

S.5 CHEMISTRY

COLLIGATIVE PROPERTIES

There are four colligative properties of a dilute solution

These are; vapour pressure lowering

Boiling point elevation

Freezing point depression

Osmotic pressure

Questions on vapour pressure lowering

1. The vapour pressure of carbon disulphide at 25°C, is 53216Pa . at the same temperature a solution of 5g of sulphur in 63cm³ of carbon disulphide has a vapour pressure of 52230Pa .density of carbon disulphide is 1.27gcm⁻³.find ;
The relative molecular mass of sulphur in carbon disulphide .
The molecular formula of sulphur in carbon disulphide.
[hint : $density = \frac{mass}{volume}$,molecular formula of sulphur in carbon disulphide is S_n , where n is the whole number]
2. The vapour pressure of pure water at 25°C is 3167Pa .the vapour pressure of a solution of 4g of a sugar in 100g of water at the same temperature is 3154.5Pa .what is the relative molecular mass of the sugar? Hence deduce the name of the sugar.
3. (a) distinguish between vapour pressure and gas pressure
(b) explain the following observation .
(i) At a given temperature, an aqueous solution of glucose has a lower vapour pressure than pure water .
(ii) The vapour pressure of a mixture of ethanol and water is higher than that of pure water.
(c) The vapour pressure of a 3 percentage solution of camphor, C₁₀ H₁₆O in ethoxy ethane,C₄H₁₀O ,if the vapour pressure of pure ethoxy ethane at the same temperature is 32670Pa.

Question on boiling point elevation

1. (a) what is meant by the following terms.
(i) Boiling point of a liquid
(ii) Boiling point elevation of a liquid
(iii) Boiling point elevation constant

(b) the boiling point of ethanol is 78°C .Calculate the boiling point of a solution containing 2.7g of urea (NH₂CONH₂) in 75g of ethanol .(Boiling point elevation constant for 1000g of ethanol = 1.15°Cmol⁻¹) .

solution

75g of ethanol dissolve 2.70g of urea

$$\begin{aligned} 1000\text{g of ethanol will dissolve } & \frac{2.7 \times 1000}{75} \\ & = 36\text{g} \end{aligned}$$

Relative formula mass of urea , $\text{NH}_2\text{CONH}_2 = 14 \times 2 + 1 \times 4 + 12 + 16$

$$= 60$$

Boiling point elevation , $\Delta T = T_1 - T_0$

Where T_1 = boiling point of the solution

T_0 = boiling point of the pure solvent (ethanol) = 78°C

60g of urea in 1000g of ethanol will cause an elevation of 1.15°C

$$\begin{aligned} 36\text{g of urea in } 1000\text{g of ethanol cause an elevation of } & \frac{1.15 \times 36}{60} \\ & = 0.69^\circ\text{C} \end{aligned}$$

therefore $\Delta t = 0.69^\circ\text{C}$

But $\Delta T = T_1 - T_0$

$$0.69 = T_1 - 78$$

$$T_1 = 78 + 0.69$$

$$T_1 = 78.69^\circ\text{C}$$

USING THE WORKED EXAMPLE ABOVE ANSWER THE FOLLOWING QUESTIONS

2. 2.00g of phosphorus was dissolved in 37.4g of carbon disulphide to form a solution which boils at 57.003°C . Calculate the relative formula mass of phosphorus and hence the molecular formula of phosphorus in carbon disulphide. [Boiling point of carbon disulphide is 56°C and the boiling point elevation constant for carbon disulphide is 2.35°C for 1mole in 1000g of the solvent]

