers?* **(1)**
5. *How many milligrams are in 4.10 x 10^{-5} kilograms?* **(1)**
6. *How many terabytes are in 5.75 x 10^{2} gigabytes?* **(1)**

UNCERTAINTY IN MEASUREMENT

Measured quantities always have some degree of **uncertainty** due to inherent limitations of the instrument (equipment errors) and interpretations of measurements (human errors). All measured quantities should be reported with all certain values plus one that is estimated.





7. *What should be the reported volume (in mL) of water in the first image?* **(1)**
8. *What is the approximate length (in cm) of the rectangle in the second image?* **(1)**

SIGNIFICANT FIGURES

All digits in measured quantities, including the one that is estimated, are called **significant figures**. To determine the number of significant figures in a measurement, read from left to right and start counting with the first digit that is not zero.

- **Zeroes between nonzero numbers are always significant**
  1005 has 4 significant figures
  7.03 cm has 3 significant figures

- **Zeroes at the beginning of a number are never significant**
  0.02 g has 1 significant figure
  0.026 g has 2 significant figures

- **Zeroes at the end of a number are significant only with a decimal point**
  3500 cm has 2 significant figures
  0.0200 g has 3 significant figures

Quantities that are exact or countable (like 12 eggs in a dozen) have an infinite number of significant figures. A greater number of significant figures implies greater certainty for a measurement.

9. *Determine the number of significant figures present in the following measured quantities: 100.50 g, 0.012 m, 8 students, 0.1450 mol, 2500 s, 54.0 mL* **(6)**

When performing calculations using measured quantities, the least certain measurement limits the certainty of the calculated quantity and determines the number of significant figures in the answer.

- **For addition and subtraction, the result has the same number of decimal places as the measurement with the fewest decimal places.**
  20.42 mL + 1.322 mL + 83.1 mL = 104.842 mL ≈ 104.8 mL (tenths place)

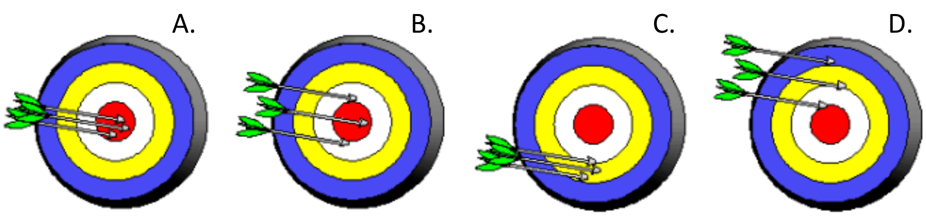
- **For multiplication and division, the result contains the same number of significant figures as the measurement with the fewest number of significant figures**
  6.221 x 5.2 cm = 32.3492 cm^2 ≈ 32 cm^2 (two significant figures)

10. *What is the density of a 68.55 g sample that occupies a volume of 20.2 mL?* **(2)**
11. *What is the collective mass of samples that measure 5.075 g, 12.010 g, and 8.2 g?* **(2)**
12. *Solve the following using rules of significant figures: (3.4 + 4.002 – 1.10) x 2.10* **(2)**

ACCURACY AND PRECISION

While the terms accuracy and precision may be used interchangeably in some instances, they are not synonymous in scientific context.

- **Accuracy** is the closeness of a measurement to an accepted value (on target).
- **Precision** is the closeness of a set of measurements to one another (consistent).



13. *Describe each of the above images in terms of accuracy and precision.* **(4)**
14. *A student experimentally measures the boiling point of water to be 90.9°C, 91.2°C, and 90.7°C. Are these measurements accurate, precise, neither or both?* **(1)**

DIMENSIONAL ANALYSIS

Measurements are made in a wide variety of units and it is often necessary to convert the originally measured unit into another. How many seconds pass in 3.05 years? How many inches are in 2.7 miles? More likely in chemistry, perhaps a measurement was made in grams but we need to know how many molecules are contained in the sample, or what volume it occupies.

The first thing we need is the equivalent relationship between two units, or **conversion factor**. We might not know how many seconds are in a year, but we do know the number of days in a year, hours in a day, minutes in an hour, and seconds in a minute. By multiplying and dividing by two equivalent values, the value of the original measurement is not changed (essentially multiplying by 1).

$$3.05\ \cancel{\text{years}} \times \frac{(365\ \cancel{\text{days}})}{(1\ \cancel{\text{year}})} \times \frac{(24\ \cancel{\text{hours}})}{(1\ \cancel{\text{day}})} \times \frac{(60\ \cancel{\text{min}})}{(1\ \cancel{\text{hour}})} \times \frac{(60\ \text{sec})}{(1\ \cancel{\text{min}})} = 9.62 \times 10^{7}\ \text{sec}$$

The converted measurement has the same number of significant figures as the original measurement because we did not gain or lose any confidence in that measurement through multiplying and dividing by exact equivalencies. The units "diagonally down" should always match, because dividing by this original (or intermediate) unit causes them to "cancel out" and leave us with the desired unit.

You probably expected the number of seconds in a year to be pretty large. If you have an idea of how big or small your answer should be, or at least if it should be larger or smaller than what you started with, you can catch certain mistakes. Until you have more experience with the common units utilized in chemistry estimation may be difficult, but the process is the same.

How many atoms would be contained in 0.6502 m^3 of gold, assuming the density of gold is 19.32 g/cm^3?

$$0.6502\ \cancel{m^3} \times \frac{(1\ \cancel{cm})^3}{(10^{-2}\ \cancel{m})^3} \times \frac{(19.32\ \cancel{g})}{(1\ \cancel{cm^3})} \times \frac{(1\ \cancel{mole})}{(196.97\ \cancel{g})} \times \frac{(6.022 \times 10^{23}\ \text{atoms})}{(1\ \cancel{mole})} = 3.841 \times 10^{28}\ \text{atoms}$$

Just like before, the answer has the same number of significant figures (4) as the original measurement. Cubic meters are a large unit of measurement and atoms are incredibly small so I expected there to be a lot of them, but where did these conversion factors come from? The first step was to use one of the metric prefixes included earlier in this packet. Note that just because 1 cm is equal to 10^{-2} m, this does not mean that 1 cm^3 is equal to 10^{-2} m^3. If you cube the unit you must also cube the conversion factor, so 1 cm^3 is actually equal to 10^{-6} m^3. Density was given in the problem and varies from element to element and with temperature, but **the mass of one mole (molar mass) comes from the Periodic Table** and **the number of "things" in one mole is always 6.022 x 10^{23} (Avogadro's number)**. You will be using these conversion factors often since moles are not directly measurable, but are an essential unit for comparison as they tell us how many of something we are dealing with. Since all atoms are different weights and sizes, mass and volume alone are not useful for most comparisons.

Print out a Periodic Table: http://www.cde.ca.gov/ta/tg/sr/documents/chemtoe.pdf

15. *Calculate the number of moles in 255 mg of NaCl.* **(2)**
16. *How many atoms are contained in 2.5 L of Ne gas at STP?* **(2)**
17. *Determine the mass in micrograms of 8.55 x 10^{25} molecules of SO_3 gas.* **(2)**
18. *Determine the number of atoms in a 3.45 kg sample of Cu.* **(2)**
19. *Assuming STP, how many mL of volume are occupied by 450 cg of CO_2 gas?* **(2)**
20. *How many liters are occupied by 1.4 moles of H_2O, assuming the density is 1.0 g/mL?* **(2)**

NOTES: One mole of any gas at Standard Temperature and Pressure (STP) occupies a volume of 22.4 L. If you are dealing with a compound such as water (H_2O) you must add the molar masses of the individual atoms to determine the molar mass of the compound: (2 x 1.01) + 16.00 = 18.02 g/mol

THE PERIODIC TABLE OF ELEMENTS

The periodic table is divided into rows (**periods**) and columns (**groups**). The row indicates how many energy levels the atom has and the column indicates how many electrons occupy the outermost shell. Elements in the same group or family exhibit many of the same physical and chemical properties.

The molar mass on the Periodic Table is a weighted average of all naturally occurring isotopes of that element. You will never find a single atom of copper with a mass of 63.55 atomic mass units. Copper can have a mass of 63 amu (29 protons + 34 neutrons) or 65 amu (29 protons + 36 neutrons). The average atomic weight indicates there is a higher percentage of ^{63}Cu than ^{65}Cu.

The atomic mass unit is presently defined by assigning a mass of exactly 12 amu to an atom of the ^{12}C isotope of carbon. An atomic mass unit is equal to approximately 1.66 x 10^{-24} g. Protons and neutrons are roughly the same size (about 1 amu) while the mass of electrons is considered negligible.

Raczium hasn't been discovered yet, but suppose it has an atomic number of 125.

Isotope	Protons	Neutrons	Electrons	Abundance
Raczium-237	125	112	125	29.5%
Raczium-238	125	113	125	12.5%
Raczium-240	125	115	125	58.0%

To find Raczium's atomic weight: (237 x 0.295) + (238 x 0.125) + (240 x 0.580) = 238.87 g/mol

21. *How many of each subatomic particle is present in an atom of Nickel-59?* **(1)**
22. *How many of each subatomic particle is present in an atom of ^{119}Sn?* **(1)**
23. *Propose a scenario in which Manganese-55 is not be the most common isotope of this element, despite the fact that manganese has an atomic mass very close to this value?* **(1)**
24. *Calculate the atomic weight of chlorine assuming 75.78% is ^{35}Cl and 24.22% is ^{37}Cl.* **(1)**
25. *Label your Periodic Table with the following terms: Alkali Metals and Alkaline Earth Metals, Chalcogens and Halogens, Noble Gases, Lanthanide Series and Actinide Series* **(4)**