1. How many milliliters of 13.2 \( M \) \( H_2SO_4 \) are needed to prepare 600.0 mL of 0.10 \( M \) \( H_2SO_4 \)? (4.5 mL)

2. 1.60 L of an aqueous solution containing 25.00 g of KCl dissolved in pure water is prepared. What is the molarity of the resulting solution? (0.210 \( M \))

3. A solution containing 292 g of Mg(NO\(_3\))\(_2\) per liter has a density of 1.108 g/mL. What is the molality of the resulting solution? (2.41 \( m \))

4. 12.49 grams of \( K_2SO_4 \) are dissolved in 275 grams of water. Calculate the mass percent of potassium sulfate in the resulting solution. (4.344 %)

5. 29.72 grams of \( Na_2SO_4 \) is dissolved in 323.4 grams of water. Assuming the sodium sulfate completely dissociates, calculate the molality of ions in the resulting solution. (1.941 \( m \))

6. 43.68 mL of 14.6 \( M \) \( H_3PO_4 \) is dissolved in enough water to make 425 mL of solution. Calculate the normality of phosphoric acid in the resulting solution. (4.50 \( N \))

7. 3.50 pounds of dextrose (\( C_6H_{12}O_6 \)) is dissolved in 12.2 gallons of water. (1.000 lb = 453.6 g, 1.000 gal. = 3.785 L, take the density of water to be 1.00 g/mL) Calculate the mole fraction of dextrose in the resulting solution. (0.00343)

8. How many molecules of sucrose (table sugar), \( C_{12}H_{22}O_{11} \), dissolved in 450.0 g of water are needed to make a 1.40 \( m \) solution? (3.79 \( \times 10^{23} \) molecules)

9. Find the mass percent of \( CuSO_4 \) in a solution whose density is 1.30 g/mL and whose molarity is 1.36 \( M \). (16.7%)

10. Calculate the normality of \( Cu^{2+} \) in a solution that is made by dissolving 24.7 g of \( Au(NO_3)_3 \) in enough water to make 155 mL of solution when copper metal is added to the solution. The relevant reaction is \( 3Cu(s) + 2Au^{3+}(aq) \rightarrow 2Au(s) + 3Cu^{2+}(aq) \). (1.25 \( N \))

11. When 0.775 g of \( NH_4NO_3 \) was added to 150.0 g of water in a Styrofoam cup, the temperature dropped by 0.413°C. The heat capacity of \( H_2O \) is 4.18 J/g°C. Assume the specific heat of the solution equals that of pure \( H_2O \) and that the calorimeter neither absorbs nor leaks heat. What is the molar heat of solution of solid \( NH_4NO_3 \)? (+26.7 kJ/mol)

12. The solubility of hydrogen chloride in water is 13.7 mol/L at 20. °C when the partial pressure of HCl above the solution is 0.722 atm. Calculate the Henry’s law constant for HCl in units of mol/L-atm. Calculate the solubility of HCl in water at 20. °C when the partial pressure of hydrogen chloride above water is 0.149 atm. (19.0 mol/L-atm, 2.83 mol/L)

13. An ideal solution is formed from a mixture of the nonvolatile solute urea, \( CO(NH_2)_2 \), and methanol, \( CH_3OH \). The vapor pressure of pure methanol at 20°C is 89 mmHg. If 5.0 g of urea is mixed with 36.0 g of methanol, calculate the vapor pressure of the methanol solution. (83 mmHg)

14. At a given temperature, you have a mixture of benzene (vapor pressure of pure benzene = 745 torr) and toluene (vapor pressure of pure toluene = 290. torr). The mole fraction of benzene in the solution is 0.590. Assuming ideal behavior, calculate the mole fraction of toluene in the vapor above the solution. (0.213)
15. At 40°C, heptane has a vapor pressure of about 92.0 torr and octane has a vapor pressure of about 31.2 torr. Assuming ideal behavior, what is the vapor pressure of a solution that contains twice as many moles of heptane as octane? (71.7 torr)

16. A solution is made by adding 0.100 mole of ethyl ether to 0.628 mole of ethyl alcohol. If the vapor pressure of ethyl ether and ethyl alcohol at 20°C are 375 torr and 20.0 torr, respectively. What is the vapor pressure of the solution at 20°C (assuming ideal behavior)? (68.8 torr)

17. A solution consisting of 0.250 mol of methylbenzene, \( C_6H_5CH_3 \), in 248 g of nitrobenzene, \( C_6H_5NO_2 \), freezes at −1.1°C. Pure nitrobenzene freezes at 6.0°C. What is the freezing-point depression constant of nitrobenzene? (7.0°C/m)

18. 22.34 g of NaCl is dissolved in 125.2 g of water. Calculate the freezing point and the boiling point of the resulting solution. \( K_B = 0.51 \text{ °C}/m \) and \( K_F = 1.86 \text{ °C}/m \) for water. The van’t Hoff factor for NaCl is \( i = 1.9 \). (F.P. = −11 °C, B.P. = 103.0 °C)

19. The freezing point (\( T_f \)) for \( t \)-butanol is 25.50°C and \( K_f \) is 9.1°C/m. Usually \( t \)-butanol absorbs water on exposure to the air. If the freezing point of a 7.6-g sample of \( t \)-butanol is measured as 24.59°C, how many grams of water are present in the sample? (0.014 g)

20. Thyroxine, an important hormone that controls the rate of metabolism in the body, can be isolated from the thyroid gland. If 0.454 g of thyroxine is dissolved in 10.0 g of benzene, the freezing point of the solution could be measured as 5.144°C. Pure benzene freezes at 5.444°C and has a value for the molal freezing point depression constant of \( K_f \) of 5.12°C/m. What is the approximate molar mass of thyroxine? (775 g/mol)

21. Polyethylene is a synthetic polymer or plastic with many uses. 1.44 g of a polyethylene sample was dissolved in enough benzene to make 100. mL of solution, and the osmotic pressure was found to be 1.86 torr at 25°C. What is the approximate molar mass of the polyethylene? (1.44 \( \times 10^5 \) g/mol)

22. A 0.234 g sample of a purified protein is dissolved in water to give 5.00 mL of solution. The osmotic pressure is found to be 23.9 torr at 24 °C. Calculate the molar mass of the protein. (3.64 \( \times 10^4 \) g/mol)