Advanced Placement Chemistry: Summer Assignment 2020-2021

Name: _____

Directions: Having completed a first course in chemistry, and having elected to take Advanced Placement Chemistry in the fall, you are asked to be responsible for many of the topics presented in the first course. In order to enhance the presentation of new concepts, you are asked to review the following topics over the summer and to complete the questions from this packet. **You must show all of your work. Answers for select calculations are attached so you can check yourself.** Completion of this packet does not guarantee success in the course, but it is **required** that each student complete the packet. **To assess your understanding of these topics one or more short quizzes may be administered at the start of the course. Students should be prepared to quiz on the first day.**

Topic 1: Metric Conversions, Significant Figures and Density

Assignment 1: Perform the following calculations and conversions, and record all answers to the appropriate number of significant figures.

1. Perform the following conversions:

(a) 454 mg to g

(b) 5.0×10^{-8} m to nm

(c) 0.076 ml to L

(d) 1.55 kg/m^3 to g/L.

2. (a) A sample of chloroform, a liquid once used as an anesthetic, has a mass of 37.25 g and a volume of 25.0 mL. What is the density?

(b) The density of magnesium is 1.74 g/cm^3. What is the volume of 175 g of this metal?

3. Round off each of the following numbers to four significant figures.

(a) 12,345,670

(b) 2.35500

(c) 456,500

(d) 3.126×10^3

(e) 0.000657030

4. Carry out the following operations and express the answer with the appropriate number of significant figures.

(a) 1.23056 + 67.809

(b) 23.67 – 500

(c) 890.05 x 12.3

(d) 88,123/22.500

(e) 324.55 – (6104.5/22.3)

Topic 2: Formula Writing and Nomenclature

Assignment 2: Memorize the Formula, charges and names of the following common ions.

Positive Ions (cations)		Negative Ions (anions)	
+1	**+2**	**-1**	**-2**
Ammonium (NH_4^+)	Barium (Ba^{2+})	Acetate ($C_2H_3O_2^-$)	Carbonate (CO_3^{2-})
Cesium (Cs^+)	Cadmium (Cd^{2+})	Bromide (Br^-)	Chromate (CrO_4^{2-})
Copper (I) or cuprous (Cu^+)	Chromium (II) or chromus (Cr^{2+})	Chlorate (ClO_3^-)	Dichromate ($Cr_2O_7^{2-}$)
Hydrogen (H^+)	Copper (II) or cupric (Cu^{2+})	Cyanide (CN^-)	Hydrogen Phosphate (HPO_4^{2-})
Lithium (Li^+)	Iron (II) or ferrous (Fe^{2+})	Dihydrogen phosphate ($H_2PO_4^-$)	Oxide (O^{2-})
Potassium (K^+)	Lead (II) or plumbous (Pb^{2+})	Fluoride (F^-)	Peroxide (O_2^{2-})
Silver (Ag^+)	Magnesium (Mg^{2+})	Hydride (H^-)	Sulfate (SO_4^{2-})
Sodium (Na^+)	Manganese (II) or manganous (Mn^{2+})	Hydrogen carbonate/bicarbonate (HCO_3^-)	Sulfide (S^{2-})
	Mercury (I) or mercurous (Hg_2^{2+})	Hydrogen sulfite/bisulfite (HSO_3^-)	Sulfite (SO_3^{2-})
	Mercury (II) or mercuric (Hg^{2+})	Hydroxide (OH^-)	
	Strontium (Sr^{2+})	Iodide (I^-)	
	Nickel (Ni^{2+})	Nitrate (NO_3^-)	
	Tin (II) or stannous (Sn^{2+})	Perchlorate (ClO_4^-)	
		Permanganate (MnO_4^-)	
		Thiocyanate (SCN^-)	
+3		**-3**	
Aluminum (Al^{3+})		Arsenate (AsO_4^{3-})	
Chromium (III) or chromic (Cr^{3+})		Phosphate (PO_4^{3-})	
Iron (III) or ferric (Fe^{3+})			

Assignment 3: Students are expected to be able to write formulas from names or names from formulas for ionic compounds and binary molecular compounds. Review the meaning of the Greek prefixes used in chemical nomenclature and their meanings. Review the rules for naming compounds. You should be able to write the names of ionic and molecular compounds from their chemical formulas. You should also be able to write the correct chemical formulas from their names

1) Name these ionic compounds:

$Ca(NO_3)_2$

SnO

$CuCr_2O_7$

$Al(CN)_3$

HCl (aq)

$(NH_4)_2SO_4$

$CrCO_3$

NiF_2

NaH, BaO_2

$Fe(OH)_3$

Ag_2CrO_4

$Cr_2(HPO_4)_3$

$KClO_4$

$Ba(SCN)_2$

2) Write the correct chemical formulas of these compounds:

cadmium bicarbonate

plumbous chloride

aluminum oxide

copper (I) cyanide

mercury (I) acetate

sodium hydrogen sulfite

chromium (III) sulfate

silver dichromate

cesium peroxide

magnesium chlorate

nickel (III) nitrate

manganese (II) hydroxide

cobaltous chloride

stannous dihydrogen phosphate

ammonium phosphate

3) Name these binary molecular compounds:

Cl_2O_7

N_2O_5

P_2O_5

$SbCl_3$

SF_6

CO_2

CO

N_2H_4

P_4O_{10}

4) Write the formulas of these binary molecular compounds:

nitrogen dioxide

sulfur trioxide

chlorine pentafluoride

bromine trifluoride

boron trifluoride

phosphorus pentachloride

Topic 3: Chemical Bonding

Assignment 4: The student is expected to be able to draw Lewis dot structures and structural formulas, identify bond/molecular polarity, draw molecular shapes using VSEPR, and identify resonance structures. Use outside resources and peers to check this assignment.

1. What is the Lewis symbol for each of the following atoms or ions:

(a) Br

(b) Mg

(c) Ca^{2+}

(d) F^{1-}

2. Draw the Lewis structures for

(a) PH_3

(b) BrO_3^{1-}

(b) CO

(c) $HClO_2$

(e) $SeCl_2$

3. Draw the resonance forms for the following:

(a) NO_2^{1-}

(b) CO_3^{2-}

(c) SCN^{1-}

4. Complete the following table according to VSEPR:

Formula	Lewis Dot Structure	Number of lone e⁻ pairs on central atom	Electron-domain geometry	Molecular geometry	Polar molecule? (yes or no)
PO_4^{-3}					
OF_2					
NCl_3					
NO_3^-					
H_2S					
PF_3					
NH_4^+					

Topic 4: Chemical Quantities / Stoichiometry

Assignment 5: The student is also expected to be able to use the mole concept in various contexts. The student should know Avogadro's Number, the molar volume of a gas measured at STP, and the meaning of the term STP. Solve the following problems and check your answers. You must be able to use units correctly in your solutions. Dimensional analysis is recommended for solving these types of problems.

1) Given 2.50 grams of $SO_{3(g)}$, determine:
   A) the number of moles present,

   B) the number of molecules present,

   C) the number of sulfur and oxygen atoms present,

   D) the volume occupied by the gas at STP,

   E) the density of the gas at STP.

2) Given 2.80×10^{22} molecules of carbon dioxide gas in a sample, determine:
   A) the number of moles of CO_2 present,

   B) the mass of the sample,

   C) the number of atoms of carbon and oxygen present,

   D) the volume of the carbon dioxide gas at STP,

   E) the density of the gas at STP.

3) Given a volume of 250. mL of fluorine gas measured at STP, determine:

A) the mass of the fluorine gas in the sample,

B) the number of molecules in the sample,

C) the number of fluorine atoms in the sample,

E) the density of the gas at STP.

Assignment 6: The student should be familiar with the definition of molarity as a unit of concentration of solutions. They should be able to work calculations involving molarity including titrations. Try these questions:

1) Find the molarity of a solution prepared by dissolving 4.52 g of Na_2SO_4 in enough water to prepare 350 mL of solution.

2) Determine the mass of lead (II) nitrate present in 200. mL of 0.50 *M* $Pb(NO_3)_{2(aq)}$.

3) What volume of 0.25 *M* $Ba(OH)_2$ contains 15.0 g of the solute?

4) Calculate the molarity of a solution made by dissolving 0.0834 mol Na_2SO_4 in enough water to form 650.0 mL of solution.

a) What is the concentration of sodium ions in solution?

b) What is the concentration of sulfate ions in solution?

5) How many milliliters of 0.210 *M* HCl are needed to neutralize completely 35.0 mL of 0.101 *M* $Ba(OH)_2$ solution?

6) How many milliliters of 3.50 *M* H_2SO_4 are needed to neutralize 75.0 g of NaOH?

7) If 45.2 mL of $BaCl_2$ solution is needed to precipitate all of the sulfate in a 544-mg sample of Na_2SO_4 (forming $BaSO_4$), what is the molarity of the solution?

8) If 42.7 mL of 0.250 *M* HCl solution is needed to neutralize a solution of $Ca(OH)_2$, how many grams of $Ca(OH)_2$ must be present in the solution?

Topic 5: Chemical Reactions

Assignment 7: The student should understand basic chemical equations and stoichiometry. Complete the following questions:

1) Balance the following equations:

A) $C_2H_6O + O_2 \rightarrow CO_2 + H_2O$

B) $Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$

C) $Na_2CO_3 + C + N_2 \rightarrow NaCN + CO$

2) Find the mass of carbon dioxide that will form when 2.60 g of C_2H_6O is burned in excess oxygen gas in the reaction from 1 A above.

3) Find the mass of sulfuric acid, which would react, with 3.50 grams of aluminum hydroxide from the reaction in 1 B above.

4) Find the volume of carbon monoxide gas, which would form when 2.80 g of N_2 reacts in question number 1 C above.

5) Identify the limiting reagent and excess reagent when 5.0g of $Al(OH)_3$ is combined with 5.0 g of H_2SO_4 in reaction 2 A above. Determine the amount of excess reagent present at the end of the reaction in grams.

6) Assume that the reaction from number 1A has a percent yield of 95 %. What volume of carbon dioxide will form when 2.50 g of oxygen gas is consumed?

Assignment 8: Students should be able to use the Periodic Table to predict the expected chemical formulas of simple ionic compounds. They should be able to predict the products in some simple chemical reactions, such as combination, decomposition, single and double displacement, and combustion reactions. Complete and balance the following chemical reactions:

1) $Al_{(s)} + Cl_{2(g)} \rightarrow$

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

3) $Ag_2O_{(s)} \rightarrow$

4) $P_2O_{5(s)} \rightarrow$

5) $Zn_{(s)} + CuSO_{4(aq)} \rightarrow$

6) $Cl_{2(g)} + KI_{(aq)} \rightarrow$

7) $Al_{(s)} + Pb(NO_3)_{2(aq)} \rightarrow$

8) $NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow$

9) $AgNO_{3(aq)} + BaCl_{2(aq)} \rightarrow$

10) $C_3H_7OH_{(l)} + O_{2(g)} \rightarrow$

Assignment 9: Solubility Rules: The student should **memorize** these solubility rules.

AP Chemistry: Solubility Rules

The following solubility rules are guidelines for determining an ionic compound's **solubility**, or its *ability to dissolve in water*. Note that nothing is completely insoluble in water.

For each family of ions, the rule and the exception ions are given. *Note that **mercury (I), Hg^{+}**, always appears in compounds as **Hg_2^{2+}**. (Example: mercury (I) chloride is Hg_2Cl_2.)*

	Generally Water Soluble
H^+	All common inorganic **acids** and simple organic acids are soluble. The seven strong acids ($HClO_3$, $HClO_4$, H_2SO_4, HNO_3, HBr, HCl, and HI) are completely soluble in water and thus exist solely as ions in solution.
Li^+, Na^+, K^+, Rb^+, Cs^+	All **alkali metal** (Group IA) cations are soluble.
NH_4^+	All **ammoniums** are soluble.
NO_3^-	All **nitrates** are soluble.
$C_2H_3O_2^-$ / CH_3COO^-	All **acetates** are soluble except Ag^+.
ClO_3^-	All **chlorates** are soluble.
Cl^-	All **chlorides** are soluble except Ag^+, Hg^+, and Pb^{2+}.
Br^-	All **bromides** are soluble except Ag^+, Hg^+, Hg^{2+}, and Pb^{2+}.
I^-	All **iodides** are soluble except Ag^+, Hg^+, Hg^{2+}, and Pb^{2+}.
SO_4^{2-}	All **sulfates** are soluble except Ag^+, Hg^+, Pb^{2+}, Ba^{2+}, Ca^{2+}, and Sr^{2+}.
	Generally Water Insoluble
OH^-	All **hydroxides** are insoluble except those of the IA cations, Ba^{2+}, Ca^{2+}, and Sr^{2+} (these are the eight strong bases and are completely soluble in water), and NH_4^+.
CO_3^{2-}	All **carbonates** are insoluble except those of the IA cations and NH_4^+.
PO_4^{3-}	All **phosphates** are insoluble except those of the IA cations and NH_4^+.
SO_3^{2-}	All **sulfites** are insoluble except those of the IA cations and NH_4^+.
S^{2-}	All **sulfides** are insoluble except those of the IA *and IIA* cations and NH_4^+.
O^{2-}	All ***metallic* oxides** are insoluble except those of the IA cations and NH_4^+.
CrO_4^{2-}, $Cr_2O_7^{2-}$	All **chromates** and **dichromates** are insoluble except those of the IA cations, NH_4^+, Ca^{2+}, and Sr^{2+}.

Predict whether the following combinations will result in a reaction. Write a balanced reaction for those reactions. **Indicate you understand the specific reactions by writing the net ionic equation for the reaction.** Hopefully you would have memorized the solubility rules before attempting to answer these questions. It is not to be assumed that all of these reactions are precipitation reactions however. **The answers for these questions are not included**. You are expected to spend some time in the library over the summer. Finding a freshman chemistry textbook in the library and reading the chapter of on aqueous reactions can easily check these reactions.

A) An aqueous solution of sodium nitrate is combined with an aqueous solution of lead (II) acetate.

B) An aqueous solution of potassium sulfate is combined with an aqueous solution of silver chlorate.

C) An aqueous solution of barium hydroxide is combined with an aqueous solution of hydrochloric acid.

D) An aqueous solution of mercury (I) nitrate is combined with an aqueous solution of ammonium chloride.

E) An aqueous solution of lithium sulfide is combined with an aqueous solution of zinc bromide.

F) An aqueous solution of potassium hydroxide is combined with an aqueous solution of sulfuric acid.

G) An aqueous solution of sodium carbonate is combined with an aqueous solution of nitric acid.

H) Sulfur dioxide is bubbled into distilled water.

I) An aqueous solution of zinc sulfate is combined with an aqueous solution of lead (II) nitrate.

Topic 6: Gas Laws

Assignment 10: Students should be able to perform calculations demonstrating the relationships between mass, volume, pressure, and temperature for gases.

1) Small quantities of oxygen gas are sometimes generated in the laboratory by heating $KClO_3$ in the presence of MnO_2 as a catalyst:

$$2KClO_3\,(s) \rightarrow 2KCl\,(s) + 3O_2\,(g)$$

What volume of O_2 is collected **over water** at 23.0^0C by reaction of 0.2890 g of $KClO_3$ if the barometric pressure is 742 torr? (water vapor pressure = 21.088 mm Hg at 23.0^0C)

2) Neon diffuses 2.814 times faster than unknown gas "A." What is the molar mass of gas A? If the unknown gas is composed of diatomic molecules, what is the identity of gas A?

3) Oxygen at 25°C and 760 torr pressure occupies a volume of 21.2 L. What is the volume of oxygen gas at 133°C and 830 torr?

4) How many grams of nitrogen dioxide gas occupy a 4.86 L flask at 11.0°C and 66.7 kPa pressure?

CHECK YOURSELF:

Assignment #1

Answers:

1)	a) 0.454 g	b) 5.0×10^{1} nm	c) 7.6×10^{-5} L	d) 1.55 g/L	
2)	a) 1.49 g/mL	b) 101 cm^3			
3)	a) 1.234×10^{7}	b) 2.355	c) 4.565×10^{5}	d) 3.216×10^{3}	e) 6.570×10^{-4}
4)	a) 69.040	b) – 476	c) 1.09×10^{4}	d) 3917.0	e) 51

Assignment #2

None provided

Assignment #3

Answers:

1) calcium nitrate, stannous oxide or tin (II) oxide, cupric dichromate or copper (II) dichromate, aluminum cyanide, hydrochloric acid, ammonium sulfate, chromium (II) carbonate, nickel (II) fluoride, sodium hydride, barium peroxide, iron (III) hydroxide or ferric hydroxide, silver chromate, chromium (III) hydrogen phosphate or chromus hydrogen phosphate, potassium perchlorate, barium thiocyanate

2) $Cd(HCO_3)_2$, $PbCl_2$, Al_2O_3, CuCN, $Hg_2(C_2H_3O_2)_2$, $NaHSO_3$, $Cr_2(SO_4)_3$, $Ag_2Cr_2O_7$, Cs_2O_2, $Mg(ClO_3)_2$, $Ni(NO_3)_3$, $Mn(OH)_2$, $CoCl_2$, $Sn(H_2PO_4)_2$, $(NH_4)_3PO_4$

3) dichlorine heptoxide, dinitrogen pentoxide, diphosphorus pentoxide, antimony trichloride, sulfur hexafluoride, carbon dioxide, carbon monoxide, dinitrogen tetrahydride, tetraphosphorus decoxide.

4) NO_2, SO_3, ClF_5, BrF_3, BF_3, PCl_5.

Assignment #4

None provided

Assignment #5

Answers:

1) 0.0313 mol, 1.88×10^{22} molecules, 1.88×10^{22} atoms S; 5.64×10^{22} atoms O; 7.00×10^{2} mL; 3.57 g/L
2) 0.0465 mol; 2.05 g; 2.80×10^{22}atoms C; 5.60×10^{22} atoms O; 1.04 L; 1.96 g/L
3) 0.424 g; 6.72×10^{21} molecules; 1.34×10^{22} atoms; 1.70 g/L

Assignment #6

Answers:

1) 0.091 *M*, 2) 33 g $Pb(NO_3)_2$ 3) 3.5×10^{2} mL of solution
4) 0.128 M Na_2SO_4 ; 0.256 M Na^+ ; 0.128 M SO_4^{2-}
5) 33.7 mL HCl 6) 268 mL H_2SO_4 7) 0.0847 M $BaCl_2$ 8) 0.396 g $Ca(OH)_2$

Assignment #7

Answers:

1) The coefficients in order are: A) 1, 3, 2, 3 B) 2, 3, 1, 6 C) 1, 4, 1, 2, 3
2) 4.97 g, 3) 6.60 g 4) 6.72 L CO 5) H_2SO_4 is the limiting reagent, 2.35 g of $Al(OH)_3$ remain after the reaction is complete 6) 1.11 L CO_2

Assignment #8

Answers:

1) This is a combination reaction. $2\ Al + 3\ Cl_2 \rightarrow 2\ AlCl_3$
2) This is another combination reaction. $2\ Mg + O_2 \rightarrow 2\ MgO$
3) This is a decomposition reaction. $2\ Ag_2O \rightarrow 4\ Ag + O_2$
4) This is another decomposition reaction. $2\ P_2O_5 \rightarrow P_4 + 5\ O_2$
5) This is a single displacement reaction. $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
6) This is another single displacement reaction. $Cl_2 + 2\ KI \rightarrow I_2 + 2\ KCl$
7) This is a third single displacement reaction. $2\ Al + 3\ Pb(NO_3)_2 \rightarrow 2\ Al(NO_3)_3 + 3\ Pb$
8) This is a double displacement reaction. It is the neutralization of a strong base (NaOH) with a strong acid (H_2SO_4). $2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2\ H_2O$
9) This is a double displacement reaction. It involves the formation of a precipitate when the two solutions are mixed. Knowledge of the solubilities of the products is essential in writing these types of reactions. $2\ AgNO_{3\,(aq)} + BaCl_{2\,(aq)} \rightarrow 2\ AgCl_{(s)} + Ba(NO_3)_{2(aq)}$ The silver chloride is the precipitate in this reaction. Solubility Rules are available in general chemistry textbooks in the library.
10) This is a combustion reaction. The products of complete combustion reactions involving organic compounds as fuels are carbon dioxide and water. $2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O$

Assignment #9

None provided

Assignment #10

Answers:

1) 0.0905 L
   For help on this question, search for lab procedures related to collecting "wet gas." For instance, collection of "wet hydgroen" is a very common procedure in honors-level coursework.
2) 159.8 g/mol; Br_2
3) 26.4 L
4) 6.32 g nitrogen dioxide