

Year End Review

Unit 1: Matter and Chemical Bonding

- Describe why Mendeleev's periodic law needed to be changed. State the modern periodic law.
- Draw Bohr/Rutherford diagrams and Lewis/electron dot diagrams for the following elements: Ca, N, Ar, B, O
- State the periodic trends for atomic radius, ionization energy, electron affinity and electronegativity.
- Explain why atomic radius decreases as you move left to right on the periodic table, but increases as you move top to bottom.
- Predict which of the following atoms:
 - has the largest first ionization energy: P, Cl, Na
 - has the smallest atomic radius: I, F, Br
 - is the most reactive metal: Cs, Ca, Al
- Draw Lewis/electron dot diagrams for the following compounds:
 - HCl
 - Cl₂
 - HCN
 - NF₃
 - BrSiN
 - COCl₂
 - SiCl₄
 - N₂
- Define or explain the following terms:
 - radioisotope
 - 2nd ionization energy
- Differentiate between:
 - average atomic mass and mass number
 - ionic, covalent and polar covalent bonding; give an example for each
- Determine whether the bonds between the following elements will be covalent, polar covalent or ionic:
 - Na and F
 - S and O
 - F and F
- Identify the ion that each of the following atoms will most likely form:
 - F
 - Ne
 - K
 - Si
 - P
 - Be
- Calculate the average atomic mass for lithium if 92.6% is ${}^7\text{Li}$ and 7.4% is ${}^6\text{Li}$.

12. Complete the following chart:

Element	Atomic Number	Mass Number	Number of Protons	Number of Electrons	Number of Neutrons
Fe	26	56			
		64	29		
			15		16
Ti		48			
	79	197			
	19			19	

13. Write the chemical formula for each of the following compounds:

- | | |
|---------------------------|----------------------------|
| a) magnesium bromide | n) beryllium iodide |
| b) carbon tetrafluoride | o) chlorine |
| c) strontium oxide | p) gold |
| d) dihydrogen disulfide | q) cobalt (III) bromide |
| e) aluminum oxide | r) phosphorous trichloride |
| f) calcium phosphide | s) silver nitrate |
| g) dinitrogen pentoxide | t) copper (I) sulfate |
| h) nitrogen trifluoride | u) potassium chlorate |
| i) dihydrogen monoxide | v) calcium phosphite |
| j) iron (III) oxide | w) chlorous acid |
| k) hydrochloric acid | x) hydrosulfuric acid |
| l) ammonium carbonate | y) sodium acetate |
| m) manganese (IV) sulfate | z) hypofluorous acid |

14. Name the following compounds:

- | | |
|---------------------------------------|--------------------------------------|
| a) CO_2 | n) $(\text{NH}_4)_3\text{PO}_4$ |
| b) Na_2S | o) $\text{Na}_2\text{C}_2\text{O}_4$ |
| c) P_2S_5 | p) KMnO_4 |
| d) KF | q) $\text{Ca}(\text{OH})_2$ |
| e) PF_3 | r) $\text{Fe}(\text{CNO})_2$ |
| f) Ca_3P_2 | s) CuClO |
| g) $\text{HBr}(\text{aq})$ | t) $\text{HNO}_2(\text{aq})$ |
| h) $\text{Zn}(\text{NO}_3)_2$ | u) $\text{Al}_2(\text{CrO}_4)_3$ |
| i) N_2 | v) $\text{Pb}(\text{SO}_4)_2$ |
| j) Cl_4 | w) $\text{HClO}_4(\text{aq})$ |
| k) AgCl | x) SO_3 |
| l) CaCO_3 | y) NaCl |
| m) $\text{H}_2\text{SO}_4(\text{aq})$ | z) CS_2 |

Unit 2: Chemical Reactions

1. Balance the following equations:
 - a) $\text{N}_2 + \text{H}_2 \rightarrow \text{NH}_3$
 - b) $\text{C}_6\text{H}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
 - c) $\text{Fe} + \text{H}_2\text{O} \rightarrow \text{Fe}_3\text{O}_4 + \text{H}_2$
 - d) $\text{N}_2\text{H}_4 + \text{O}_2 \rightarrow \text{N}_2 + \text{H}_2\text{O}$
 - e) $\text{C}_5\text{H}_{12} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
 - f) $\text{Pb}(\text{NO}_3)_2 + \text{NaI} \rightarrow \text{PbI}_2 + \text{NaNO}_3$
 - g) $\text{AlH}_3 + \text{O}_2 \rightarrow \text{Al}_2\text{O}_3 + \text{H}_2\text{O}$
2. Classify the following reactions as synthesis, decomposition, single displacement or double displacement reactions. Indicate products in the cases where they are missing and balance all equations.
 - a) $\text{Al} + \text{Cl}_2 \rightarrow$
 - b) $\text{Ba}(\text{NO}_3)_2 + \text{Na}_2\text{SO}_4 \rightarrow$
 - c) $\text{KClO}_3 \rightarrow \text{KCl} + \text{O}_2$
 - d) $\text{Fe}(\text{OH})_3 + \text{HCl} \rightarrow$
 - e) $\text{NH}_3 + \text{O}_2 \rightarrow \text{NO} + \text{H}_2\text{O}$
 - f) $\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_4\text{Cl}$
 - g) $\text{HCl} + \text{AgNO}_3 \rightarrow$
 - h) $\text{Zn} + \text{HCl} \rightarrow$
 - i) $\text{Ca} + \text{FeSO}_4 \rightarrow$
 - j) $\text{Mg} + \text{O}_2 \rightarrow$
 - k) $\text{Cl}_2 + \text{KBr} \rightarrow \text{Br}_2 + \text{KCl}$

Unit 3: Quantities in Chemical Reactions

1. Calculate the number of moles contained in:
 - a) 76.9 g CaBr_2
 - b) 0.73 g H_2
 - c) 14.93 g $(\text{NH}_4)_2\text{SO}_4$
 - d) 236.2 g Al
2. Calculate the mass of:
 - a) 9.20 mol NaCl
 - b) 0.360 mol Cl_2
 - c) 1.26 mol NaF
 - d) 10.2 mol C_3H_6
3. Calculate the percentage carbon in each of the following compounds:
 - a) NaHCO_3
 - b) $\text{C}_6\text{H}_{12}\text{O}_6$
 - c) $\text{Al}_2(\text{CO}_3)_3$
4. Calculate the simplest (empirical) formula for a compound containing:
 - a) 29.1% sodium, 40.5% sulfur, 30.4% oxygen
 - b) 31.9% potassium, 28.9% chlorine, 39.2% oxygen
5. The composition of nicotine is 74.0% carbon, 8.7% hydrogen and 17.3% nitrogen. The molar mass of nicotine is 162 g/mol. Calculate its molecular formula.

6. A compound contains 12.1% carbon, 16.2% oxygen and 71.7% chlorine. What is the molecular formula if one mole has a mass of 297 g?
7. $3\text{Cu(s)} + 8\text{HNO}_3\text{(aq)} \rightarrow 3\text{Cu(NO}_3)_2\text{(aq)} + 2\text{NO(g)} + 4\text{H}_2\text{O(l)}$
a) How many moles of nitric acid are needed to react with 2.56 mol of copper?
b) How many grams of water will be produced if 245.6 g of copper are reacted?
c) How many grams of copper (II) nitrate will be produced if 4.5 mol of nitric acid are reacted?
8. Under the right conditions, ammonia can be converted to nitrogen monoxide by the following (unbalanced) reaction:
 $\text{NH}_3\text{(g)} + \text{O}_2\text{(g)} \rightarrow \text{NO(g)} + \text{H}_2\text{O(l)}$
a) How many grams of O_2 are needed to react with 56.8 g NH_3 ?
b) How many grams of NO could be produced by reacting 125.0g NH_3 ?
9. $\text{Al} + \text{CuCl}_2 \rightarrow \text{Cu} + \text{AlCl}_3$
If 0.25 g of aluminum reacts with 0.51 g of copper (II) chloride, how many grams of copper will be produced?
10. $\text{CaF}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{HF} + \text{CaSO}_4$
If 10.0 g of calcium fluoride reacts with 15.5 g of sulfuric acid, how many grams of HF will be produced?
11. Marble is made primarily of calcium carbonate. When calcium carbonate reacts with hydrogen chloride, it forms calcium chloride, carbon dioxide and water. Suppose 15.7 g of calcium carbonate is reacted with 11.1 g of hydrogen chloride. If 9.4 g of calcium chloride is actually produced, what is the percent yield?

Unit 4: Solutions and Solubility

1. Define the following terms: solubility, saturated solution, unsaturated solution, supersaturated solution
2. How does temperature affect the solubility of gases, liquids and solids in a liquid solvent?
3. Describe what happens on a molecular level when an ionic compound is dissolved in water.
4. Calculate the concentration of the following solution in mol/L:
a) 2.3 mol of HCl is dissolved in 3.4 L of water
b) 17.4 g of NaCl is dissolved in 425 mL of water
5. If you add water to dilute 450 mL of a 2.1 mol/L solution to a final volume of 1300 mL, what is the concentration of the new solution?
6. What volume of 1.25 mol/L Na_2CO_3 solution would contain 3.26 g Na_2CO_3 ?

7. Differentiate between the Arrhenius and Bronsted theories of acids and bases.
8. In the following equations, indicate the acid, base, conjugate acid and conjugate base:
 - a) $\text{HBr} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{Br}^-$
 - b) $\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{OH}^-$
9. Calculate the pH of the following solutions:
 - a) a solution which has a hydronium ion concentration of 2.5×10^{-4}
 - b) a 0.35 mol/L HCl solution
 - c) a 0.03 mol/L NaOH solution
10. Write the balanced chemical, total ionic and net ionic equations and identify the spectator ions for the following reactions:
 - a) $\text{Na}_2\text{S}(\text{aq}) + \text{FeSO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{FeS}(\text{s})$
 - b) $\text{NiCl}_2(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{NiCO}_3(\text{s}) + \text{NaCl}(\text{aq})$
11. Predict the products of the following reactions. If a precipitate forms, write the total ionic and net ionic equations.
 - a) $\text{NaBr}(\text{aq}) + \text{KNO}_3(\text{aq}) \rightarrow$
 - b) $\text{BaCl}_2(\text{aq}) + \text{Pb}(\text{NO}_3)_2(\text{aq}) \rightarrow$
 - c) $\text{Na}_2\text{CO}_3(\text{aq}) + (\text{NH}_4)_2\text{CO}_3(\text{aq}) \rightarrow$
12. 25.0 mL of 0.400 mol/L $\text{Pb}(\text{NO}_3)_2(\text{aq})$ is mixed with a 0.220 mol/L $\text{KI}(\text{aq})$ solution. A precipitate containing lead is formed.
 - a) What volume of $\text{KI}(\text{aq})$ is needed to completely react with the $\text{Pb}(\text{NO}_3)_2(\text{aq})$?
 - b) What will the mass of the precipitate be?
13. 13.84 mL of hydrosulfuric acid just neutralizes 25.00 mL of a 0.1000 mol/L solution of sodium hydroxide. What is the concentration of the acid?

Unit 5: Gases and Atmospheric Chemistry

1. Define each of the following:
 - a) Boyle's Law
 - b) Charles Law
 - c) Gay-Lussac's Law
 - d) Dalton's Law of Partial Pressures
 - e) Avogadro's hypothesis
 - f) molar volume
 - g) STP and SATP
2. Outline the kinetic molecular theory of gases.
3. Convert the following temperatures to Kelvin:
 - a) 26°C
 - b) -413°C
 - c) 125°C
4. Convert the following temperatures to $^\circ\text{C}$.
 - a) 926K
 - b) 100K
 - c) 333K

5. A student collects 25.0 mL of a gas at 90.0 kPa. What volume would the gas occupy at 150.0 kPa?
6. A gas measuring 252 mL is collected at 104.4 kPa. What pressure is needed to reduce the volume to 195 mL?
7. A gas occupies 50.0 mL at SATP. If the pressure remains constant, what temperature would be required to increase the volume of this gas to 65.0 mL?
8. A gas occupies a volume of 68.0 mL at SATP. What volume would the gas occupy at 30.0°C and 96.0 kPa?
9. 16.0 g of oxygen is introduced into an evacuated 10.0 L flask at 77°C. What is the pressure inside the container?
10. An 81.5 mL sample of hydrogen is collected over water at 98.0 kPa and 23.0°C. How many grams of hydrogen are present in this sample? (P_{w} at 23.0°C is 2.81 kPa)
11. What is the molar mass of a gas if 2.82 g of the gas occupy 3.16 L at STP?
12. How many grams of copper are needed to produce 224 mL of NO(g) at a 29.0°C and 100.0 kPa?
$$3\text{Cu(s)} + 8\text{HNO}_3\text{(aq)} \rightarrow 3\text{Cu(NO}_3)_2\text{(aq)} + 2\text{NO(g)} + 4\text{H}_2\text{O(l)}$$
13. A 130.8 g sample of Zn reacts with excess HCl.
$$\text{Zn(s)} + \text{HCl(aq)} \rightarrow \text{ZnCl}_2\text{(aq)} + \text{H}_2\text{(g)}$$
 - a) Calculate the volume of H₂ gas produced at SATP.
 - b) Calculate the volume of H₂ generated at 27.0°C and 98.6 kPa.