Unit 1: Matter and Chemical Bonding

- ☐ Determine atomic number, atomic mass, number of electrons and number of neutrons for an element
- ☐ Identify how ionic and covalent bonds are formed
- ☐ Identify the properties of ionic and molecular compounds – similarities/differences
- ☐ Identify trends and predict patterns on the periodic table for
    - ☐ Reactivity
    - ☐ atomic radii
    - ☐ Ionization Energy
    - ☐ Electron Affinity
    - ☐ Electro Negativity
- ☐ Draw Lewis structures to represent ionic bonding between atoms in ionic compounds
- ☐ Draw Lewis structures to represent covalent bonding between atoms in molecules
- ☐ Predict the type of bond (ionic, polar covalent, non-polar covalent) based on the electronegativity of the elements
- ☐ Determine if a molecule is polar or non-polar based on symmetry – Lewis structures
- ☐ Predict the intermolecular forces between molecules
- ☐ Predict the physical properties of a substance based on its bonding/intermolecular forces (Melting Point, solubility, conductivity)

Practice Problems

1. Complete the table below.

Element name	Element symbol	Atomic number	Group number	Family name	Period number	Metal or nonmetal
fluorine						
	Ba					
				noble gas	3	

2. What is the group number of the alkaline earth metals?
3. What is the family name for Group 17?
4. What is electronegativity?
5. What is the difference between ionization energy and electron affinity?
6. Why does ionization energy increase from left to right in a period on the periodic table?
7. Which element has the smallest atomic radius?
8. The electronegativity of magnesium, Mg, is 1.2. Would you expect aluminum's electronegativity to be higher or lower?

9. For a science fair project, a student wants to design a simple device for removing certain gases from polluted air. He knows that polar molecules dissolve well in water, so he bubbles polluted air through a jug of water to remove unwanted gases. For his project, the student uses air containing the following gases:

1. $N_{2(g)}$
2. $O_{2(g)}$
3. $HF_{(g)}$
4. $NH_{3(g)}$

5. $CH_{4(g)}$
6. $OCl_{2(g)}$
7. $C_3H_{8(g)}$
8. $CH_3OCH_{3(g)}$

List the gases that will dissolve by writing down their corresponding numbers.

10. Draw Lewis diagrams to explain the empirical formula for the following substances.
    a. $KI_{(s)}$
    b. $Br_{2(l)}$
    c. $O_{2(g)}$
    d. $BaCl_{2(s)}$

11. Write a sentence to describe the theoretical structure of ionic compounds.

12. List three empirical properties of the molecular elements (i.e., nonmetals).

13. A student records the following evidence in a lab book.

Unknown substance	Pure state	Solubility in water	Solution conductivity
I	solid	high	low
II	solid	low	low
III	solid	high	none
IV	solid	high	high

Which of the substances in the table above is most likely an ionic compound? Explain your answer.

14. Use Lewis dot diagrams to explain the formula for $CaCl_2$.

15. Use Lewis dot diagrams to explain the formula for Na_2O.

16. Draw the Lewis dot diagrams for ammonia and ammonium ion.

17. Draw the Lewis dot diagram for carbon monoxide and carbon dioxide.

18. Use Lewis dot diagrams to explain why oxygen and fluorine are diatomic elements.

19. Use a Lewis dot diagram to explain why ammonia is a polar molecule.

Unit 2 Part 1: Nomenclature

☐ I can identify and name ionic compounds
☐ I can identify and name compounds with multivalent metals
☐ I can identify and name polyatomic ions
☐ I can name molecular compounds
☐ I can name binary acids
☐ I can name oxyacids
☐ I can convert names into molecular formulas for ionic compounds
☐ I can convert names into molecular formulas for compounds with multivalent metals
☐ I can convert names into molecular formulas for ionic compounds containing polyatomic ions
☐ I can convert names into molecular formulas for molecular compounds
☐ I can convert names into molecular formulas for binary acids
☐ I can convert names into molecular formulas for oxyacids

Practice

Name the following:

NaF	
CCl_4	
MgO	
$CaSO_4$	
MgS	
CaF_2	
N_2O_4	
NaBr	
Li_3N	
Na_3PO_4	
$AlCl_3$	
NO_2	
$Pb(NO_3)_2$	
CO	
$CuSO_4$	

Give the formula:

potassium oxide _____   silicon dioxide _____

lithium sulphide _____   ammonium hydroxide__ _____

sodium carbonate _____   copper(I) nitrate _____

nitrogen dioxide _____   diphosphorous pentoxide _____

potassium fluoride _____   sodium phosphide _____

iron(II) chloride _____   aluminum sulphate _____

carbon tetrafluoride _____   calcium chloride _____

aluminum nitride _____

Unit 2 Part 2: Reactions

- ☐ Can balance chemical equations
- ☐ Can identify the states for elements, ionic compounds, and commonly used substances ie: carbon dioxide, CO_2
- ☐ Can identify synthesis reactions
- ☐ Can identify decomposition reactions
- ☐ Can identify single displacement reactions
- ☐ Can identify double displacement reactions
- ☐ Can identify combustion reactions
- ☐ Can identify oxidation reactions
- ☐ Can identify neutralization reactions
- ☐ Can predict the products of synthesis reactions
- ☐ Can predict the products of decomposition reactions
- ☐ Can use the activity series of metals to predict the products of single displacement reactions
- ☐ Can use the solubility table to predict precipitates
- ☐ Can identify acids and bases and the products of neutralization reactions with
  - — Hydroxide
  - — Carbonate
- ☐ Can identify hazards associated with handing acids and bases
- ☐ Can identify the products of complete combustion
- ☐ Can identify the products of incomplete combustion
- ☐ Can identify the reaction conditions for complete combustion
- ☐ Can identify the reaction conditions for incomplete combustion
- ☐ Can identify the hazards associated with incomplete combustion
- ☐ Can identify acidic oxides and the products of their reactions with water
- ☐ Can identify basic oxides and the products of their reactions with water

Practice

1. Predict the products for the following chemical reaction:
   A sulfuric acid spill is neutralized by a sodium hydroxide solution.
2. Predict the products and write a balanced chemical equation for the following chemical reaction:
   Mercury(II) oxide is decomposed by heat to test the law of conservation of mass.
3. Predict the products and write a balanced chemical equation for the following chemical reaction:
   Copper wire is added to an aqueous solution of silver nitrate to recover the silver.
4. Predict the products and write a balanced chemical equation for the following chemical reaction:
   Aqueous calcium chloride is added to a small amount of solution suspected to contain sodium phosphate.
5. Predict the products and write a balanced chemical equation for the following chemical reaction:
   Pure methane gas is burned in a barbecue.
6. Predict the products and write a balanced chemical equation for the following chemical reaction.
   Charcoal (pure carbon) is burned in a barbecue.
7. What are the products of the reaction between butane, $C_4H_{10(g)}$, and oxygen?
8. Complete the following chemical reaction equation, including states of matter and balancing:
   $FeCl_{3(aq)} + Zn_{(s)} \rightarrow$

Unit 3: Quantities in Chemical Reactions

- ☐ I can use my nomenclature to convert names to chemical formulas and vise versa
- ☐ I can predict the products of reactions
    - ☐ Synthesis
    - ☐ Decomposition
    - ☐ Single displacement
    - ☐ Double displacement
    - ☐ Combustion
- ☐ I can balance chemical equations
- ☐ I can use scientific notation
- ☐ I can use significant figures
- ☐ I can use my calculator to do calculations using scientific notation
- ☐ I can convert moles to number of entities using Avogadro's number
- ☐ I can convert number of entities to moles using Avogadro's number
- ☐ I can determine the molecular mass of compounds using the periodic table
- ☐ I can convert mass to moles using the mole equation
- ☐ I can convert moles to mass using the mole equation
- ☐ I can determine molar mass using the mole equation
- ☐ I can calculate % composition of compounds using molar mass
- ☐ I can determine empirical formulas
- ☐ I can determine molecular formulas
- ☐ I can do basic (mole) stoichiometry using mole ratios
- ☐ I can do mass stoichiometry
- ☐ I can do determine limiting reagents and do the related stoichiometry
- ☐ I can determine % yield

Stoichiometry Problem Solving Model

1) Write out a **BALANCED** chemical equation for the reaction studied.
2) List the given and required information under the chemical they pertain to.
3) Convert your given information into moles (determine limiting reactant if it applies)
4) Use mole ratio (from the balanced chemical equation) to determine the number of moles of the required.
5) Convert the moles of required to the measurement unit asked for.

Practice

1. State the law of definite proportions.
2. Determine the number of molecules found in 5.00 mol of water.
3. Determine the number of oxygen atoms found in 1.75 mol of potassium sulfate, K_2SO_4.
4. Convert 0.227 mol of potassium sulfate into mass (in grams).
5. Calculate the mass (in grams) found in 0.805 mol of sulfur.
6. Briefly state the difference between empirical and molecular formulas and provide an example of each
7. Translate the following into a balanced chemical equation:
   One mole of aqueous ethanol reacts with 3 mol of oxygen gas to produce 2 mol of carbon dioxide gas and 3 mol of water in the gaseous state.
8. Consider the following balanced equation: $4ZnS + 6O_2 \rightarrow 4ZnO + 4SO_2$
   Determine the number of moles of zinc oxide produced when 2.5 mol of zinc sulfide is combined with 4.0 mol of O_2.

Unit 4: Solutions

- ☐ I can remember the 4 unique characteristics of water
- ☐ I can name the parts of a solution
- ☐ I can predict the solubility of substances based on whether they are polar, non-polar or ionic compounds
- ☐ I can explain how a salt dissolves in water
- ☐ I can explain why polar molecules are soluble in water while non-polar molecules are not soluble in water
- ☐ I can write dissociation equations and balance them
- ☐ I can calculate the molarity of solution using the equation C=n/V
    - ☐ And I can rearrange this equation appropriately to solve for n or V
- ☐ I can use the equation $C_cV_c=C_dV_d$ to solve problems involving dilution
- ☐ I can determine the concentration of a solution as a %V/V, %W/V and %W/W
- ☐ I can determine the concentration of a solution in ppm, ppb and solve problems using the formula ppm = $(m_{solute}/m_{solution}) \times 10^6$
- ☐ I can determine the precipitate in a double displacement reaction using the solubility table
- ☐ I can write formula equations for double displacement reactions
- ☐ I can write total ionic equations for double displacement reactions
- ☐ I can write net ionic equations for double displacement reactions
- ☐ I can determine a procedure to check for and remove certain ions from a solution using solubility rules (solubility table)
- ☐ I can use stoichiometry to solve problems involving solutions
- ☐ I can name some properties of acids
- ☐ I can name some properties of bases
- ☐ I can remember the pH scale
- ☐ I can name acids
- ☐ I can name bases
- ☐ I can recall the Ahrrenius definition of and acid and a base
- ☐ I can write ionization equations
- ☐ I can recall the difference between a weak acid and a strong acid and explain why hydrochloric acid, HCl, is a strong acid while acetic acid, CH3COOH, is a weak acid.
- ☐ I can explain what a titration is and why we perform them
- ☐ I can use stoichiometry to determine the concentration of an unknown acid/base from a titration

Practice

1. As temperature increases, the solubility of $NaNO_3$ in water increases and the solubility of oxygen decreases. Give reasons for these different solubility trends.
2. Why is water a polar molecule?
3. Using the solubility table below, state whether the following ionic compounds are soluble or insoluble in water.

Compound	Soluble or insoluble
(a) PbI_2	
(b) $KClO_3$	
(c) $CaCO_3$	
(d) $BaSO_4$	

4. Differentiate between the terms saturated, unsaturated, and supersaturated.

5. Consider the following reaction: aqueous nickel(II) nitrate reacts with aqueous sodium sulphite. For this reaction, write
   a. a balanced chemical equation
   b. a total ionic equation
   c. a net ionic equation
6. Write the ionic equation to represent the dissociation of calcium hydroxide.
7. List three empirical properties for acids and three empirical properties for bases.
8. According to the revised Arrhenius theory, define an acid and a base.
9. Define acid and base according to the Bronsted-Lowry theory.
10. Identify the two acid-base conjugate pairs in the following reaction:
    $HF(aq) + H_2O(l) \rightarrow H_3O^+(aq) + F^-(aq)$
11. Write the balanced chemical equation for the neutralization of aqueous phosphoric acid by potassium hydroxide.

Unit 5: Gas Laws

☐ I can name the common states of matter and the differences between them
☐ I can name the three types of motion and relate this to types of matter
☐ I can convert units of pressure
☐ I can convert temperature from Celsius to kelvins and vise versa
☐ I can use Charles' Law
☐ I can use Boyle's Law
☐ I can use Gay Lussac's law
☐ I can use the combined gas law
☐ I can use Avogadro's gas law
☐ I can use the ideal gas law
☐ I can use the law of combining volumes to solve problems involving stoichiometry
☐ I can use the ideal gas law to solve problems involving stoichiometry

Practice

1. If the absolute temperature of a gas is doubled and the pressure is tripled, what happens to the volume of the gas? Assume ideal gas behaviour.
2. What are the three types of motion for particles?
3. What does the acronym KMT stand for?
4. Rank the following states of matter on their fluidity, from the most fluid to the least fluid:
   a. Solid
   b. Liquid
   c. gas
5. Use the kinetic molecular theory to explain why gases are more compressible than solids or liquids.
6. On a piece of paper, sketch the relationship that exists between the pressure of a gas and the volume it occupies, assuming the temperature and amount of gas used remains constant. The pressure values were determined beforehand and measured in atmospheres, while the volume was measured in litres. Explain the relationship in your own words.
7. Explain Boyle's law using the kinetic molecular theory.
8. Solve for the missing variable in the following chart:

P_1	P_2	V_1	V_2
101 kPa	125 kPa	7.52 L	?

9. Complete the following chart, assuming that the initial conditions were taken at SATP:

P_1	V_1	T_1	P_2	V_2	T_2
			125 kPa	15.5 L	375 K

10. A bubble of methane gas, CH_4, is released from a deep bog. The temperature at the bottom of the bog is 12ºC with a pressure of 375 kPa. If the bubble has a volume of 475 mL at the bottom, what will the new volume be, just underneath the surface of the bog water level, if the outside temperature is 35ºC and the pressure is 99.5 kPa?

Additional Practice

1. Natural argon contains three isotopes: Ar-36, Ar-38, and Ar-40. In a sample, 0.34% of the atoms are Ar-36, 0.06% of the atoms are Ar-38, and 99.60% of the atoms are Ar-40. Using a sample population of 10,000 argon atoms, calculate the average atomic mass of argon.

2. Sodium thiosulfate, $Na_2S_2O_3$, can be used as a fixer in the field of photography. Calculate the percentage composition, by mass, of each element in sodium thiosulfate.

3. What is the empirical formula of a compound whose percentage composition is found to be 2.20% hydrogen, 26.7% carbon, and 71.1% oxygen?

4. Glucose contains 39.95% C, 6.71% H, and 53.34% O, by mass. If the molar mass of glucose was found experimentally to have a molar mass of 180.0 g/mol, calculate its molecular formula.

5. Potassium chlorate decomposes to form potassium chloride and oxygen gas. What mass of potassium chlorate is required to form 120.0 g of potassium chloride?

6. Consider the following balanced equation: $2AgNO_3 + CaCl_2 \rightarrow 2AgCl + Ca(NO_3)_2$
   Calculate the number of moles of AgCl that will be produced when 135.0 g of calcium chloride are reacted.

7. Consider the following balanced equation: $2Li_3PO_4 + 3Zn(NO_3)_2 \rightarrow Zn_3(PO_4)_2 + 6LiNO_3$
   Determine the mass of lithium phosphate required to react completely with 415.0 g of zinc nitrate

8. Consider the following balanced equation: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
   Determine the limiting reagent when 12.0 g of methane, CH_4, and 20.0 g of oxygen gas are available for reaction.

9. Consider the following reaction: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
   How many grams of carbon dioxide will be produced when 15.0 g of CH_4 and 30.0 g of O_2 are available for reaction?

10. Sodium chloride is produced when sodium metal combines with chlorine gas as shown in the following balanced equation: $2 Na + Cl_2 \rightarrow 2 NaCl$
    In an experiment, 36.9 g of sodium chloride is produced when 15.9 g of Na and 27.4 g of chlorine are combined. Determine the percentage yield of the product.

11. D5W is an intravenous solution used as a fluid and nutrient replenisher for patients. As a hospital pharmacist you need to make 750 mL of this solution with a concentration of 0.30 mol/L. What mass of glucose, $C_6H_{12}O_6$, will you need to dissolve in water?

12. T.S.P. is an all purpose cleaner that can be used to clean driveways. What volume of solution would you get if you dissolved 150.0 g of sodium phosphate with water to produce a 0.23 mol/L solution?

13. Concentrated hydrogen peroxide in high school labs is 30% W/V H_2O_2 dissolved in water. Calculate the mass of pure H_2O_2 dissolved in a 450-mL bottle?

14. A "sports drink" contains 50 mg of sodium ions and 55 mg of potassium ions per 400 mL serving. Calculate the concentration of the sodium and potassium ions in ppm.

15. What volume of a 17.4 mol/L acetic acid stock solution is required to make 2.0 L of a 1.5 mol/L acetic acid solution?

16. The concentration of an HCl acid solution is initially 6.0 mol/L. What would the concentration of a new solution be if 200 mL of the original HCl solution is diluted to 1.0 L with water?

17. How much water must be added to 600 mL of a 1.5 mol/L $CaCl_2$ solution to make the concentration of the resulting solution 1.0 mol/L?

18. Assume that laundry detergent is mostly sodium carbonate. Calculate the concentration of the sodium carbonate if a 95.0-g scoop of detergent is dissolved in 25.0 L of water in the washing machine?

19. A titration was performed on a 10.00-mL sample of water taken from an acidic lake. If it took 8.66 mL of 0.0512 mol/L $NaOH_{(aq)}$ to neutralize the sulfuric acid in the lake water sample, calculate the concentration of the sulfuric acid.

20. A teaspoon of milk of magnesia contains 12.0 mg of magnesium hydroxide. What volume of 0.01 mol/L HCl in a person's stomach would be neutralized by this teaspoon of antacid?

21. Determine the volume of a balloon at STP assuming that it occupies a volume of 7.75 L at a temperature of 0ºC and a pressure of 125 kPa.

22. Determine the volume occupied by 3.45 g of carbon dioxide gas at STP.

23. What is the reading on the pressure gauge if a canister holds 0.155 mol of N_2 at 23ºC and has a volume of 8.95 L?

24. Calculate the volume that 3.25 mol of He gas will occupy at a temperature of 25ºC and a pressure of 799 mm of Hg.

25. Determine the number of moles of neon gas contained in a 5.25-L gas tank at 105 kPa and a temperature of 299 K. If the gas is nitrogen instead of neon, will the answer be the same? Explain your reasoning.

26. A balloon is brought to the top of Mt. Logan where it occupies a volume of 775 mL at a temperature of – 28ºC and a pressure of 92.5 kPa. What is the pressure at the bottom of the mountain if the same balloon has a volume of 825 mL at a temperature of 15ºC?

27. A sample of neon occupies 3.25 L at 35ºC and 1829 mm Hg. What will the temperature of the gas be, in degrees Celsius, at a volume of 4250 mL and a pressure of 1.25 atm?

28. How is the activity series used to predict single displacement reactions? Create three single displacement reactions where a reaction occurs and two where a reaction does not occur.