Unit 1 and 2: Matter and Chemical Bonding and Reactions

Multiple Choice: *Identify the letter of the choice that best completes the statement or answers the question.*

1. The person given credit for developing the first modern periodic table is
    a. Dalton
    b. Democritus
    c. Thomson
    d. Mendeleev
    e. Chadwick

2. Which of the following matches of group number and common name is incorrect?
    a. Group 7 - transition metals
    b. Group 2 - alkali earth metals
    c. Group 17 – halogens
    d. Group 2 - actinides
    e. Group 18 - noble gases

3. Why does ionization energy increase from left to right in a period?
    a. Nuclear charge increases from left to right in a period.
    b. Nuclear charge decreases from left to right in a period.
    c. The number of energy levels increases from left to right in a period.
    d. The number of energy levels decreases from left to right in a period.
    e. The number of electrons decreases from left to right in a period.

4. Why does electron affinity increase from bottom to top in a chemical family?
    a. Nuclear charge increases from bottom to top in a chemical family.
    b. Nuclear charge decreases from bottom to top in a chemical family.
    c. The number of energy levels increases from bottom to top in a chemical family.
    d. The number of energy levels decreases from bottom to top in a chemical family.
    e. The number of electrons increases from bottom to top in a chemical family.

5. Which of the following formulas does <u>NOT</u> represent a molecular compound?
    a. $CO_{2(g)}$
    b. $CoCl_{2(s)}$
    c. $SO_{2(g)}$
    d. $PCl_{5(g)}$
    e. $HCl_{(g)}$

6. An electron dot diagram for a nitrogen atom should show
    a. 1 lone pair and 3 bonding electrons
    b. 2 lone pairs and 2 bonding electrons
    c. 2 lone pairs and 3 bonding electrons
    d. 3 lone pairs and 1 bonding electrons
    e. 3 bonding electrons

7. The formula for lithium sulfate is
    a. $Li_1SO_{4(s)}$
    b. $Li_2SO_{3(s)}$
    c. $Li_2SO_{4(s)}$
    d. $Li_3SO_{4(s)}$
    e. $Li_1SO_{3(s)}$

8. Hydrogen can be used as an alternative fuel for automobiles. Classify the following chemical reaction:
    $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$
    a. combustion reaction
    b. decomposition reaction
    c. single displacement
    d. double displacement
    e. simple decomposition

9. Classify the following reaction: $Mg(OH)_2 + 2HNO_3 \rightarrow Mg(NO_3)_2 + 2H_2O$
    a. combustion
    b. synthesis
    c. decomposition
    d. single displacement
    e. double displacement

10. The greenhouse effect is caused by
    a. infrared radiation
    b. ultraviolet radiation
    c. water
    d. carbon dioxide
    e. all of the above

11. Classify the following chemical reaction: $3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$
    a. combustion
    b. synthesis
    c. decomposition
    d. single displacement
    e. double displacement

Short Answer

12. Why does ionization energy increase from left to right in a period on the periodic table?

13. Which element has the smallest atomic radius?

14. Examine the following 1st, 2nd, and 3rd ionization energies and state which element is most likely a noble gas.

	1st (eV)	2nd (eV)	3rd (eV)
Element X	5.139	47.286	71.64
Element Y	7.646	15.035	80.143
Element Z	21.564	40.962	63.45

15. Draw the electron dot diagrams for oxygen, sodium, boron, and neon.
16. Use electron dot diagrams to explain why hydrogen and nitrogen are diatomic elements.
17. Provide both the classical name and the IUPAC name for the following acids.

	Aqueous (aq)	Non-aqueous
(a) $HClO_{3(aq)}$		
(b) $HNO_{2(aq)}$		
(c) $HI_{(aq)}$		

18. Predict the products and write a balanced chemical equation for the following chemical reaction:
    Sodium metal is added to water.
19. Complete the following chemical reaction equation, including states of matter and balancing:
    $Na_2SO_{4(aq)}$ + $Pb(NO_3)_{2(aq)}$ →   What type of reaction is this?
20. a) Explain, in your own words, why ionic compounds are brittle, have extremely high melting points, and are solid at SATP. b) What is the structural diagram for $CaCl_2$ and MgO
21. Give an example of a compound that has polar covalent bonds but is a) non-polar overall b) polar overall. Represent these compounds with proper diagrams indicating their bond and overall polarity. What intermolecular forces are present in each molecule?

Unit 3: Quantities in Chemical Reactions Review

Multiple Choice: *Identify the letter of the choice that best completes the statement or answers the question.*

1. Chlorine has two naturally occurring isotopes, namely $^{37}_{17}Cl$ and $^{35}_{17}Cl$. The composition of chlorine is 25.0% $^{37}_{17}Cl$ and

   75.0% $^{35}_{17}Cl$. The average atomic mass of chlorine is
   a. 36.5 u   d. 45.5 u
   b. 35.5 u   e. 32.0 u
   c. 34.6 u
2. A mass of 2.20 kg of sodium phosphate is converted into the following number of moles
   a. 7.45 mol   d. 13.4 mol
   b. 74.5 mol   e. 45.8 mol
   c. 1.34 x 10^{-2} mol

3. The number of molecules found in 0.87 mol of carbon monoxide is
   a. 4.1 x 10^{23} molecules   d. 9.3 x 10^{24} molecules
   b. 5.2 x 10^{23} molecules   e. 1.5 x 10^{25} molecules
   c. 2.9 x 10^{24} molecules

4. A 100.0-g sample of a compound is composed of 16.3 g of carbon, 32.1 g of chlorine, and
    51.6 g of fluorine. The empirical formula of the compound is
   a. CClF   d. $C_3Cl_2F_6$
   b. CClF$_3$ e. $C_9Cl_6F_{18}$
   c. $C_2Cl_2F_6$
5. When copper is combined with a solution of silver nitrate, the resulting products are copper(II) nitrate and silver. The
    balanced equation for this reaction is
   a. Cu + $2AgNO_3$ → $Cu(NO_3)_2$ + $2Ag$
   b. $3Cu$ + $3AgNO_3$ → $3Cu(NO_3)_2$ + $3Ag$
   c. $2Cu$ + $2AgNO_3$ → $2CuNO_3$ + $2Ag$
   d. Cu + $2AgNO_3$ → $CuNO_3$ + $2Ag$
   e. $2Cu$ + $2AgNO_3$ → $2Cu(NO_3)_2$ + $2Ag$

Problem

6. Magnesium hydroxide, $Mg(OH)_2$, can be commonly found in antacids. Calculate the percentage composition, by mass, of each element in magnesium hydroxide.

7. A compound was found to contain 10.06% C, 89.10% Cl, and 0.84% H, by mass. If the molar mass of the compound is 119.6g/mol, calculate its molecular formula.

8. Consider the following reaction: $AlCl_{3(aq)} + 4NaOH_{(aq)} \rightarrow NaAlO_{2(aq)} + 3NaCl_{(aq)} + 2H_2O_{(l)}$
   How many grams of sodium chloride can be obtained from 4.46g of $AlCl_3$?

9. 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, 36.9g of sodium chloride is produced when 15.9g of Na and 27.4g of chlorine are combined. Determine the percentage yield of the product.

Unit 4: Solutions and Solubility Review

Multiple Choice: *Identify the letter of the choice that best completes the statement or answers the question.*

1. Which of the following has a concentration of 2 mol/L?
   a.   2 mol/1 L
   b.   2 mol/1000 mL
   c.   5 mol/2.5 L
   d.   2 mol/2 L
   e.   a, b, and c only

2. A solution that contains the maximum quantity of a solute at a specific temperature is
   a.   saturated
   b.   unsaturated
   c.   supersaturated
   d.   dissolved
   e.   none of the above

3. As the temperature of a solution increases, the solubility of salts _____ and the solubility of gases _____.
   a.   doesn't change, doesn't change
   b.   increases, decreases
   c.   increases, increases
   d.   decreases, decreases
   e.   decreases, increases

4. Which of the following combinations of aqueous solutions would produce a precipitate?
   a.   ammonium sulphide and zinc bromide
   b.   potassium chloride and sodium nitrate
   c.   iron(III) nitrate and potassium hydroxide
   d.   all of the above
   e.   a and c only

5. A compound that ionizes in water to form hydroxide ions is
   a.   an acid
   b.   a salt
   c.   a base
   d.   both a and b
   e.   both b and c

6. According to its Arrhenius definition, a weak base
   a.   partially reacts with water to form $OH^-(aq)$
   b.   fully reacts with water to form $OH^-(aq)$
   c.   completely dissociates to form $OH^-(aq)$
   d.   has very high pH
   e.   is an ionic hydroxide

Problem

7. 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?

8. 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?

9. Standard solutions of sodium oxalate, $Na_2C_2O_{4(aq)}$, are required for certain types of chemical analyses. If 8.5 g of sodium oxalate is dissolved in 500 mL of distilled water, calculate the concentration of the sodium ion and the concentration of the oxalate ion dissolved in this solution.

10. A student mixed 100.0 mL of a 0.100 mol/L solution of barium chloride with 100.0 mL of a 0.100 mol/L solution of iron(III) sulfate. The barium sulfate precipitate was filtered, dried, and was measured to have a mass of 2.0 g. Calculate the % yield of the barium sulfate.

11. A swimming pool has a pH of 7.5. Calculate the hydrogen ion concentration in the pool.

12. 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. What is the pH of this lake water?

13. The hydrogen ion concentration in beer is 3.12×10^{-5} mol/L. Calculate the pH of beer.

Unit 5: Gases Review

Multiple Choice: *Identify the letter of the choice that best completes the statement or answers the question.*

1. Which of the following statements are true?
    i.   As temperature goes down, molecules move more rapidly.
    ii. If the volume is constant, an increase in pressure may be a result of an increase in the number of molecules in the container.
    iii. The molecules of a gas are in constant, random, and nonlinear motion.
    iv. The volume of a given mass of gas varies directly with its absolute temperature when the pressure remains constant.
    a. (i) and (ii)   d. (i) and (iii)
    b. (ii) and (iii)   e. (ii) and (iv)
    c. (iii) and (iv)

2. How many molecules of an ideal gas are contained in 8.2 L at –73ºC and 50.6 kPa?
    a.   0.25   d.   7.5 x 1023
    b.   1.5 x 1023   e.   4.2 x 10–25
    c.   –4.1 x 1023

3. N_2 has a volume of 5.50 L at a pressure of 199.99 kPa and at a temperature of 25ºC. What must the temperature be if the new volume is 10.0 L, but is a constant pressure?
    a. 370ºC   d. 32ºC
    b. 269ºC   e. –109ºC
    c. 154ºC

4. The number of grams of helium in a balloon at a pressure of 99.8 kPa, a temperature of 301 K, and a volume of 0.785 L would be
    a.   0.125 g   d.   0.278 g
    b.   814 g   e.   none of the above
    c.   337 g

Problems

5.   What is the initial pressure of a gas if it occupied a volume of 375 mL, but now occupies a volume of 1.25 L at a pressure of 95.5 kPa. Assume that the temperature remains constant throughout the process.

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

7.   A sample of a gas occupies 15.5 L at 245ºC and under a pressure of 95.5 kPa. At what temperature, in degrees Celsius, will the gas occupy a volume of 20.5 L if the pressure is increased to 107 kPa?

8.   What pressure, in kPa, is exerted by 75.0 g of xenon gas in a 2.25-L flask at 27ºC?

9.   What mass of CO_2 can be produced at a temperature of 1500ºC and an atmospheric pressure of 92.5 kPa, if 15.5 L of C_2H_2 gas is burned at STP conditions?
$$2C_2H_{2(g)} + 5O_{2(g)} \rightarrow 2H_2O_{(g)} + 4CO_{2(g)}$$