

Solutions – Concentration, Gas Solubility, Soln. Vapor Pressure

Expressing concentration in various units

Give the equations for:

Molarity (M)

Molality (m)

Parts by mass

Mass percent

Parts by volume

Volume percent

Mole fraction (X)

Mole percent (mol %)

Examples & problems:

1. What is the molality of a solution prepared by dissolving 32.0 g of CaCl_2 in 271 g of water?

2. How many grams of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) must be dissolved in 563 g of ethanol ($\text{C}_2\text{H}_5\text{OH}$) to prepare a $2.40 \times 10^{-2} m$ solution?

3. Find the concentration of calcium (in ppm) in a 3.50 g pill that contains 40.5 mg of Ca.

4. The label on a 0.750 L bottle of Italian chianti indicates “11.5% alcohol by volume.” How many liters of alcohol does the wine contain?

5. A sample of rubbing alcohol contains 142 g of isopropyl alcohol ($\text{C}_3\text{H}_7\text{OH}$) and 58.0 g of water. What are the mole fractions of alcohol and water?

6. An alcohol solution contains 35.0 g of 1-propanol (C_3H_7OH) and 150. g of ethanol. Calculate the mass percent and the mole fraction of each alcohol.

7. Hydrogen peroxide is a powerful oxidizing agent used in concentrated solution in rocket fuels and in dilute solution as a hair bleach. An aqueous solution of H_2O_2 is 30.0% by mass and has a density of 1.11 g/mL. Calculate – (a) molality, (b) mole fraction of H_2O_2 , and (c) molarity.

8. A sample of commercial concentrated hydrochloric acid is 11.8 *M* HCl and has a density of 1.190 g/mL. Calculate – (a) mass %, (b) molality, and (c) mole fraction of HCl.

Gas Solubility and Vapor Pressures of Solutions

Define and/or give the equation for-
Henry's law:

Raoult's law:

vapor pressure lowering:

ideal solution:

boiling point elevation:

freezing point depression:

osmotic pressure:

Examples & problems:

1. Calculate the vapor pressure lowering when 10.0 mL of glycerol ($C_3H_8O_3$) is added to 500. mL of water at 50. C. At this temperature, the vapor pressure of pure water is 92.5 torr and its density is 0.988 g/mL. The density of glycerol is 1.26 g/mL.

2. Calculate the vapor pressure lowering of a solution of 2.00 g of aspirin ($M = 180.15$ g/mol) in 50.0 g of methanol at 21.2 C. Pure methanol has a vapor pressure of 101 torr at this temperature.

3. You add 1.00 kg of ethylene glycol ($C_2H_6O_2$) antifreeze to your car radiator which contains 4450 g of water. What are the boiling and freezing points of the solution?

4. What is the minimum concentration (molality) of ethylene glycol solution that will protect the car's cooling system from freezing at 0.00 F? (Assume solution is ideal.)

5. Biochemists have discovered more than 400 mutant varieties of hemoglobin, the blood protein that carries oxygen throughout the body. A physician studying a variety associated with a fatal disease first finds its molar mass. She then dissolves 21.5 mg of the protein in water at 5.0 C to make 1.50 mL of solution and measure an osmotic pressure of 3.61 torr. What is the molar mass of this variety of hemoglobin?

6. A 0.30 M solution of sucrose that is at 37 C has approximately the same osmotic pressure as blood does. What is the osmotic pressure of blood?

7. The partial pressure of carbon dioxide gas inside a bottle of cola is 4 atm at 25 C. What is the solubility of CO₂? The Henry's law constant for CO₂ dissolved in water is 3.3×10^{-2} mol/L atm at 25 C.