AP Chemistry Summer Assignment

Welcome to AP Chemistry! In order to have a smooth transition, students are expected to come in with some strong background knowledge. These are some of the things you need to be able to do:

- Unit Conversions and Dimensional Analysis: You need to be able to show proper work for the AP exam. Attached you will find a sheet that shows the metric conversion factors that you need to have memorized by the first day of school.
- Ions: You need to memorize the AP list of ions that is attached. Hopefully, you know many of these ions already from your first-year chemistry course. You need to be able to write the formulas of ionic compounds using the charges.
- Solubility Rules: You need to memorize the general solubility rules that are attached. These rules will allow you to predict whether a precipitate will form during a double replacement reaction.
- Oxidation Numbers: Look over the attached rules and begin familiarizing yourself with them. We will learn how to assign oxidation numbers in AP Chemistry, and you will have a head start if you know these rules.
- Don't forget Avogadro's number – 6.022×10^{23} atoms (or molecules/formula units) in a mole!

Pages 2-10 of this packet (Topics 1-8) will be **due at the end of the first week of school in August**.

Enjoy your summer and see you next year!

- Ms. Zuber 😊
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Topic 1: Significant Figures

1. Determine the number of significant figures in each of the following:

   a. 0.7540 _____

   b. 12500 _____

   c. 1000.01 _____

   d. 1200 _____

   e. 1.04×10^3 _____

   f. 0.0080050 _____

2. Perform the following calculations and round to the appropriate number of significant figures:

   a. $34.66 + 333.0$ _____

   b. $1.23 + 9.66$ _____

   c. $455 - 1.22$ _____

   d. 18.2×1.998 _____

   e. $10.2 \div 1.34$ _____

   f. $\frac{100.23+59.4}{5.22}$ _____

3. Round each of the following numbers to three significant figures:

   a. 167.789 _____

   b. 0.00000445345 _____

   c. 25.0545 _____

   d. 3.1415926536 _____

   e. 8504.0435 _____

   f. 14.4355 _____

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Topic 2: Metric and Temperature Conversions

1. Use dimensional analysis (factor-label method) to make the following metric conversions:

   a. 3.40 m to cm _____ × _____ = _____

   b. 289 cm to nm _____ × _____ × _____ = _____

   c. 125145 J to kJ _____ × _____ = _____

   d. 164 mg to g _____ × _____ = _____

   e. 46.5 mL to L _____ × _____ = _____

2. Make the following temperature conversions:

   a. 162°F to °C _____

   b. -18 °C to K _____

   c. 212 K to °C _____

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Topic 3: Nomenclature

1. Name or write the formula for the following ionic compounds:

a. LiCl		g. tin(II) bromide	
b. $Mg(OH)_2$		h. potassium phosphate	
c. K_3P		i. nickel(II) perchlorate	
d. Fe_2O_3		j. sodium hydroxide	
e. FeO		k. zinc phosphate	
f. $ZnCl_2$		l. ammonium sulfate	

2. Name or write the formula for the following covalent compounds:

a. CO		e. nitrogen tribromide	
b. CBr_4		f. tetraphosphorus decaoxide	
c. SO_2		g. xenon hexafluoride	
d. N_2O_4		h. dicarbon tetrafluoride	

3. Name or write the formula for the following acids:

a. HCl		e. hydrobromic acid	
b. HNO_3		f. hydronitric acid	
c. $HC_2H_3O_2$		g. phosphoric acid	
d. H_2SO_4		h. hydrosulfuric acid	

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Topic 4: Atomic Structure

1. Determine the number of protons, neutrons and electrons in each of the following:

   a. $^{39}_{19}K$ protons: _____ neutrons: _____ electrons: _____

   b. $^{23}_{11}Na^{1+}$ protons: _____ neutrons: _____ electrons: _____

   c. $^{208}_{82}Pb$ protons: _____ neutrons: _____ electrons: _____

   d. $^{33}_{15}P^{3-}$ protons: _____ neutrons: _____ electrons: _____

2. Write the symbol for the atom that contains
   a. 24 protons, 21 electrons and 24 neutrons

   b. 34 protons, 45 neutrons, 34 electrons

   c. 8 protons, 10 neutrons, 10 electrons

3. What experimental evidence supports these statements?
   a. The nucleus of an atom is small.

   b. The atom consists of both positive and negative charges.

   c. The nucleus of the atom is positive.

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Topic 5: Writing and Balancing Chemical Equations

1. Balance the following chemical equations:
   a. _____ $Cr_{(s)}$ + _____ $O_{2(g)} \rightarrow$ _____ $Cr_2O_{3(s)}$

   b. _____ $SiH_{4(g)} \rightarrow$ _____ $Si_{(s)}$ + _____ $H_{2(g)}$

   c. _____ $SO_{3(g)} \rightarrow$ _____ $SO_{2(g)}$ + _____ $O_{2(g)}$

   d. _____ $Pb(NO_3)_{2(s)} \rightarrow$ _____ $PbO_{(s)}$ + _____ $NO_{2(g)}$ + _____ $O_{2(g)}$

   e. _____ $C_3H_{8(g)}$ + _____ $O_{2(g)} \rightarrow$ _____ $CO_{2(g)}$ + _____ $H_2O_{(g)}$

   f. _____ $C_2H_5OH_{(l)}$ + _____ $O_{2(g)} \rightarrow$ _____ $CO_{2(g)}$ + _____ $H_2O_{(g)}$

2. Write a balanced chemical equation for each of the following reaction descriptions:
   a. When solid calcium carbonate is heated, solid calcium oxide and gaseous carbon dioxide are formed.

   b. Aluminum metal reacts with oxygen to form solid aluminum oxide.

   c. When solid mercury(II) sulfide is heated with oxygen, liquid mercury metal and gaseous sulfur dioxide are produced.

   d. When aqueous solutions of aluminum sulfate and barium chloride are mixed, solid barium sulfate and aqueous aluminum chloride are formed.

   e. Solid sodium bicarbonate reacts with hydrochloric acid to produce sodium chloride, water, and carbon dioxide gas.

   f. Gaseous ammonia and oxygen react to produce nitrogen monoxide gas and water

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Topic 6: Moles and Stoichiometry

1. Vinegar is a dilute solution of acetic acid, CH_3COOH.
   a. Calculate the molar mass of acetic acid.

   b. How many molecules of CH_3COOH are contained within 43.4 g of acetic acid?

   c. How much would 0.450 moles of acetic acid weigh?

2. How many moles of hydrogen gas can be produced if 1.35 g of solid zinc reacts with excess hydrochloric acid according to the equation

$$Zn + 2\ HCl \rightarrow H_2 + ZnCl_2$$

3. The reaction for the combustion of propane is

$$\_\_\_\_ C_3H_8 + \_\_\_\_ O_2 \rightarrow \_\_\_\_\_ CO_2 + \_\_\_\_ H_2O$$

   a. If 20.0 g of C_3H_8 and 20.0 g of O_2 are reacted, how many moles of CO_2 can be produced?

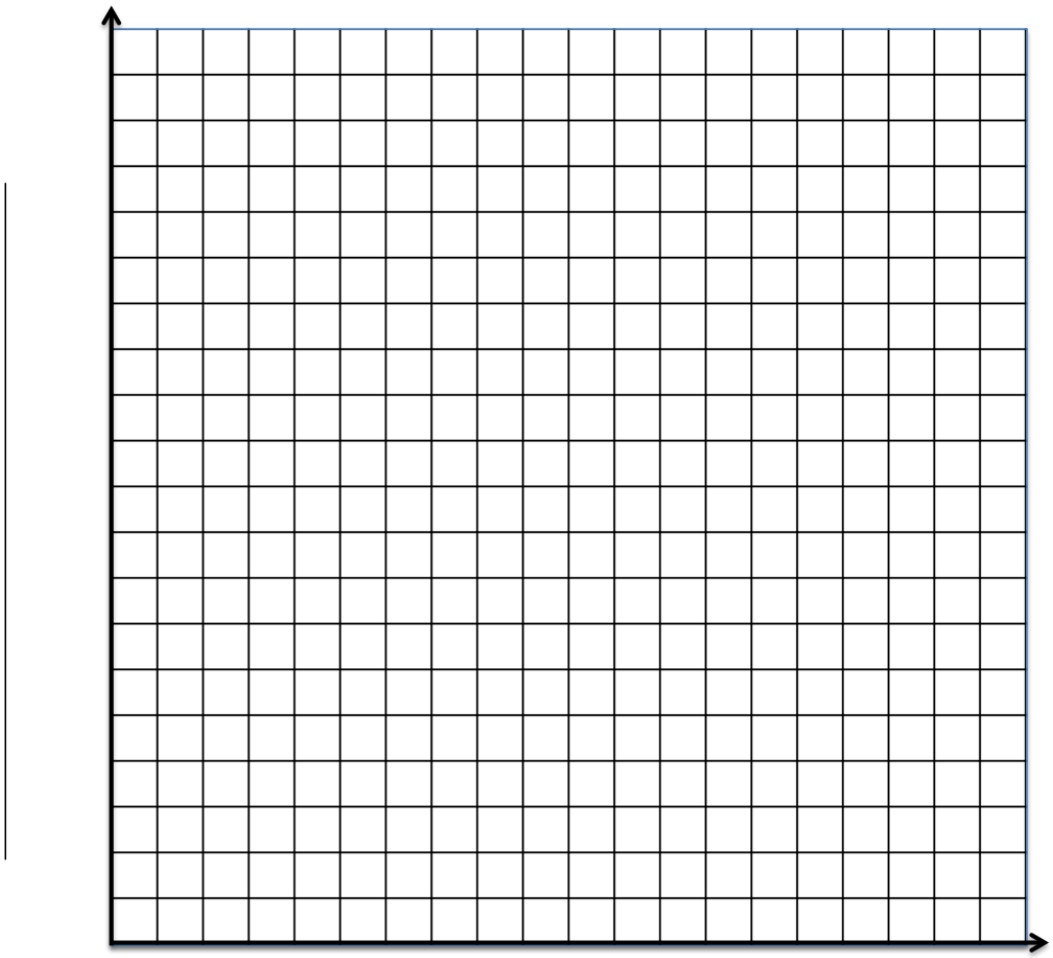
4. If 20.0 g of C_3H_8 and 80.0 g of O_2 are reacted, how many grams of CO_2 can be produced?

Topic 7: Graphing and Data Analysis

4. When anhydrous calcium chloride is dissolved in water, the temperature of the system changes. A student obtains the following data when dissolving increasing amounts of $CaCl_2$ into 100 mL of water:

Mass of $CaCl_2$ dissolved, g	0.91	2.94	5.92	8.81	10.89
ΔT, $^\circ C$	1.8	6.6	12.8	18.9	23.2

Plot the data on the graph below. Choose an appropriate scale and label the axes appropriately.



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Refer to the graph to answer the following questions.

Independent Variable: _____

Dependent Variable: _____

Provide a descriptive title for the graph: _____

5. Describe the relationship between grams of calcium chloride salt and change in temperature in a sentence.

6. Draw a line of best fit. Determine its slope, including units.

7. Predict the change in temperature when

   a. 4.33 g of $CaCl_2$ are dissolved

   b. 9.56 g of $CaCl_2$ are dissolved

   c. 15.4 g of $CaCl_2$ are dissolved

8. Predict what mass of $CaCl_2$ will result in

   d. a 12.4˚C change in temperature

   e. a 44.9 ˚C change in temperature

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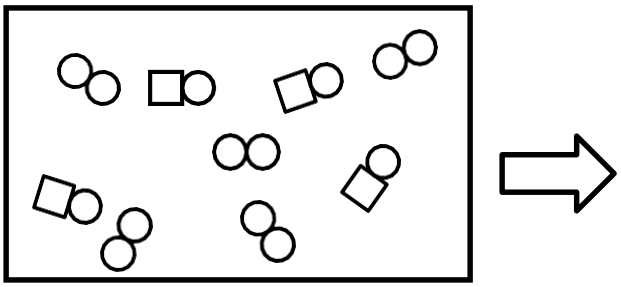
Topic 8: Particulate Diagrams

1. Consider the synthesis of nitrogen dioxide

$$2\ NO + 1\ O_2 \rightarrow 2\ NO_2$$

a. In the diagram below, nitrogen atoms are represented with squares and oxygen atoms are represented with circles. Using the conservation of matter, draw what you would expect to find in the reaction vessel once the reaction is complete.

Before Reaction: After Reaction

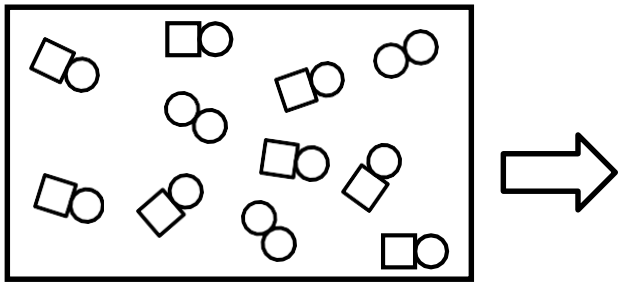


Limiting Reactant: Excess Reactant:

Explanation

b. Consider the same reaction, with different starting quantities. Draw the contents of the reaction vessel after the reaction is complete.

Before Reaction: After Reaction



Limiting Reactant: Excess Reactant:

Explanation

Topic 9: Things to Memorize

CONVERSION FACTORS

Memorize these Conversion Factors

Metric Prefixes

Prefix	Symbol	Numerical	Exponential
giga	G	1,000,000,000	10^{9}
mega	M	1,000,000	10^{6}
kilo	k	1,000	10^{3}
hecto	h	100	10^{2}
deca	da	10	10^{1}
no prefix means:		1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}

How to Use Metric Prefix Conversions Factors:
1 kilogram = 1000 grams
1 centimeter = 0.01 meters
1 nanosecond = 10^{-9} seconds

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AP Chemistry Ion List

Cations	
Hydrogen	H^{1+}
Lithium	Li^{1+}
Sodium	Na^{1+}
Potassium	K^{1+}
Rubidium	Rb^{1+}
Cesium	Cs^{1+}
Beryllium	Be^{2+}
Magnesium	Mg^{2+}
Calcium	Ca^{2+}
Strontium	Sr^{2+}
Barium	Ba^{2+}
Aluminum	Al^{3+}
Silver	Ag^{1+}
Zinc	Zn^{2+}
Chromium (III)	Cr^{3+}
Manganese (II)	Mn^{2+}
Iron (II)	Fe^{2+}
Iron (III)	Fe^{3+}
Cobalt (II)	Co^{2+}
Cobalt (III)	Co^{3+}
Nickel (II)	Ni^{2+}
Copper (I)	Cu^{1+}
Copper (II)	Cu^{2+}
Mercury (I)	Hg_2^{2+}
Mercury (II)	Hg^{2+}
Tin (II)	Sn^{2+}
Tin (IV)	Sn^{4+}
Lead (II)	Pb^{2+}
Lead (IV)	Pb^{4+}
Hydronium	H_3O^{1+}
Ammonium	NH_4^{1+}

Anions	
Hydride	H^{1-}
Fluoride	F^{1-}
Chloride	Cl^{1-}
Bromide	Br^{1-}
Iodide	I^{1-}
Oxide	O^{2-}
Peroxide	O_2^{2-}

Sulfide	S^{2-}
Nitride	N^{3-}
Phosphide	P^{3-}
Nitrate	NO_3^{1-}
Nitrite	NO_2^{1-}
Carbonate	CO_3^{2-}
Hydrogen carbonate (Bicarbonate)	HCO_3^{1-}
Sulfate	SO_4^{2-}
Hydrogen sulfate (Bisulfate)	HSO_4^{1-}
Sulfite	SO_3^{2-}
Hydrogen sulfite (Bisulfite)	HSO_3^{1-}
Phosphate	PO_4^{3-}
Dihydrogen phosphate	$H_2PO_4^{1-}$
Hydrogen phosphate	HPO_4^{2-}
Phosphite	PO_3^{3-}
Hypochlorite	ClO^{1-}
Chlorite	ClO_2^{1-}
Chlorate	ClO_3^{1-}
Perchlorate	ClO_4^{1-}
Hypobromite	BrO^{1-}
Bromite	BrO_2^{1-}
Bromate	BrO_3^{1-}
Perbromate	BrO_4^{1-}
Hypoiodite	IO^{1-}
Iodite	IO_2^{1-}
Iodate	IO_3^{1-}
Periodate	IO_4^{1-}
Hydroxide	OH^{1-}
Cyanide	CN^{1-}
Thiocyanate	SCN^{1-}
Thiosulfate	$S_2O_3^{2-}$
Acetate	CH_3COO^{1-} or $C_2H_3O_2^{1-}$
Permanganate	MnO_4^{1-}
Chromate	CrO_4^{2-}
Dichromate	$Cr_2O_7^{2-}$
Oxalate	$C_2O_4^{2-}$

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RULES FOR NAMING ACIDS

Memorize These Rules

When the name of the anion ends in –ide, the acid name begins with the prefix hydro-, the stem of the anion has the suffix –ic and it is followed by the word acid.

-ide becomes hydro _____ic Acid

Cl- is the Chloride ion so HCl = hydrochloric acid

When the anion name ends in –ite, the acid name is the stem of the anion with the suffix –ous, followed by the word acid.

-ite becomes _____ous Acid

ClO_2^{-1} is the Chlorite ion so $HClO_2$ = Chlorous acid.

When the anion name ends in –ate, the acid name is the stem of the anion with the suffix –ic, followed by the word acid.

-ate becomes _____ic Acid

ClO_3^{-1} is the Chlorate ion so $HClO_3$ = Chloric acid.

Rules for Determining Oxidation Number

Memorize These Rules

Oxidation Number: A number assigned to an atom in a molecular compound or polyatomic ion that indicates the general distribution of electrons among the bonded atoms.

1. The oxidation number of any neutral element is ZERO.
2. The oxidation number of a monatomic ion equals the charge on the ion.
3. The more electronegative element in a binary compound is assigned the number equal to the charge it would have if it were an ion.
4. The oxidation number of fluorine in a compound is always -1
5. Oxygen has an oxidation number of -2 unless it is combined with F, when it is +2, or it is in a peroxide, when it is -1.
6. The oxidation state of hydrogen is +1 unless it is combined with a metal, in which case it is -1.
7. In compounds, the elements of groups 1 and 2 as well as aluminum have oxidation number of +1, +2, and +3, respectively.
8. The sum of the oxidation numbers of all atoms in a neutral compound is ZERO.
9. The sum of the oxidation number of all atoms in a polyatomic ion equals the charge of the ion.

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SOLUBILITY RULES

Memorize These Rules

Compounds containing …	Generally are …	Exceptions include those of …
Alkali metals	Soluble	None
Ammonium	Soluble	None
Nitrate, Acetate, Chlorate	Soluble	None

Compounds containing …	Generally are …	Exceptions include those of …
Chloride, Bromide, Iodide	Soluble	Lead(II), Silver, Mercury(I)
Sulfate	Soluble	Lead(II), Silver, Mercury(I), Calcium, Strontium, Barium

Compounds containing …	Generally are …	Exceptions include those of …
Hydroxide	Insoluble	Alkali metals, Calcium, Strontium, Barium
Carbonate, Phosphate, Chromate	Insoluble	Ammonium, Alkali metals

† Lead(II) is Pb^{+2}

‡ Mercury(I) is Hg_2^{+2}

Common Student Misconceptions about Solubility (Do not need to memorize)

1. **"Like always dissolves like."**
   This is only a generalization and there are exceptions. For example, acetic acid is totally miscible in water, and also miscible in nonpolar solvents like benzene and carbon tetrachloride.
2. **"The solubility of a solid in a liquid increases with increasing temperature."**
   This is not always true. For example, sodium sulfite, calcium acetate, and lithium sulfate have solubilities that decrease with an increase in temperature.
3. **"Insoluble compounds do not dissolve."**
   This is not really true. All ionic compounds, even those we classify as *insoluble* dissolve to some slight extent in water.