CHM 211 Test 1 Name: ____________________
Fall 2023 (Please print)

Multiple Choice: (4 points each. Put answers in left margin as capital letters.)

1. Which of the following is a heterogeneous mixture?

   A) air B) concrete C) gasoline D) magnesium E) a cup of coffee

2. How many significant figures are in the answer to the following problem: $\frac{8.511+2.311}{27316}$?

   A) 1 B) 2 C) 3 D) 4 E) 5

3. Which of these properties of the metal lithium is chemical?

   A) can be cut with a sharp knife
   B) changes from silvery gray to black when placed in moist air
   C) in the liquid state, it boils at 1317 ºC
   D) light enough to float on water
   E) silvery gray in color

4. One millimeter equals 10^x meters. What is x?

   A) -3 B) -2 C) 2 D) 3 E) 6

5. Which is false about the periodic table?

   A) Columns are called groups or families.
   B) Rows are called periods.
   C) Elements in rows tend to have similar chemical and physical properties.
   D) Elements on the left side of the periodic table tend to form cations.
   E) All are true.

6. Which of the following would must be a molecular formula?

   A) $C_2H_4O_2$ B) C_2H_5 C) $C_4H_5N_2O$ D) HO E) NO_2

7. The correct number of protons, neutrons, and electrons in Si^{2-} (Si-28) is:

   A) 12p, 14n, 16e C) 14p, 14n, 14e E) 16p, 4n, 14e
   B) 14p, 14n, 12e D) 14p, 14n, 16e

8. What is the concentration of a sodium chloride (NaCl) solution after 25 mL of water is added to 50 mL of a solution that is initially 2.00 *M*?

   A) 1.00 *M* B) 1.33 *M* C) 1.50 *M* D) 2.00 *M* E) 4.00 *M*

9. Which of the following is false?

   A) An unsaturated solution contains **any** amount of solute less than the maximum.
   B) Concentration is the amount of one material dissolved in a second material
   C) Dilute and concentrated are relative terms, without a specific value designating either.
   D) Parts per million is a concentration term typically used for very dilute solutions.
   E) All are true statements.

Discussion Questions: (**You must show your work to receive credit**.)

1. Define: (12 points)

   matter – anything that occupies space and has mass
   liquid – a substance with definite volume, but takes the shape of its container
   empirical formula – chemical formula with the relative number of each type of atom in the compound

2. Magnesium is used in automobile wheels because it is "lighter" than steel. What is a more scientifically correct statement of this? (5 points)

   Magnesium is used in automobile wheels because it is less dense than steel.

3. How are metalloids (semimetals) different from either metals or nonmetals? Provide an example or two to illustrate your points. (10 points)

   Metalloids differ from metals and nonmetals in that they have some properties of each rather than an average. Thus, a material might have high density (like a metal), but be an insulator (like a nonmetal).

4. For the following, give the name or formula where appropriate: (15 points)

   $HClO_2$ – chlorous acid
   Cl_2O_3 – dichlorine trioxide
   $CoSO_4$ – cobalt(II) sulfate
   potassium phosphate – K_3PO_4
   methane – CH_4

5. A solution of $CaCl_2$ in water forms a mixture that is 28.0% calcium chloride by mass. If the total mass of the solution is 266.1 g, what masses of $CaCl_2$ and water were used? What is the $CaCl_2$ molar concentration? Assume the solution density is 1.00 g/mL. (15 points)

   $$\text{mass}_{CaCl2} = (266.1\ g_{soln})\left(\frac{0.280\ g_{CaCl2}}{1\ g_{soln}}\right) = 74.5\ g_{CaCl2}$$

   $$\text{mass}_{H2O} = 266.1\ g_{soln} - 74.5\ g_{CaCl2} = 191.6\ g_{H2O}$$

   $$[CaCl_2] = (74.5\ g_{CaCl2})\left(\frac{1\ mol_{CaCl2}}{110.98_{CaCl2}}\right)\left(\frac{1}{266.1\ g}\right)\left(\frac{1.00\ g_{soln}}{mL_{soln}}\right)\left(\frac{1000\ mL_{soln}}{L_{soln}}\right) = 2.52\ M$$

6. Vanillin is the principal flavorant in the vanilla bean. It contains 63.2% carbon, 5.30% hydrogen, and 31.6% oxygen by mass. It has a molar mass of about 150 g/mol. What is its empirical and molecular formulae. (**You may not work backwards from its molar mass**.) (12 points)

Assume 100 g of compound:

$mol_C = (63.2\ g_C)\left(\frac{1\,mol_C}{12.011\,g_C}\right) = 5.26\ mol_C$ $\qquad \frac{5.26\ mol_C}{1.98\ mol_O} = 2.66\ mol_C$ per mol_O

$mol_H = (5.30\ g_H)\left(\frac{1\,mol_H}{1.00794\,g_P}\right) = 5.28\ mol_H$ $\qquad \frac{5.28\ mol_H}{1.98\ mol_O} = 2.67\ mol_H$ per mol_O

$mol_O = (31.6\ g_O)\left(\frac{1\,mol_O}{15.9994\,g_O}\right) = 1.98\ mol_O$ $\qquad \frac{1.98\ mol_O}{1.98\ mol_O} = 1$

Because 2.66 is not close to a whole number, multiply through by 3 to yield

$\Rightarrow$ empirical formula = $C_8H_8O_3$

Empirical weight = 152 g/eu

$\frac{MW}{EW} = \frac{152\ g/mol}{150\ g/eu} = 1.01$ eu/mol

$\Rightarrow$ molecular formula = $C_8H_8O_3$