

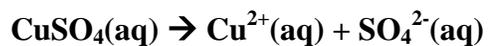
Colligative Properties Worksheet

- 1) What mass of water is needed to dissolve 34.8 g of copper(II) sulfate in order to prepare a 0.521 m solution?
- 2) The vapor pressure of water at 20° C is 17.5 torr. What is the vapor pressure of water over a solution containing 300. g C₆H₁₂O₆ and 455 g of water?
- 3) Calculate the freezing point of a solution made from 32.7 g of propane, C₃H₈, dissolved in 137.0 g of benzene, C₆H₆. The freezing point of benzene is 5.50° C and its K_f is 5.12° C/m.
- 4) Calculate the boiling point of a solution made from 227 g of MgCl₂ dissolved in 700. g of water. What is the boiling point of the solution? K_b = 0.512° C/m.
- 5) Calculate the concentration of nitrogen gas in a 1.00 L container exerting a partial pressure of 572 mm Hg at room temperature. Henry's law constant for nitrogen at 25° C is 6.8 x 10⁻⁴ mol/L·atm.
- 6) A solution contains 21.6 g of a nonelectrolyte and 175 g of water. The water freezes at -7.18° C and K_f = 1.86° C/m. Is the nonelectrolyte CH₃OH or C₂H₅OH?

Solutions

1) $m_1 = 34.8 \text{ g CuSO}_4$

$m = 0.521 \text{ m}$



$m = n/\text{kg}$

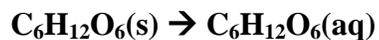
$\text{kg} = n/m = (34.8 \text{ g CuSO}_4 \times 1 \text{ mol CuSO}_4/159.61 \text{ g CuSO}_4)/0.521 \text{ m}$

$m_w = 0.418 \text{ kg H}_2\text{O} = 418 \text{ g H}_2\text{O}$

2) $P_A^\circ = 17.5 \text{ torr}$

$m_w = 455 \text{ g H}_2\text{O}$

$m_s = 300. \text{ g C}_6\text{H}_{12}\text{O}_6$



$P_w = X_w \times P_w^\circ$

$X_w = n_w/(n_w + n_s)$

$n_w = 455 \text{ g H}_2\text{O} \times 1 \text{ mol H}_2\text{O}/18.02 \text{ g H}_2\text{O} = 25.2 \text{ mol H}_2\text{O}$

$n_s = 300. \text{ g C}_6\text{H}_{12}\text{O}_6 \times 1 \text{ mol C}_6\text{H}_{12}\text{O}_6/180.18 \text{ g C}_6\text{H}_{12}\text{O}_6 = 1.67 \text{ mol C}_6\text{H}_{12}\text{O}_6$

$P_w = 25.2 \text{ mol}/(25.2 \text{ mol} + 1.67 \text{ mol}) \times 17.5 \text{ torr} \times 1 \text{ mm Hg}/1 \text{ torr}$

$P_w = 16.4 \text{ mm Hg}$

3) $m_1 = 32.7 \text{ g C}_3\text{H}_8$ $T_f^\circ = 5.50^\circ \text{ C}$

$m_2 = 137.0 \text{ g C}_6\text{H}_6$ $K_f = 5.12^\circ \text{ C/m}$

$m = n/\text{kg}$

$m = (32.7 \text{ g C}_3\text{H}_8 \times 1 \text{ mol C}_3\text{H}_8 / 44.11 \text{ g C}_3\text{H}_8) / (137.0 \text{ g} \times 1 \text{ kg} / 10^3 \text{ g})$

$m = 5.41 \text{ m}$

$\Delta T_f = K_f \times m \times i = 5.12^\circ \text{ C/m} \times 5.41 \text{ m} \times 1 = 27.7^\circ \text{ C}$

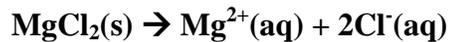
$\Delta T_f = T_f^\circ - T_f$

$27.7^\circ \text{ C} = 5.50^\circ \text{ C} - T_f$

$T_f = -22.2^\circ \text{ C}$

4) $m_1 = 227 \text{ g MgCl}_2$ $K_b = 0.512^\circ \text{ C/m}$

$m_2 = 700. \text{ g H}_2\text{O}$



$m = n/\text{kg}$

$m = 227 \text{ g MgCl}_2 \times 1 \text{ mol MgCl}_2 / 95.20 \text{ g MgCl}_2 / (700. \text{ g} \times 1 \text{ kg} / 10^3 \text{ g})$

$m = 3.41 \text{ m}$

$\Delta T_b = K_b \times m \times i = 0.512^\circ \text{ C/m} \times 3.41 \text{ m} \times 3 = 5.24^\circ \text{ C}$

$\Delta T_b = T_b - T_b^\circ$

$5.24^\circ \text{ C} = T_b - 100.00^\circ \text{ C}$

$T_b = 105.24^\circ \text{ C}$

5) $P_g = 572 \text{ mm Hg}$ $V = 1.00 \text{ L}$
 $k = 6.8 \times 10^{-4} \text{ mol/L}\cdot\text{atm}$ $T = 25^\circ \text{ C}$

$$S_g = kP_g$$

$$S_g = 6.8 \times 10^{-4} \text{ mol/L}\cdot\text{atm} \times 572 \text{ mm-Hg} \times 1 \text{ atm}/760 \text{ mm-Hg}$$

$$S_g = 5.1 \times 10^{-4} \text{ M}$$

6) $m_u = 21.6 \text{ g}$ $T_f = -7.18^\circ \text{ C}$
 $m_w = 175 \text{ g}$ $K_f = 1.86^\circ \text{ C/m}$

$$\Delta T_f = m \times K_f \times i$$

$$m = \Delta T_f / K_f$$

$$m = 7.18^\circ\text{C} / (1.86^\circ\text{C/m}) = 3.86 \text{ m}$$

$$m = n/\text{kg}$$

$$n = m \times \text{kg} = 3.86 \text{ m} \times 175 \text{ g} \times 1 \text{ kg}/10^3 \text{ g} = 0.676 \text{ mol}$$

$$n = m/\text{MM}$$

$$\text{MM} = m/n = 21.6 \text{ g}/0.676 \text{ mol} = 32.0 \text{ g/mol}$$

The electrolyte is CH_3OH .