Name: _____

**Part I.** ***Circle your answers***

1. If a sample of matter is uniform throughout and *cannot* be separated into other substances by *physical means*, it is _____.

   A) a compound
   **B) either a compound or an element**
   C) a homogeneous mixture
   D) a heterogeneous mixture
   E) an element

2. What volume of 10.0 M $H_2SO_4$ is required to prepare 4.0 L of 0.50 M $H_2SO_4$?

   **A) 0.20 L**
   B) 0.40 L
   C) 0.50 L
   D) 1.0 L
   E) 4.0 L

3. A solution of silver nitrate is mixed with a solution of potassium fluoride. If a precipitate forms, the precipitate is:

   **A) Silver fluoride**
   B) Potassium nitrate
   C) Potassium fluorate
   D) Nitric fluoride
   E) No precipitate is formed

4. If 5.0 mol of both hydrochloric acid and sodium sulfide are mixed and reacted according to the equation below, how many moles of hydrogen sulfide ($H_2S$) are produced?

   $$HCl + Na_2S \rightarrow H_2S + NaCl$$

   A) 1 mol
   B) 1.25 mol
   **C) 2.5 mol**
   D) 3 mol
   E) 5 mol

5. Which of the following is *not* a physical process?

   A) distillation
   B) filtration
   C) chromatography
   D) evaporation
   **E) none of the above**

6. Of the choices below, which one is not an ionic compound?

**A) $PCl_5$**
B) $MoCl_6$
C) RbCl
D) $PbCl_2$
E) NaCl

7. Boron has two naturally occurring isotopes, $^{10}B$ with an atomic mass of 10.0129370 amu and $^{11}B$ with an atomic mass of 11.0093054 amu. The atomic mass of boron is 10.81 (from the periodic table). The percent abundances of the boron isotopes are _____% $^{10}B$ and _____% $^{11}B$.

A) 81.0, 19.0
B) 9.9, 90.1
C) 49.0, 51.0
**D) 20.0, 80.0**
E) 1.0, 99.0

**Part II.**

8. Complete the following table (all empty cells):

| NAME | FORMULA |
|---|---|
| Calcium chlorate | **$Ca(ClO_3)_2$** |
| **Carbon tetrabromide** | $CBr_4$ |
| Ammonium phosphate | **$(NH_4)_3PO_4$** |
| **Iron (III) oxide** | $Fe_2O_3$ |

9. Complete the following table (all empty cells in both rows):

| Symbol | # of protons | # of neutrons | # of electrons | atomic number | mass number |
|---|---|---|---|---|---|
| $^{51}V^{+5}$ | *23* | *28* | *18* | *23* | *51* |
| $^{34}S^{-2}$ | *16* | **18** | **18** | *16* | **34** |

10. Selenium, an element used in the manufacture of solar energy devices, forms an oxide that contains only one atom of selenium (per formula unit) and is 37.8% oxygen by mass. What is the molecular formula of the oxide? In a 100 g sample:

$$37.8\text{ g O} \times \frac{1\text{ mol O}}{16.00\text{ g O}} = 2.36\text{ mol O}$$

$$62.2\text{ g Se} \times \frac{1\text{ mol Se}}{78.96\text{ g Se}} = 0.788\text{ mol Se}$$

$$Se_{\frac{0.788}{0.788}} O_{\frac{2.36}{0.788}} = \boxed{SeO_3}$$

11. A solution with a total volume of 1000.0 mL contains 37.1 g $Mg(NO_3)_2$. If you remove 20.0 mL of this solution and then dilute this 20.0 mL sample with water until the new volume equals 500.0 mL, what is the concentration of $Mg^{+2}$ ion in the 500.0 mL of solution? What is the concentration of nitrate ion?

$$37.1\text{ g } Mg(NO_3)_2 \times \frac{1\text{ mol } Mg(NO_3)_2}{148.33\text{ g } Mg(NO_3)_2} \times \frac{1}{1\text{ L soln.}} = 0.250\text{ M } Mg(NO_3)_2 \quad \text{(original solution)}$$

$$\frac{0.250\text{ mol } Mg(NO_3)_2}{1000\text{ mL soln}} \times 20\text{ mL} = \frac{5.00\times10^{-3}\text{ mol}}{.5\text{ L}} = 0.0100\text{ M } Mg(NO_3)_2 \quad \text{(New solution)}$$

**Concentration of $Mg^{+2}$** 0.0100 M **Concentration of $NO_3^-$** 0.0200 M

12. For each question below, equal volumes of two aqueous solutions are mixed. List the species that are present (ions, compounds, etc.) and their concentrations after mixing if they remain in solution. Include the phases for the species present. You don't need to list water.

a) Equal volumes of a 1.0 M lead (II) nitrate mixed with 1.0 M sodium chloride

**$PbCl_2$ (s)**
**1.0 M $NO_3^{-1}$**
**0.5 M $Na^+$**
**0.25 M $Pb^{+2}$**

b) Equal volumes of 1.0 M ammonium carbonate mixed with 1.0 M potassium perchlorate

**1.0 M $NH_4^+$**
**0.5 M $K^+$**
**0.5 M $CO_3^{-2}$**
**0.5 M $ClO_4^{-1}$**

13. Solid sulfur and oxygen gas react to produce sulfur trioxide as shown below. In a particular experiment, 5.0 g of $O_2$ are reacted with 6.0 g of $S_8$.

$$S_8(s) + 12O_2(g) \rightarrow 8SO_3(g) \qquad S_8 + 12O_2 \rightarrow 8SO_3$$

a) If we assume complete consumption of the limiting reactant, what is the mass and identity of the reactant that still remains at the end of the reaction?

$$6.0\text{ g } S_8 \times \frac{1\text{ mol } S_8}{256.8\text{ g } S_8} \times \frac{8\text{ mol } SO_3}{1\text{ mol } S_8} = 0.1871\text{ mol } SO_3$$

$$5.0\text{ g } O_2 \times \frac{1\text{ mol } O_2}{32.00\text{ g } O_2} \times \frac{8\text{ mol } SO_3}{12\text{ mol } O_2} = 0.1042\text{ mol } SO_3$$ ← correct amount, $O_2$ is limiting

$$0.1042\text{ mol } SO_3 \times \frac{80.06\text{ g } SO_3}{1\text{ mol } SO_3} = 8.34\text{ g } SO_3$$

By mass balance: $11\text{ g} - 8.34\text{ g} = 2.6$ ($S_8$ remain)

c) What is the % yield of $SO_3$ in this experiment if 7.9 g of $SO_3$ are isolated?

$$\%\text{ yield} = \frac{7.9\text{ g}}{8.34\text{ g}} \times 100\% = \boxed{95\%}$$

14. An iron nail is suspended on a thin wire in a sealed jar of moist air. The surface of the nail becomes red over time.

a) Describe what is happening to the mass of the nail over time.

***The mass of the solid (the nail) is increasing over time as Fe (s) converts to FeO and/or $Fe_2O_3$***

b) List the chemical changes taking place in the jar.

**The oxygen in the air is being reacted (consumed) over time as it oxidizes (rusts) the iron metal in the nail. Other components in the air should remain the same as the reaction proceeds.**