SHOW ALL CALCULATIONS

Ideal Gas Law
\[ p = \frac{R T}{V_m} \]

Gas Constant
\[ R = 0.082057 \text{ L atm mol}^{-1} \text{ K}^{-1} = 8.31451 \text{ J mol}^{-1} \text{ K}^{-1} \]

Pressure Conversion
1 atm = 101.325 kPa = 760 Torr

1. The vapour pressure of a 500 g sample of benzene was 400 torr at 60.6°C, but it fell to 386 torr when 19.0 g of an involatile organic compound was dissolved in it. Calculate the molar mass of the compound. (15 points)

2. The enthalpy of fusion of anthracene (MW 178 g mol\(^{-1}\)) is 28.8 kJ mol\(^{-1}\) and its melting point is 480 K. Calculate its ideal solubility (in units of molality) in benzene at 298 K. (15 points)

3. At 298 K, the density of a 50 percent by mass ethanol-water solution is 0.914 g cm\(^{-3}\). Given that that partial molar volume of water (MW 18.01 g mol\(^{-1}\)) in the solution is 17.4 cm\(^3\) mol\(^{-1}\), calculate the partial molar volume of the ethanol (MW 46.07 g mol\(^{-1}\)). (15 points)

4. The osmotic pressure of an aqueous solution at 313 K is 183 kPa. Calculate the freezing point of the solution. (15 points)

5. The vapour pressure of pure liquid A at 300 K is 575 Torr and that of pure liquid B is 390 Torr. These two compounds form ideal liquid and gaseous mixtures. Consider the equilibrium composition of a mixture in which the mole fraction of A in the vapour is 0.350. Calculate the total pressure of the vapour and the composition of the liquid mixture. (15 points)

6. A saturated solution of Na\(_2\)SO\(_4\), with excess of the solid, is present at equilibrium with its vapour in a closed vessel. (a) How many phases and components are present? (b) What is the variance of the system? Identify the independant variables. (15 points)