DETERMINING THE CONCENTRATION OF A SOLUTION

The **concentration** of a solution is the amount of solute per unit of solvent. Concentration can be measured qualitatively or quantitatively. **Qualitative** measurement is expressed as concentrated or dilute. **Quantitative** measurement is expressed in molarity, molality or mole fraction.

Types of qualitative measurement:

1. **Saturated Solutions** contain the maximum amount of solute that can be dissolved at current temperature and pressure.
2. **Unsaturated solutions** contain less than maximum amount of solute. (dilute)
3. **Supersaturated solutions**: under certain conditions solutions can be forced to dissolve more than the "normal" maximum amount of solute. (concentrated)

Types of quantitative measurement:

Molarity (*M*) = $\frac{\text{moles of solute}}{\text{Liters of solution}}$

- For example: 0.20 mol ethylene glycol is dissolved in enough water to give 2.0 L of solution, what is its molarity?

$$\frac{0.20 \text{ mol ethylene glycol}}{2.0 \text{ L solution}} = 0.10\ M \text{ ethylene glycol}$$

Practice: Complete the following word problems.

1. Find the number of moles of HNO_3 contained in 1.0L of a 0.1M solution.

2. 10 g of NaOH is dilute to 100mL. Find the molarity of the resulting solution.

3. Calculate the number of grams of NaCl which must be weighed out to make 1.0L of a 0.10 M solution.

Molality (*m*) =moles of solute
Kilograms of solvent

- For example: 0.20 mol of ethylene glycol is dissolved in 2.0×10^3 grams of water, what is its molality?
  $\frac{0.20 \text{ mol ethylene glycol}}{2.0 \text{ kg solvent}} = 0.10\ m$ ethylene glycol

Practice: Complete the following word problems.

1. What is the molality of a solution containing 0.30moles of calcium chloride in 1000 g of water?

2. A solution contains 96.0 grams of methanol, CH_3OH, in 3500 grams of water. Calculate the molality of the solution.

3. How many grams of water must be added to 90.0 g of glucose, $C_6H_{12}O_6$, to make a 0.250 m solution?

Mole Fraction=moles of component
Total moles of solution

- For example: If a solution is made up of 1 mol of ethylene glycol and 9 mol of water, what is the mole fraction of the ethylene glycol and the water?
  Mole fraction of ethylene glycol: $\frac{1 \text{ mol ethylene glycol}}{10 \text{ mol total}} = 10$
  Mole fraction of water: $\frac{9 \text{ mol water}}{10 \text{ mol total}} = 90$

Practice: Complete the following word problems.

1. What are the mole fractions of a solution containing 1.00 mol of HCl dissolved in 3.31 mol of water?

2. What are the mole fractions of a solution containing 4.57g of glucose, $C_6H_{12}O_6$, and 25.2g of water?

3. What are the mole fractions of a solution prepared with 10.0 g of NaOH and 500.0 g of water?

Name: _____ **Period:** ___ **Date:** _____

Homework: Molarity, Molality, Mole Fraction

Complete the following word problems. (Show your work on a separate sheet of paper.)

1. What is the molarity of the solution produced when 145 g of sodium chloride (NaCl) is dissolved in sufficient water to prepare 2.75 L of solution?

2. How many grams of potassium chloride (KCl) are needed to prepare 0.750 L of a 1.50M solution of potassium chloride in water?

3. What is the molarity of the solution produced when 85.6 g of hydrochloric acid (HCl) is dissolved in sufficient water to prepare 0.385 L of solution?

4. To produce 3.00 L of a 1.90 M solution of sodium hydroxide (NaOH), how many grams of sodium hydroxide must be dissolved?

5. If 8.77 g of potassium iodide (KI) are dissolved in sufficient water to make 4.75 L of solution, what is the molarity of the solution?

6. In order to prepare 2.00 L of a 3.00 M solution of ferric chloride ($FeCl_3$), how many grams of ferric chloride must be used?

7. What is the molarity of the solution produced when 14.1 grams of ammonia (NH_3) is dissolved in sufficient water to prepare 0.100 L of solution?

8. To prepare 10.5 L of a 2.50 M solution of potassium hydroxide (KOH), how many grams of potassium hydroxide must be used?

9. What is the molality of a solution containing 75.2 g of silver perchlorate ($AgClO_4$) dissolved in 885 g of benzene?

10. What is the molality of a solid solution containing 0.125 g of chromium and 81.3 g of iron?

11. If 18.6 g of methanol is used to dissolve 2.68 g of $Hg(CN)_2$, what is the molality of the solution?

12. What is the molality of solid solder wire if it is made from 68.7 g of lead dissolved in 117 g of tin?

13. What is the molality of a solution made by dissolving 8.11 g of potassium sulfide (K_2S) in 47.6 g of ethanol?

14. What is the molality of a solution containing 1330 g of methanol (CH_3OH) and 16.6 g of sodium bromide (NaBr)?

15. What is the molality of a solid solution containing 867 g of aluminum and 14.9 g of copper?

16. What is the molality of a solution produced using 15.2 g of calcium chloride ($CaCl_2$) and 345 g of methanol (CH_3OH)?

17. In order to prepare a 0.523 m aqueous solution of potassium iodide (KI), how many grams of potassium iodide must be added to 2.00 kg of water?

18. A gas mixture contains 45.6 g of carbon monoxide and 899 g of carbon dioxide. What is the mole fraction of carbon monoxide?

19. A gas mixture contains the following gases with the mole fractions indicated: CH_4 (0.510), C_2H_6 (0.431), C_3H_8 (0.011), and C_4H_{10} (0.013). The mixture also contains the gas acetylene (C_2H_2). What is the mole fraction of acetylene?

20. What is the mole fraction of oxygen in a mixture that contains 66.8 g of oxygen, 44.1 g of nitrogen, and 21.5 g of hydrogen?

21. What is the mole fraction of xenon in a mixture that contains 0.584 g of xenon, 86.40 g of argon, and 3.62 g of neon?

22. A gas mixture contains the following gases with the mole fractions indicated: NH_3 (0.214), Cl_2 (0.452), NH_2Cl (0.118), and N_2 (0.175). The mixture also contains HCl gas. What is the mole fraction of HCl gas?

23. A gas mixture contains the following gases with the mole fractions indicated: H_2O (0.164), H_2 (0.278), O_2 (0.455), and CO_2 (0.101). The mixture also contains carbon monoxide. What is the mole fraction of carbon monoxide?

24. A gas mixture contains 70.25 g of steam, 1.470 g of hydrogen, and 6.58 g of nitrogen. What is the mole fraction of steam?