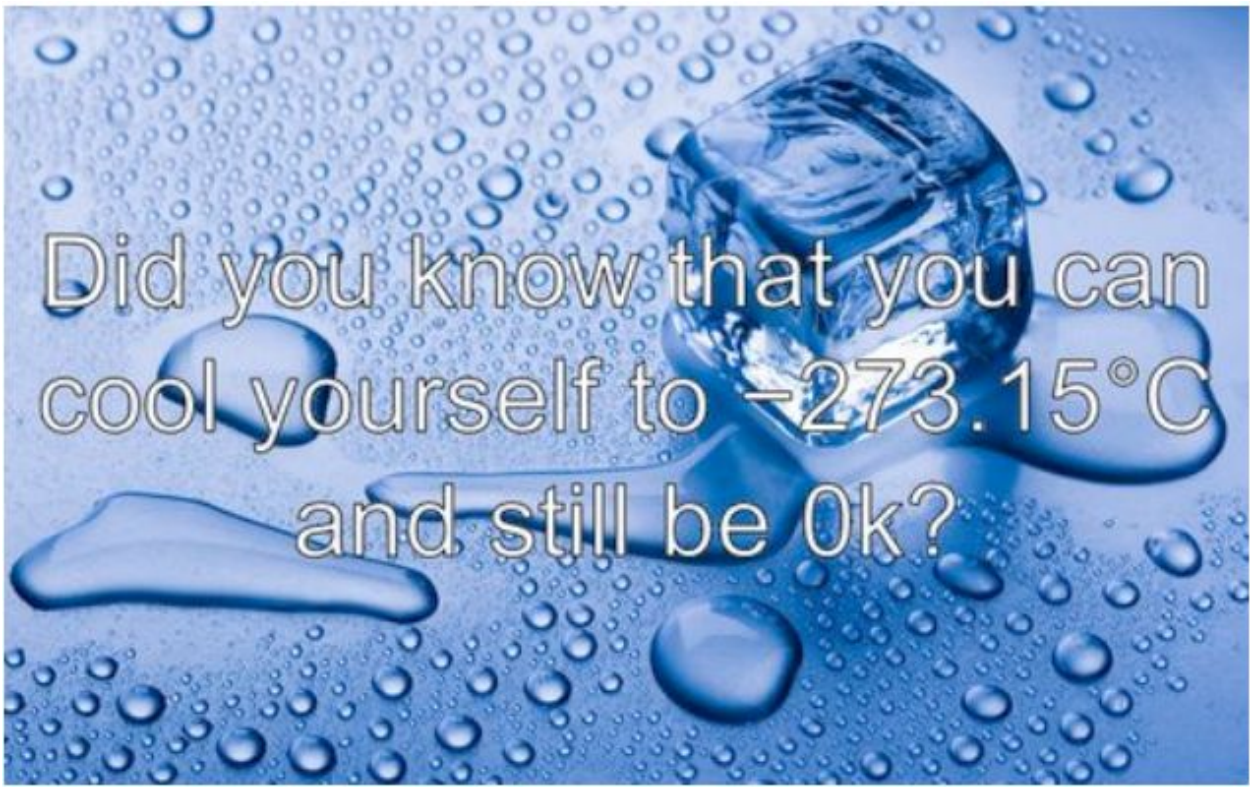
AP Chemistry
Summer Assignment



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Required: **don't forget any polyatomic ions. You can find a list here.**

The following problems are **optional**. We will not be spending much class time on these subjects, but they will be tested both on chapter tests and the AP exam. Doing these problems will not only keep you in shape, but will give you a sense of where your weaknesses lie so you can get the assistance you need.

Please feel free to work in groups, remembering that in the end, only your own knowledge of Chemistry will produce the results you want on the AP test.

Caveat: I don't know the details of what most of you were taught last year. If you don't know something, please briefly look it up and come to class with questions. **Don't fret**.

1. **Measurement**

A. Explain how a volume measurement is made when measuring water in a graduated cylinder.

B. Identify the best piece of lab equipment and process that would be used to measure the following:

1. Mass of a solid precipitate obtained through filtration
2. Create 500ml of a 1M HCl solution from 2M stock

2. **Significant Figures**

A. Round off the following quantities to the indicated number of significant figures.

1. 7.4855 grams (3 significant figures)
2. 298.693 cm (5 significant figures)
3. 11.968 lbs. (1 significant figure)
4. 344.9 oz. (2 significant figures)

B. Calculate the following to the correct number of significant figures.

1. X = 128.5 + 2116.44 – 2244.47
2. X = 0.004010 X 2.0000 X 50054

3. **Dimensional Analysis**

A. A metal slug weighing 25.17 grams is added to a flask with a volume of 59.7mL. It is found that 43.7 grams of methanol (density = 0.791 g/mL) must be added to the metal to fill the flask. What is the density of the metal?

B. A solid with an irregular shape and a mass of 11.33 grams is added to a graduated cylinder filled with water (density = 1.00 g/mL) to the 35.0mL mark. After the solid sinks to the bottom, the water level is read to be at the 42.3mL mark. What is the density of the solid?

C. Air is 21% oxygen by volume. Oxygen has a density of 1.31 g/L. What is the volume, in liters, of a room that holds enough air to contain 55 kilograms of oxygen?

4. **Periodic Table & Atom: Protons, Neutrons, Electrons**

A. Who discovered the electron? Describe the experiment that led to the deduction that electrons are negatively charged.

B. Selenium is widely sold as a dietary supplement. It is advertised to “protect” women from breast cancer. Write the nuclear symbol for naturally occurring selenium. It has 34 protons and 46 neutrons.

C. Complete the following table using the periodic table if necessary.

Nuclear Symbol	Charge	Number of Protons	Number of Neutrons	Number of Electrons
$^{79}_{35}Br$	0			
	-3	7	7	
	+5	33	42	
$^{90}_{40}Zr^{4+}$				

D. Strontium has four isotopes with the following masses: 83.9134 (0.56%), 85.9094 (9.86%), 86.9089 (7.00%), and 87.9056 (82.58%). Calculate the average atomic mass of strontium.

E. Define an isotope. What is the same and what is different between isotopes of the same element?

F. Complete the table below.

Element	Electron Configuration
Mg	
	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^3$
Br	
	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^1$

G. Complete the table below.

Element	Noble Gas Electron Configuration
Ti	
Ca^{2+}	
S^{2-}	
Sn	

H. Define ionization energy. Arrange the following elements in order based on increasing first ionization energy: Na, Mg, K

I. Define atomic radius. Arrange the following elements in order based on decreasing atomic radii: Cl, S, Ca

J. Define electronegativity. Arrange the following elements in order based on increasing electronegativity: Be, Mg, Ca.

5. **<u>Nomenclature</u>**

A. Complete the table below

Name	Formula
	ICl_3
	N_2O_5
	PH_3
	$HClO_4$
	HNO_3
	HCl
	$K_2Cr_2O_7$
	$Fe_2(SO_3)_3$
	NaClO
	SnO_2

B. Complete the table below.

Name	Formula
Iron (III) carbonate	
Sulfur hexafluoride	
Silicon dioxide	

Hypochlorous acid	
Oxalic acid	
Carbon monoxide	
Sulfur trioxide	
Copper (II) sulfate	
Barium oxide	
Titanium (IV) oxide	

C. Explain why each of the following statements is incorrect.

1. In an ionic compound the number of cations is always equal to the number of anions.
2. The molecular formula for strontium bromide is $SrBr_2$.
3. The mass number is always equal to the atomic number.
4. For any ion, the number of electrons is always more than the number of protons.

6. **<u>Molar Mass</u>**

A. Calculate the molar mass of the following:

1. cane sugar, $C_{12}H_{22}O_{11}$
2. laughing gas, N_2O
3. vitamin A, $C_{20}H_{30}O$

B. Complete the following table for TNT, $C_7H_5(NO_2)_3$.

Number of Grams	Number of Moles	Number of Molecules	Number of N Atoms
127.2			
	1.248		
		4.32×10^{22}	
			5.55×10^{19}

7. **Percent Composition**

A. Turquoise has the following chemical formula: $CuAl_6(PO_4)_4(OH)_8*4H_2O$. Calculate the mass percent of each metal in turquoise. (Hint: if $*4H_2O$ is unfamiliar to you, look up "hydrates". The mass of 4 moles of water will be **added** to the molar mass of the rest of the compound)

B. A tablet of Tylenol has a mass of 0.611 grams. It contains 251mg of its active ingredient, acetaminophen, $C_8H_9NO_2$.

1. What is the mass percent of acetaminophen in a tablet of Tylenol?
2. Assume that all the nitrogen in the tablet is in the acetaminophen. How many grams of nitrogen are present in a tablet of Tylenol?

8. **Empirical & Molecular Formulas**

A. Determine the empirical formula of the following compounds:

1. the food enhancer MSG which has the composition 35.51%C, 4.77% H, 37.85% O, 8.29% N, and 13.6% Na.
2. Zircon, a diamond like mineral, which has the composition 34.91% O, 15.32% Si, and 49.76%Zr.

B. Determine the molecular formula of the following compounds:

1.Nicotine which has the composition 74.0% C, 8.65% H, and 17.4% N and a molar mass of 162.23 g/mol.

2. A compound containing 40.0 percent carbon, 5.7 percent hydrogen and 53.3 percent oxygen has a molar mass of 175 g/mol. What is the molecular formula?

9. **Balancing Equations**

A. Balance the following equations:

1. $H_2S + SO_2 \rightarrow S + H_2O$
2. $CH_4 + NH_3 + O_2 \rightarrow HCN + H_2O$
3. $Fe_2O_3 + H_2 \rightarrow Fe + H_2O$

10. **Stoichiometry**

A. Diborane, B_2H_6, can be prepared by the following reaction:

$$3NaBH_4 + 4BF_3 \rightarrow 2B_2H_6 + 3NaBF_4$$

1. How many moles of $NaBH_4$ react with 1.299 moles of BF_3?
2. How many grams of B_2H_6 can be obtained from 0.893 moles of $NaBH_4$?
3. If 1.987 grams of B_2H_6 is obtained, how many grams of $NaBF_4$ are produced?

11. **Limiting Reagents & Theoretical Yield**

A. The space shuttle used aluminum metal and ammonium perchlorate in its reusable booster rockets. The products of the reaction are aluminum oxide, aluminum chloride, nitrogen monoxide gas, and steam. The reaction mixture of a test sample contains 7.00 grams of aluminum and 9.32 grams of ammonium perchlorate.

1. Write the balanced equation for the reaction.
2. What is the theoretical yield of aluminum oxide?
3. If 1.56 grams of aluminum oxide is formed, what is the percent yield?
4. How many grams of excess reactant remain?

B. Oxyacetylene torches used for welding reach temperatures near 2000°C. The reaction involved in the combustion of acetylene is

$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

1. Starting with 175 grams of both acetylene and oxygen, what is the theoretical yield, in grams, of carbon dioxide?
2. If 68.5L (density = 1.85 g/L) of carbon dioxide is produced, what is the percent yield at the same conditions of temperature and pressure?

C. If 45ml of a 1.50M $AgNO_3$ solution is added to 25.0grams of NaCl, how many grams of AgCl can be produced?

D. How many liters of a 3.0M phosphoric acid solution are required to react with 4.50 grams of zinc metal?

E. How many grams of aluminum metal are required to react with 35ml of 2.0M hydrochloric acid?

F. Determine the percent yield for the reaction in which 15.8 grams of NH_3 and excess oxygen gas produce 21.8grams of NO gas at STP and some water.

12. **Molarity**

A. A reagent bottle is labeled 0.450M K_2CO_3.

1. How many moles of K_2CO_3 are present in 45.6mL of this solution
2. How many milliliters of this solution are required to furnish 0.800 moles of K_2CO_3?
3. If 50.0mL of this solution is added to enough water to make 125mL of solution, what is the molarity of the diluted solution?
4. Explain how to produce 250.00 ml of 3.50 M potassium permanganate solution using solid potassium permanganate, distilled water and a 250 ml volumetric flask.

13. **Gas Laws**

A. A 22.50 gram piece of dry ice, CO_2, sublimes at a pressure of 0.40 MPa and a temperature of 205 K.

1. What is the volume of the gas under those conditions?

2. What will be the volume of the gas if it is then brought to room temperature, roughly 18.5°C and 1.18 atm?

B. Use the ideal gas law to complete the following table, for CO_2

Pressure	Volume	Temperature	Moles	Grams
	1.75L	19°C	1.66	
433mmHg	92.4mL		0.395	
1.1atm	8.66L	25°C		

14. **Light (speed, frequency, wavelength, energy)**

A. A photon of violet light has a wavelength of 423nm. Calculate
   1. the frequency
   2. the energy in joules per photon
   3. the energy in kilojoules per mole

B. Describe the relationship between wavelength and frequency.

C. Describe the relationship between energy and frequency.

D. Identify the color of light in the visible spectrum that has the highest energy.

E. Identify the color of light in the visible spectrum that has the longest wavelength.

15. **Lewis Dot Structures**

A. Complete the table below:

Formula	**Lewis Dot Structure**	**Geometry Name**	**Bond Angles**
CCl_4			
NCl_3			

N_2O			
CO_3^{2-}			

Formula	Polar Bonds (Y/N)	Polar molecule (Y/N)	Hybridization	Number of sigma / pi bonds	Type(s) of IMF
CCl_4					
NCl_3					
CO_2					

16. **<u>Acids and Bases</u>**
    A. Find the pH of solutions with H^+ ion concentrations of:
        1. 6.0M
        2. 4.6×10^{-8}M

3. 7.2×10^{-14}M

B Write the dissociation equation for each of the following:

1. Hydrocyanic acid
2. Phosphoric Acid
3. Hydrofluoric acid
4. Sulfuric acid

17. **Oxidation and Reduction**

A. If a redox reaction is occurring, tell which substance is being oxidized, which is being reduced and write balanced half-reactions for both.

1. $Na + CuCl_2 \rightarrow NaCl + Cu$
2. $Na + O_2 \rightarrow Na_2O$
3. $Al_2O_3 \rightarrow Al + O_2$
4. $Cu(NO_3)_2 + K_2SO_4 \rightarrow CuSO_4 + KNO_3$

ASSORTED VOCABULARY:

Absorbance: Light that does not pass through a solution A = abc
Activation Energy: Minimum energy needs to be added to a system in order for the chemical reaction to occur
Anion: Negatively charge ion
Arrhenius Acid: Donates a H^+ ion
Arrhenius Base: Donates a OH^- ion
Atom: Smallest constituent unit of ordinary matter that has the properties of a chemical element
Atomic Mass: Average of all naturally occurring isotopes
Atomic Number: Number of protons; defines the atom
Boiling: Phase change from a liquid to a gas
Bronsted-Lowry Acid: Donates a proton, H^+
Bronsted-Lowry Base: Accepts a proton, H^+
Calorimetry: Means of measuring the heat gained/ lost by a system during a chemical reaction
Catalyst: Lowers the activation energy. Not a reactant. Not a product
Cation: Positively charged ion
Chemical Equilibrium: Rate of the forward reaction equals the rate of the reverse reaction
Condensation: Phase change from a gas to a liquid
Conversion Factor: Allows for the conversion from one unit of measure to another
Covalent Bond: Bond formed by the sharing of electrons between atoms.
Deposition: Phase change from a gas to a solid
Dipole-Dipole: Permanent IMF present in polar molecules
Direct Relationship: Relationship between two variables where when one changes, the other changes in the same manner
Dissociate: To break into ions

Dissolve: To break into smaller pieces
Distillation: Process of separating liquids based on differences in boiling temperatures
Double Bond: Two shared pairs of electrons
Electrolyte: Dissociates into charge particles which are capable of conducting electricity
Electrolytic Cell: Redox reaction that is spontaneous
Electron Affinity: Energy released when an atom gains an electron
Electron: Negatively charged particle. Charge = -1, Mass ~0amu. Located in the orbitals surrounding the nucleus
Electronegativity: The ability of an atom to attract electrons from another atom
Empirical Formula: Lowest whole number ratio of atoms in a compound
Endothermic: Energy is gained by the system
Evaporation: Process of removing water from an aqueous solution. Solute is left behind
Exothermic: Energy is released by the system
Filtrate: Liquid that passes through the filter paper
Filtration: Process of separating a precipitate from its aqueous solution
Formula Unit: Ionically bonded atoms
Freezing: Phase change from a liquid to a solid
Galvanic / Voltaic Cell: Redox reaction that is spontaneous
Halogen: Elements in group 17. Form halides as ions
Hydrogen Bonding: Strong dipole that results when H is bonded to F, O, or N
Indirect relationship: Relationship between two variables where when one changes, the other changes in the opposite manner
Insoluble: Does not dissolve in water
Intermediate: Species produced in one step and consumed in another step
Intermolecular Forces, IMF: Attractive forces between molecules
Ion: Charge particle
Ionic Bond: Bond formed by the transfer of 1 or more electrons from the least electronegative atom to the more electronegative atom
Ionization Energy: Energy required to remove the outer electron
Kinetic Energy: Energy of motion, temperature is a measure of KE
Limiting Reactant: Reactant to runs out first thus limiting the amount of product that can be formed
London Dispersion Forces: Temporary IMF caused by the movement of electrons
Lone Pair: Unbonded electrons
Mass Number: Mass of all protons and neutrons
Melting: Phase change from a solid to a liquid
Molar Mass: grams per 1 mol
Molarity: moles of solute per liter of solution
Molecular Formula: actual number of moles of each atom in a compound
Molecule: Covalently bonded atoms
Neutron: Neutral particle. No charge. Mass = 1amu, Located in the nucleus
Noble Gas: Group 18 on the PT. Each has 8 valence electrons. Nonreactive
Orbital: Regions of probability where electrons are located. Each orbital can contain up to 2 electrons
Oxidation Number: A charge assigned to an atom that represents that charge it would have if it contained and ionic bond. Oxidation numbers are written as charge value, +4, -6, +2
Oxidation: Process of losing electrons which increases the oxidation number
Percent Error: Absolute value ((Theoretical – Experimental) / Theoretical) x 100%
Percent Yield: (Quantity produced / Theoretical Amount) x 100%
Precipitate: Solid matter that forms from the reaction of two aqueous solutions

Proton: Positively charged particle. Charge = +1, Mass = 1amu, Located in the nucleus
Reduction: Process of gaining electrons which reduces the oxidation number
Significant Figures: Those digits that carry meaning contributing to its precision
Single Bond: One shared pair of electrons
Soluble: Dissolves in water
Solute: The species that gets dissolved to form a solution
Solution: Solute and solvent
Solvent: The species that does the dissolving to form a solution
Sources of Error: These are factors in the lab which result in either increased or decreased yields. These do NOT include human error, calculation errors, incorrect massing…..
Specific Heat: Energy required to raise 1 gram of a substance 1C
Strong Acid: Dissociates 100%
Strong Base: Dissociates 100%
Sublevel: s, p, d, and f. defines the shape
Sublimation: Phase change from a solid to a gas
Surroundings: This refers to everything outside of the system
System: This refers to the reaction
Transmittance: Light that passes through a solution
Triple Bond: Three shared pairs of electrons
Valence electrons: Outer electrons which are available for bonding
Weak Acid: Dissociate very little. Remains mostly in its molecular form
Weak Base: Dissociates very little. Remains mostly in its molecular form