UCONN ECE/AP CHEMISTRY SUMMER ASSIGNMENT
Mrs. Mathur

*I understand that due to the school closing there were some topics that could not be completed during the school year. Please try your best to become familiar with these topics by using the UCONN online chemistry book (*https://openstax.org/details/chemistry*) or watching the suggested videos (khan academy.com) and then attempt the questions listed in the packet. Please do not worry if you are unable to fully understand or correctly arrive at a solution. It's the effort that matters!*

Welcome to UCONN ECE/ AP Chemistry class! In order to be successful in this class, please review and take notes from the first 4 chapters of the recommended book for UCONN ECE Chemistry available to you in the electronic form using the following website

https://openstax.org/details/chemistry

The UCONN ECE/ AP Chemistry course is designed to be the equivalent of a college course. A score of 4 or higher on the AP Chemistry exam can earn you 8 college credits. Successful completion of this course will require *regular attendance, excellent work ethics and strong mathematical background* Plan on staying after school at least once per week.
It is not all about memorization; however, having these items memorized is essential for success in learning the concepts covered in the course. Make flashcards, have your friends and family quiz you, take the lists with you on vacation, but get this information firmly planted in your head. **Do not** wait until the night before school begins

Here is a list of items that you must review over summer.

1. Memorize the charges of the monoatomic and polyatomic ions.
2. Memorize the solubility rules.
3. Rules for naming acids.
4. List of strong acids and bases.
5. Rules for naming ionic and Molecular compounds.

Take notes from the first 4 chapters of the book available electronically. (https://openstax.org/details/chemistry)

6. Attempt the entire practice problem packet to the best of your ability.

There will be a quick quiz on polyatomic ions during the first week of school.

Solubility Rules

1. All compounds containing alkali metal cations and the ammonium ion are soluble.
2. All compounds containing NO_3 ,ClO_4^-, ClO_3^-, and $C_2H_3O_2^-$ anions are soluble.

3. All chlorides, bromides, and iodides are soluble except those containing Ag^+, Pb^{2+}, or Hg^{2+}.
4. All sulfates are soluble except those containing Hg^{2+}, Pb^{2+}, Sr^{2+}, Ca^{2+}, or Ba^{2+}.
5. All hydroxides are insoluble except compounds of the alkali metals, Ca^{2+}, Sr^{2+}, and Ba^{2+}.
6. All compounds containing PO_4^{3-}, S^{2+}, and CO_3^{2--} ions are insoluble except those that also contain alkali metals or NH_4^+.

Common Oxidation Numbers

Table 4-3

Oxidation Numbers of Common Monatomic Ions

1+	2+		3+	4+
cesium, Cs^+	barium, Ba^{2+}	magnesium, Mg^{2+}	aluminum, Al^{3+}	germanium(IV), Ge^{4+}
copper(I), Cu^+	cadmium, Cd^{2+}	manganese(II), Mn^{2+}	bismuth(III), Bi^{3+}	lead(IV), Pb^{4+}
hydrogen, H^+	calcium, Ca^{2+}	mercury(II), Hg^{2+}	cerium(III), Ce^{3+}	silicon(IV), Si^{4+}
lithium, Li^+	cobalt(II), Co^{2+}	nickel(II), Ni^{2+}	chromium(III), Cr^{3+}	thorium(IV), Th^{4+}
potassium, K^+	copper(II), Cu^{2+}	strontium, Sr^{2+}	gallium(III), Ga^{3+}	tin(IV), Sn^{4+}
rubidium, Rb^+	iron(II), Fe^{2+}	tin(II), Sn^{2+}	iron(III), Fe^{3+}	zirconium(IV), Zr^{4+}
silver, Ag^+	lead(II), Pb^{2+}	zinc, Zn^{2+}		
sodium, Na^+				
thallium(I), Tl^+				

1−	2−	3−	4−
bromide, Br^-	oxide, O^{2-}	nitride, N^{3-}	carbide, C^{4-}
chloride, Cl^-	selenide, Se^{2-}	phosphide, P^{3-}	
fluoride, F^-	sulfide, S^{2-}		
hydride, H^-	telluride, Te^{2-}		
iodide, I^-			

NAMING OF ACIDS AND BASES –
RULES AND PRACTICE

(-ic acids from –ate ions, -ous acids from –ite ions)
"I took a bite and got nauseous."
"I ate it and got sick."
ACIDS

Naming binary acids (no oxygen) hydro _____ ic

HF Hydrofluoric acid
HCl Hydrochloric acid
HBr Hydrobromic acid
HI Hydroiodic acid

Naming oxyacids,(polyatomic ions end with ate) _____ic
H_2SO_4 Sulfuric acid
HNO_3 Nitric acid
H_3PO_4 Phosphoric acid

Naming oxyacids,(polyatomic ions end with ite) _____ ous
H_2SO_3 Sulfurous acid
HNO_2 Nitrous acid
H_3PO_3 Phosphorous acid

BASES

Ionic bases are named per the standard rules of naming ionic compounds.
Examples: aluminum hydroxide is $Al(OH)_3$ KOH is potassium hydroxide

The only molecular base you know now is ammonia (NH_3). In water it forms NH_4OH

PRACTICE IN NAMING ACIDS AND BASES

1. sulfuric acid _____
2. nitrous acid _____
3. hydrochloric acid _____
4. tin (IV) hydroxide _____
5. phosphorous acid _____
6. HBr _____
7. H_3PO_4 _____
8. $Ca(OH)_2$ _____
9. H_2CO_3 _____
10. HF _____

Common Polyatomics

Common Polyatomic Ions			
$C_2H_3O_2^-$	acetate	OH^-	hydroxide
NH_4^+	ammonium	ClO^-	hypochlorite
CO_3^{2-}	carbonate	NO_3^-	nitrate
ClO_3^-	chlorate	NO_2^-	nitrite
ClO_2^-	chlorite	$C_2O_4^{2-}$	oxalate
CrO_4^{2-}	chromate	ClO_4^-	perchlorate
CN^-	cyanide	MnO_4^-	permanganate
$Cr_2O_7^{2-}$	dichromate	PO_4^{3-}	phosphate
HCO_3^-	bicarbonate	SO_4^{2-}	sulfate
HSO_4^-	bisulfate	SO_3^{2-}	sulfite
HSO_3^-	bisulfite		

Polyatomic Anions

Most of the work on memorization occurs with these ions, but there are a number of patterns that can greatly reduce the amount of memorizing that one must do.

1. “ate” anions have one more oxygen then the “ite” ion, but the same charge. If you memorize the “ate” ions, then you should be able to derive the formula for the “ite” ion and vice-versa.

a. sulfate is SO_4^{-2}, so sulfite has the same charge but one less oxygen (SO_3^{2-})

b. nitrate is NO_3^-, so nitrite has the same charge but one less oxygen (NO_2^-)

2. If you know that a sufate ion is SO_4^- then to get the formula for hydrogen sulfate ion, you add a hydrogen ion to the front of the formula. Since a hydrogen ion has a 1+ charge, the net charge on the new ion is less negative by one.

a. Example: PO_4^{3-} HPO_4^{-2} $H_2PO_4^-$

phosphate hydrogen phosphate dihydrogen phosphate

3. Learn the hypochlorite; chlorite; chlorate; perchlorate series, and you also know the series containing iodite/iodate as well as bromite/bromate.

   a. The relationship between the “ite” and “ate” ion is predictable, as always. Learn one and you know the other.
   b. b. The prefix “hypo” means “under” or “too little” (think “hypodermic”, “hypothermic” or “hypoglycemia”)

i. Hypochlorite is “under” chlorite, meaning it has one less oxygen

c. The prefix “hyper” means “above” or “too much” (think “hyperkinetic”)

i. the prefix “per” is derived from “hyper” so perchlorate (hyperchlorate) has one more oxygen than chlorate.

d. Notice how this sequence increases in oxygen while retaining the same charge:

ClO^{-1} ClO_2^{-1} ClO_3^{-1} ClO_4^{-1}

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hypochlorite chlorite chlorate perchlorate

Rules for Naming Ionic Compounds

1. Balance Charges (charges should equal zero)
2. Cation is always written first (in name and in formula). Use Roman numeral for *transition metal cation only*. Ex Fe^{+2} is named Iron (II)
3. Change the ending of the anion to –ide. Polyatomic ions have special names that must be memorized.

Write the formulas of the following Ionic compounds

1) ammonium chloride
2) iron (III) nitrate
3) titanium (III) bromide
4) copper (I) phosphide
5) tin (IV) selenide
6) gallium arsenide
7) lead (IV) sulfate
8) beryllium bicarbonate
9) manganese (III) sulfite
10) aluminum cyanide

Write the names of the following ionic compounds

11) $Cr(PO_4)_2$
12) $V(CO_3)_2$
13) $Sn(NO_2)_2$
14) Co_2O_3
15) $Ti(C_2H_3O_2)_2$
16) V_2S_5
17) $Cr(OH)_3$
18) LiI
19) Pb_3N_2
20) AgBr

Naming Molecular compounds

1) Use Greek prefixes (mono, di tri, tetra, penta, hexa, hepta, octa, nona, deca) for the number of atoms and the name ends with –ide.

Examples

CCl_4 = Carbon tetra chloride

P_2O_5 = diphosphorus pentcxide

Practice Problems Molecular Compounds

1) BBr_3
2) C_2Br_6
3) IO_2
4) CH_4
5) N_2O_3
6 SF_6
7 H_2O_2
8 NH_3
9 SiO_2
10 AsF_3

Mixed naming Practice

1)	dinitrogen trioxide	8 ZnS	15 HCl
2)	nitrogen	9 SiF_4	16. HNO_2
3)	methane	10 Ag_3PO_4	17 H_3PO_4
4)	lithium acetate	11 K_3N	18 HIO
5)	phosphorus trifluoride	12 V_2S_3	19 H_2SO_3
6)	vanadium (V) oxide	13 $Zn(NO_2)_2$	20 HI
7)	aluminum hydroxide	14 P_4	

Accuracy /Precision

1) A student performed an analysis of a sample for its iron content and got the following results:

15.3% 15.4% 15.22% 15.6%

The actual amount of iron in the sample was 15.50%. Comment on the accuracy and precision of the experimental results.

Calculations, Sig Figs, and Conversions

1. Perform the following calculations with correct significant figures:

A. $$\frac{4.6584 \times 48.34}{4.18}$$

B. $(5.02 - 4.68 + 38.760 + 14.0) / 3.1416$

C. $171.5 + 72.915 - 8.23$

D. $$\frac{0.102 \times 0.021 \times 273}{1.10}$$

2) Write the following numbers in scientific notation rounding your answer to three significant figures

1. 1001

2. 53

3. 6,926,300,000

4. -392

5. 0.00361

6. 0.13592

7. -0.0038

8. 0.00000013

9. -0.567

10. 0.02453

3) How many significant digits are in each of the following measurements?

_____1. 23 cm
_____2. 107 mm
_____3. 8.0335 cm
_____4. 0.238 kg
_____5. 0.05568 mg
_____6. 76.414 dL
_____7. 14.809 cm
_____8. 0.0004898 mm

Density:

4). Calculate the mass of a sample of copper that occupies 5.3 x 10-2 cm3 if the density of copper is 8.94 g/cm3.

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5) An 9.46 g sample of a solid is placed in a 25.00 ml flask. The remaining volume in the flask is filled with benzene in which the solid is insoluble. The solid and the benzene together weigh 26.83 g. The density of the benzene is 0.879 g/ml. What is the density of the solid?

4. **Fill** in the following table:

Element/ion	**# of protons**	**# of neutrons**	**# of electrons**
Fe			
Na^{+}			
	27		25
S^{2-}			

Use the website below or find your own to learn about the 5 types of chemical reactions, how to write balances chemical reactions.

https://www.khanacademy.org/science/in-in-class-10-chemistry-india/x87dd2847d57ee419:in-in-chemical-reactions-and-equations

6) Predict and balance the following synthesis reactions

1. Hydrogen burned in oxygen
2. Hydrogen gas reacts with nitrogen gas
3. Complete burning of sulfur in oxygen
4. Calcium oxide added to water

Predict and Balance the following decomposition reactions

1. Barium hydroxide heated
2. Sodium carbonate heated
3. Lithium chlorate heated
4. Electrolysis of aluminum oxide
5. Hydrogen peroxide heated

Predict and balance the following redox /single replacement reactions

1. Iron filings added to a solution of copper II sulfate
2. Aluminum is added to an aqueous solution of hydrochloric acid
3. Potassium metal is added to cold water
4. Zinc metal added to mercury II nitrate
5. Sodium metal reacts with chlorine gas

Predict and balance the following double replacement/precipitation reactions in aqueous solutions

1. Potassium iodide with lead II nitrate
2. Sodium sulfite with acetic acid
3. Sodium carbonate with sulfuric acid
4. Barium nitrate with sodium oxalate
5. Sodium bicarbonate with sulfuric acid
6. Calcium chloride with potassium carbonate

Stoichiometry

Concept of mole/molar ratio

1) How many moles of sodium atoms correspond to 1.56×10^{21} atoms of sodium?

2) How many moles of Al atoms are needed to combine with 1.58 mol of O atoms to make aluminum oxide, Al_2O_3?

3) How many moles of Al are in 2.16 mol of Al_2O_3?

4) Aluminum sulfate, $Al_2(SO_4)_3$, is a compound used in sewage treatment plants.
   a. How many moles of Al are in a sample of this compound if the sample also contains 0.900 mol S?
   b. How many moles of S are in 1.16 mol $Al_2(SO_4)_3$?

5) How many moles of H_2 and N_2 can be formed by the decomposition of 0.145 mol of ammonia, NH_3?

6) What is the total number of atoms in 0.260 mol of glucose, $C_6H_{12}O_6$?

7) Determine the mass in grams of each of the following:
   a. 1.35 mol Fe
   b. 24.5 mol O
   c. 0.876 mol Ca
   d. 1.25 mol $Ca_3(PO_4)_2$
   e. 0.625 mol $Fe(NO_3)_3$
   f. 0.600 mol C_4H_{10}
   g. 1.45 mol $(NH_4)_2CO_3$

8) Calculate the number of moles of each compound:
   a. 21.5 g $CaCO_3$
   b. 1.56 g NH_3
   c. 16.8 g $Sr(NO_3)_2$
   d. 6.98 µg Na_2CrO_4

https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiome/empirical-molecular-formula/v/formula-mass-composition
https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiome/empirical-molecular-formula/v/formula-mass-composition

Percent composition and empirical formulas

9) Calculate the percentage composition by mass of each element in the following compounds:
   a. NaH_2PO_4

   b. $NH_4H_2PO_4$

10) Phencyclidine is $C_{17}H_{25}N$. A sample suspected of being this illicit drug was found to have a percentage composition of 83.71% C, 10.42% H, and 5.61% N. Do these data acceptably match the theoretical data for phencyclidine?

11) How many grams of O are combined with 7.14×10^{21} atoms of N in the compound N_2O_5?

12) Quantitative analysis of a sample of sodium pertechnetate with a mass of 0.896g found 0.111g Na and 0.477g technetium (Tc). The remainder was oxygen. Calculate the empirical formula of sodium pertechnetate, $Na_xTc_yO_z$.

13) A substance was found to be composed of 22.9% Na, 21.5% B, and 55.7% O. What is the empirical formula of this compound?

14) When 0.684 g of an organic compound containing only C, H, and O was burned in oxygen 1.312g CO_2 and 0.805g H_2O were obtained. What is the empirical formula of the compound.

Balancing equations

15) Balance the following reactions:
   a. $Ca(OH)_2 + HCl \rightarrow CaCl_2 + H_2O$
   b. $AgNO_3 + CaCl_2 \rightarrow Ca(NO_3)_2 + AgCl$
   c. $Fe_2O_3 + C \rightarrow Fe + CO_3$
   d. $NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$
   e. $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$
   f. $Mg(OH)_2 + HBr \rightarrow MgBr_2 + H_2O$
   g. $Al_2O_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$
   h. $KHCO_3 + H_3PO_4 \rightarrow K_2HPO_4 + H_2O + CO_2$
   i. $C_9H_{10}O + O_2 \rightarrow CO_2 + H_2O$

https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiome/limiting-reagent-stoichiometry/v/stoichiometry-limiting-reagent

Stoichiometry/limiting reactants

16) Chlorine is used by textile manufacturers to bleach cloth. Excess chlorine is destroyed by its reaction with sodium thiosulfate, $Na_2S_2O_3$:

$$Na_2S_2O_{3(aq)} + 4Cl_{2(g)} + 5H_2O_{(aq)} \rightarrow 2NaHSO_{4(aq)} + 8HCl_{(aq)}$$

   a. How many moles of $Na_2S_2O_3$ are needed to react with 0.12mol of Cl_2?
   b. How many moles of HCl can form from 0.12mol of Cl_2?
   c. How many moles of H_2O are required for the reaction of 0.12mol of Cl_2?
   d. How many moles of H_2O react if 0.24mol HCl is formed?

17) The incandescent white of a fireworks display is caused by the reaction of phosphorous with O_2 to give P_4O_{10}.
   a. Write the balanced chemical equation for the reaction.
   b. How many grams of O_2 are needed to combine with 6.85g of P?
   c. How many grams of P_4O_{10} can be made from 8.00g of O_2?

d. How many grams of P are needed to make 7.46g P_4O_{10}?

20) In *dilute* nitric acid, HNO_3, copper metal dissolves according to the following equation:

$$3Cu_{(s)} + 8HNO_{3(aq)} \rightarrow 3Cu(NO_3)_{2(aq)} + 2NO_{(g)} + 4H_2O_{(aq)}$$

How many grams of HNO_3 are needed to dissolve 11.45g of Cu?

21) The reaction of powdered aluminum and iron(II)oxide,

$$2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(l)}$$

produces so much heat the iron that forms is molten. Because of this, railroads use the reaction to provide molten steel to weld steel rails together when laying

track. Suppose that in one batch of reactants 4.20mol Al was mixed with 1.75mol Fe_2O_3.

a. Which reactant, if either, was the limiting reactant?
b. Calculate the mass of iron (in grams) that can be formed from this mixture of reactants.

22) Silver nitrate, $AgNO_3$, reacts with iron(III) chloride, $FeCl_3$, to give silver chloride, AgCl, and iron(III) nitrate, $Fe(NO_3)_3$. A solution containing 18.0g $AgNO_3$ was mixed with a solution containing 32.4g $FeCl_3$. How many grams of which reactant *remains* after the reaction is over?

Theoretical and percent yield

23) Barium sulfate, $BaSO_4$, is made by the following reaction:

$$Ba(NO_3)_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaNO_{3(aq)}$$

An experiment was begun with 75.00g of $Ba(NO_3)_2$ and an excess of Na_2SO_4. After collecting and drying the product, 63.45g $BaSO_4$ was obtained. Calculate the theoretical yield and percent yield of $BaSO_4$.

24) Aluminum sulfate can be made by the following reaction:

$$2AlCl_{3(aq)} + 3H_2SO_{4(aq)} \rightarrow Al_2(SO_4)_{3(aq)} + 6HCl_{(aq)}$$

It is quite soluble in water, so to isolate it the solution has to be evaporated to dryness. This drives off the volatile HCl, but the residual solid has to be treated to a little over 200°C to drive off all the water. In one experiment, 25.0g of $AlCl_3$ was mixed with 30.0g H_2SO_4. Eventually, 28.46g of pure $Al_2(SO_4)_3$ was isolated. Calculate the percent yield.