

# 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  $\text{NO}_3^-$ ,  $\text{ClO}_4^-$ ,  $\text{ClO}_3^-$ , and  $\text{C}_2\text{H}_3\text{O}_2^-$  anions are soluble.
3. All chlorides, bromides, and iodides are soluble except those containing  $\text{Ag}^+$ ,  $\text{Pb}^{2+}$ , or  $\text{Hg}^{2+}$ .
4. All sulfates are soluble except those containing  $\text{Hg}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ca}^{2+}$ , or  $\text{Ba}^{2+}$ .
5. All hydroxides are insoluble except compounds of the alkali metals,  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ , and  $\text{Ba}^{2+}$ .
6. All compounds containing  $\text{PO}_4^{3-}$ ,  $\text{S}^{2-}$ , and  $\text{CO}_3^{2-}$  ions are insoluble except those that also contain alkali metals or  $\text{NH}_4^+$ .

### Common Oxidation Numbers

Table 4-3

Oxidation Numbers of Common Monatomic Ions			
<b>1+</b>	<b>2+</b>		<b>3+</b>
cesium, $\text{Cs}^+$ copper(I), $\text{Cu}^+$ hydrogen, $\text{H}^+$ lithium, $\text{Li}^+$ potassium, $\text{K}^+$ rubidium, $\text{Rb}^+$ silver, $\text{Ag}^+$ sodium, $\text{Na}^+$ thallium(I), $\text{Tl}^+$	barium, $\text{Ba}^{2+}$ cadmium, $\text{Cd}^{2+}$ calcium, $\text{Ca}^{2+}$ cobalt(II), $\text{Co}^{2+}$ copper(II), $\text{Cu}^{2+}$ iron(II), $\text{Fe}^{2+}$ lead(II), $\text{Pb}^{2+}$	magnesium, $\text{Mg}^{2+}$ manganese(II), $\text{Mn}^{2+}$ mercury(II), $\text{Hg}^{2+}$ nickel(II), $\text{Ni}^{2+}$ strontium, $\text{Sr}^{2+}$ tin(II), $\text{Sn}^{2+}$ zinc, $\text{Zn}^{2+}$	aluminum, $\text{Al}^{3+}$ bismuth(III), $\text{Bi}^{3+}$ cerium(III), $\text{Ce}^{3+}$ chromium(III), $\text{Cr}^{3+}$ gallium(III), $\text{Ga}^{3+}$ iron(III), $\text{Fe}^{3+}$
<b>4+</b>			
			germanium(IV), $\text{Ge}^{4+}$ lead(IV), $\text{Pb}^{4+}$ silicon(IV), $\text{Si}^{4+}$ thorium(IV), $\text{Th}^{4+}$ tin(IV), $\text{Sn}^{4+}$ zirconium(IV), $\text{Zr}^{4+}$
<b>1-</b>	<b>2-</b>		<b>3-</b>
bromide, $\text{Br}^-$ chloride, $\text{Cl}^-$ fluoride, $\text{F}^-$ hydride, $\text{H}^-$ iodide, $\text{I}^-$	oxide, $\text{O}^{2-}$ selenide, $\text{Se}^{2-}$ sulfide, $\text{S}^{2-}$ telluride, $\text{Te}^{2-}$	nitride, $\text{N}^{3-}$ phosphide, $\text{P}^{3-}$	<b>4-</b>
			carbide, $\text{C}^{4-}$

**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<sub>2</sub>SO<sub>4</sub> Sulfuric acid

HNO<sub>3</sub> Nitric acid

H<sub>3</sub>PO<sub>4</sub> Phosphoric acid

*Naming oxyacids, (polyatomic ions end with ite)*

\_\_\_\_\_ ous

H<sub>2</sub>SO<sub>3</sub> Sulfurous acid

HNO<sub>2</sub> Nitrous acid

H<sub>3</sub>PO<sub>3</sub> Phosphorous acid

**BASES**

*Ionic bases are named per the standard rules of naming ionic compounds.*

Examples: aluminum hydroxide is Al(OH)<sub>3</sub> KOH is potassium hydroxide

*The only molecular base you know now is ammonia (NH<sub>3</sub>). In water it forms NH<sub>4</sub>OH*

**PRACTICE IN NAMING ACIDS AND BASES**

- |                             |    |                                      |
|-----------------------------|----|--------------------------------------|
| 1. sulfuric acid _____      | 6  | HBr _____                            |
| 2. nitrous acid _____       | 7  | H <sub>3</sub> PO <sub>4</sub> _____ |
| 3. hydrochloric acid _____  | 8  | Ca(OH) <sub>2</sub> _____            |
| 4. tin (IV) hydroxide _____ | 9  | H <sub>2</sub> CO <sub>3</sub> _____ |
| 5. phosphorous acid _____   | 10 | HF _____                             |



## 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  $\text{Fe}^{+2}$  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)  $\text{Cr}(\text{PO}_4)_2$
- 12)  $\text{V}(\text{CO}_3)_2$
- 13)  $\text{Sn}(\text{NO}_2)_2$
- 14)  $\text{Co}_2\text{O}_3$
- 15)  $\text{Ti}(\text{C}_2\text{H}_3\text{O}_2)_2$
- 16)  $\text{V}_2\text{S}_5$
- 17)  $\text{Cr}(\text{OH})_3$
- 18)  $\text{LiI}$
- 19)  $\text{Pb}_3\text{N}_2$
- 20)  $\text{AgBr}$

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

$\text{CCl}_4$  = Carbon tetra chloride

$\text{P}_2\text{O}_5$  = diphosphorus pentoxide

Practice Problems Molecular Compounds

- |                            |                          |
|----------------------------|--------------------------|
| 1) $\text{BBr}_3$          | 6 $\text{SF}_6$          |
| 2) $\text{C}_2\text{Br}_6$ | 7 $\text{H}_2\text{O}_2$ |
| 3) $\text{IO}_2$           | 8 $\text{NH}_3$          |
| 4) $\text{CH}_4$           | 9 $\text{SiO}_2$         |
| 5) $\text{N}_2\text{O}_3$  | 10 $\text{AsF}_3$        |

### Mixed naming Practice

- |                           |                                      |                                   |
|---------------------------|--------------------------------------|-----------------------------------|
| 1) dinitrogen trioxide    | 8 ZnS                                | 15 HCl                            |
| 2) nitrogen               | 9 SiF <sub>4</sub>                   | 16. HNO <sub>2</sub>              |
| 3) methane                | 10 Ag <sub>3</sub> PO <sub>4</sub>   | 17 H <sub>3</sub> PO <sub>4</sub> |
| 4) lithium acetate        | 11 K <sub>3</sub> N                  | 18 HIO                            |
| 5) phosphorus trifluoride | 12 V <sub>2</sub> S <sub>3</sub>     | 19 H <sub>2</sub> SO <sub>3</sub> |
| 6) vanadium (V) oxide     | 13 Zn(NO <sub>2</sub> ) <sub>2</sub> | 20 HI                             |
| 7) aluminum hydroxide     | 14 P <sub>4</sub>                    |                                   |

### 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. Round your answer after the final operation.

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

6. 0.13592

2. 53

7. -0.0038

3. 6,926,300,000

8. 0.00000013

4. -392

9. -0.567

5. 0.00361

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  $5.3 \times 10^{-2} \text{ cm}^3$  if the density of copper is  $8.94 \text{ g/cm}^3$ .

.

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  $0.879 \text{ g/ml}$ . What is the density of the solid?

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

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

Use the website below or find your own to learn about the 5 types of chemical reactions, how to write balanced 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  $1.56 \times 10^{21}$  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,  $\text{Al}_2\text{O}_3$ ?
- 3) How many moles of Al are in 2.16 mol of  $\text{Al}_2\text{O}_3$ ?
- 4) Aluminum sulfate,  $\text{Al}_2(\text{SO}_4)_3$ , 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  $\text{Al}_2(\text{SO}_4)_3$ ?
- 5) How many moles of  $\text{H}_2$  and  $\text{N}_2$  can be formed by the decomposition of 0.145 mol of ammonia,  $\text{NH}_3$ ?
- 6) What is the total number of atoms in 0.260 mol of glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$ ?
- 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  $\text{Ca}_3(\text{PO}_4)_2$
  - e. 0.625 mol  $\text{Fe}(\text{NO}_3)_3$
  - f. 0.600 mol  $\text{C}_4\text{H}_{10}$
  - g. 1.45 mol  $(\text{NH}_4)_2\text{CO}_3$
- 8) Calculate the number of moles of each compound:
  - a. 21.5 g  $\text{CaCO}_3$
  - b. 1.56 g  $\text{NH}_3$
  - c. 16.8 g  $\text{Sr}(\text{NO}_3)_2$
  - d. 6.98  $\mu\text{g}$   $\text{Na}_2\text{CrO}_4$

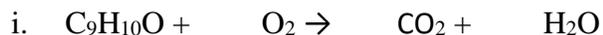
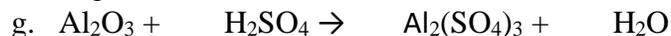
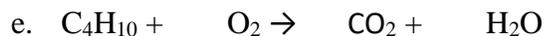
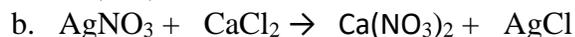
<https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiome/empirical-molecular-formula/v/formula-mass-composition>

### Percent composition and empirical formulas

- 9) Calculate the percentage composition by mass of each element in the following compounds:
- $\text{NaH}_2\text{PO}_4$
  - $\text{NH}_4\text{H}_2\text{PO}_4$
- 10) Phencyclidine is  $\text{C}_{17}\text{H}_{25}\text{N}$ . 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  $7.14 \times 10^{21}$  atoms of N in the compound  $\text{N}_2\text{O}_5$ ?
- 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,  $\text{Na}_x\text{Tc}_y\text{O}_z$ .
- 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  $\text{CO}_2$  and 0.805g  $\text{H}_2\text{O}$  were obtained. What is the empirical formula of the compound.

## Balancing equations

15) Balance the following reactions:



<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,  $\text{Na}_2\text{S}_2\text{O}_3$ :



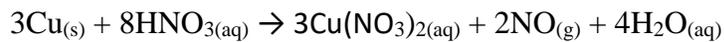
- How many moles of  $\text{Na}_2\text{S}_2\text{O}_3$  are needed to react with 0.12mol of  $\text{Cl}_2$ ?
- How many moles of  $\text{HCl}$  can form from 0.12mol of  $\text{Cl}_2$ ?
- How many moles of  $\text{H}_2\text{O}$  are required for the reaction of 0.12mol of  $\text{Cl}_2$ ?
- How many moles of  $\text{H}_2\text{O}$  react if 0.24mol  $\text{HCl}$  is formed?

17) The incandescent white of a fireworks display is caused by the reaction of phosphorous with  $\text{O}_2$  to give  $\text{P}_4\text{O}_{10}$ .

- Write the balanced chemical equation for the reaction.

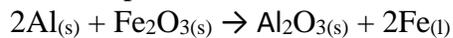
- b. How many grams of O<sub>2</sub> are needed to combine with 6.85g of P?
- c. How many grams of P<sub>4</sub>O<sub>10</sub> can be made from 8.00g of O<sub>2</sub>?
- d. How many grams of P are needed to make 7.46g P<sub>4</sub>O<sub>10</sub>?

20) In *dilute* nitric acid, HNO<sub>3</sub>, copper metal dissolves according to the following equation:



How many grams of HNO<sub>3</sub> are needed to dissolve 11.45g of Cu?

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



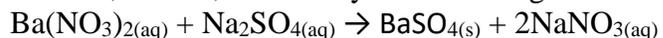
produces so much heat the iron that forms is molten. Because of this, railroads use the reaction to provide molten steel to weld steel rails together when laying track. Suppose that in one batch of reactants 4.20mol Al was mixed with 1.75mol  $\text{Fe}_2\text{O}_3$ .

- 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,  $\text{AgNO}_3$ , reacts with iron(III) chloride,  $\text{FeCl}_3$ , to give silver chloride,  $\text{AgCl}$ , and iron(III) nitrate,  $\text{Fe}(\text{NO}_3)_3$ . A solution containing 18.0g  $\text{AgNO}_3$  was mixed with a solution containing 32.4g  $\text{FeCl}_3$ . How many grams of which reactant *remains* after the reaction is over?

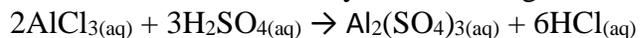
### Theoretical and percent yield

23) Barium sulfate, BaSO<sub>4</sub>, is made by the following reaction:



An experiment was begun with 75.00g of Ba(NO<sub>3</sub>)<sub>2</sub> and an excess of Na<sub>2</sub>SO<sub>4</sub>. After collecting and drying the product, 63.45g BaSO<sub>4</sub> was obtained. Calculate the theoretical yield and percent yield of BaSO<sub>4</sub>.

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



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<sub>3</sub> was mixed with 30.0g H<sub>2</sub>SO<sub>4</sub>. Eventually, 28.46g of pure Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> was isolated. Calculate the percent yield.