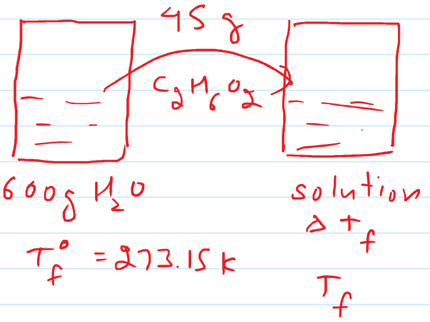
Question

45 g of ethylene glycol ($C_2H_6O_2$) is mixed with 600 g of water. Calculate

(a) freezing point depression

(b) freezing point of the solution.

Answer



$H_2O \rightarrow A \qquad C_2H_6O_2 \rightarrow B$

a) $\Delta T_f = K_f\, m$

$= K_f \dfrac{w_B \times 1000}{M_B \times w_A}$

$= 1.86 \times \dfrac{45 \times 1000}{62 \times 600}$

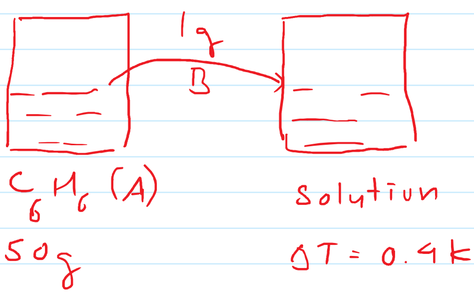
$= 2.25\ K$

b) $T_f = T_f^o - \Delta T_f = 273.15 - 2.25 = 270.9\ K$

Question

1.00 gm of a non-electrolyte solute dissolved in 50 g of benzene lowered the freezing point of benzene by 0.4 K the freezing point depression constant of benzene is 5.12 K kg mol^{-1}. Find the molar mass of the solute.

Answer



$\Delta T_f = m K_f$

$= \dfrac{w_B \times 1000}{M_B \times w_A} K_f$

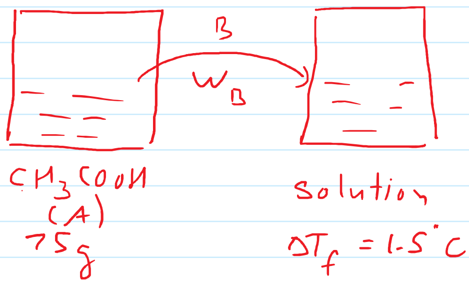
$0.4 = \dfrac{1}{M_B \times 50} \times 1000 \times 5.12$

$M_B = 256\ g\,mol^{-1}$

Question

Calculate the mass of ascorbic acid ($C_6H_8O_6$) to be dissolved in 75 g of acetic acid to lower its melting point by 1.5 °C. k_f = 3.9 K kg mol^{-1}

Answer.



$M_B = 6 \times 12 + 8 \times 1 + 6 \times 16 = 176\text{ g}$

$\Delta T_f = K_f\, m$

$= k_f \dfrac{w_B \times 1000}{M_B \times W_A}$

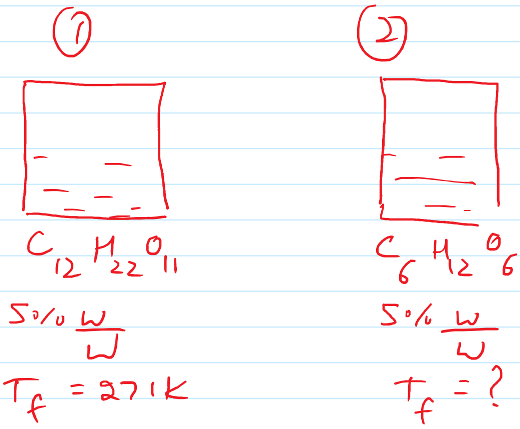
$1.5 = \dfrac{3.9 \times w_B \times 1000}{176 \times 75}$

$w_B = 5.077\text{ gm}$

Question

A 5% solution (by mass) of cane sugar in water has freezing point of 271 K. Calculate the freezing point of 5% glucose in water, if freezing point of pure water is 273.15 K.

Answer



Solution 1

5% $\frac{w}{w}$ $C_{12}H_{22}O_{11}$ solution

→ 5 g $C_{12}H_{22}O_{11}$ in 100 g solution

→ 5 g $C_{12}H_{22}O_{11}$ in 95 g water

$m = \dfrac{w_B \times 1000}{M_B \times w_A}$

$= \dfrac{5 \times 1000}{342 \times 95} = 0.1537\ \dfrac{\text{mol}}{\text{kg}}$

$\Delta T_f = m k_f$

$T_f^0 - T_f = 0.1537 \times k_f$

$273.15 - 271 = 0.1537 \times k_f$

$k_f = 13.99$ K kg mol^{-1}

Solution 2

5% $\frac{w}{w}$ $C_6H_{12}O_6$ means

5 g $C_6H_{12}O_6$ in 100 gm solution

5 g $C_6H_{12}O_6$ in 95 g solution

$$m = \frac{w_B \times 1000}{M_B \times w_A}$$

$$\frac{5 \times 1000}{180 \times 95} = 0.2926 \ \frac{mol}{kg}$$

$$\Delta T_f (2) = k_f m = 13.99 \times 0.2926 = 4.09 k$$

$$T_f (\text{glucose solution}) = T_f^0 - \Delta T_f$$

$$= 273.15 - 4.09$$

$$= 269.06 k$$

Question

Two elements A and B form compounds having formula AB_2 and AB_4. When dissolved in 20 g benzene (C_6H_6), 1 g of AB_2 lowers the freezing point by 2.3 k, whereas 1.0 gm AB_4, lowers it by 1.3 k. The molal depression constant for benzene is 5.1 k kg mol^{-1}. Calculate atomic masses of A and B.

Answer

AB_2 solution (in benzene)

$$\Delta T_f = 2.3 \ k$$

$$= k_f m$$

$$2.3 = 5.1 \times \frac{w_{AB_2} \times 1000}{M_{AB_2} \times w_{benzene}}$$

$$= 5.1 \times \frac{1 \times 1000}{(M_A + 2M_B) \times 20}$$

$$M_A + 2M_B = 110.87 \quad - I$$

AB_4 solution (in benzene)

$$\Delta T_f = 1.3 k$$

$$= k_f m$$

$$1.3 = 5.1 \times \frac{w_{AB_4} \times 1000}{M_{AB_4} \times w_{benzene}}$$

$$1.3 = 5.1 \times \frac{1 \times 1000}{(M_A + 4M_B) \times 20}$$

$$M_A + 4M_B = 196.154 - II$$

II − I

$$2M_B = 85.284$$

$$M_B = 42.64\ g \quad - \text{III}$$

put III in I

$$M_A + 2(42.64) = 110.87$$

$$M_A = 25.59\ g$$