

Question #63764, Chemistry / General chemistry

What volume of ethylene glycol (C₂H₆O₂), a nonelectrolyte, must be added to 12.2 L of water to produce an antifreeze solution with a freezing point of -33.2°C? (The density of ethylene glycol is 1.11 g/cm³, and the density of water is 1.00 g/cm³.)

Solution

$$\Delta T = K \cdot b$$

$$K (\text{H}_2\text{O}) = 1.86 \text{ }^\circ\text{C}$$

$$b (\text{C}_2\text{H}_6\text{O}_2) = \Delta T / K = 33.2 / 1.86 = 17.85 \text{ (mol/kg)}$$

$$b (\text{C}_2\text{H}_6\text{O}_2) = n (\text{C}_2\text{H}_6\text{O}_2) / m (\text{H}_2\text{O})$$

$$m (\text{H}_2\text{O}) = V \cdot \rho = 12.2 \cdot 1 = 12.2 \text{ (kg)}$$

$$n (\text{C}_2\text{H}_6\text{O}_2) = b (\text{C}_2\text{H}_6\text{O}_2) \cdot m (\text{H}_2\text{O}) = 17.85 \cdot 12.2 = 217.77 \text{ (mol)}$$

$$n (\text{C}_2\text{H}_6\text{O}_2) = m / M;$$

$$m (\text{C}_2\text{H}_6\text{O}_2) = n \cdot M = 217.77 \cdot (12 \cdot 2 + 1 \cdot 6 + 16 \cdot 2) = 13501.74 \text{ (g)} = 13.5 \text{ (kg)}$$

$$V (\text{C}_2\text{H}_6\text{O}_2) = m / \rho = 13.5 / 1.11 = 12.16 \text{ (L)}$$

Answer

$$V (\text{C}_2\text{H}_6\text{O}_2) = 12.16 \text{ L}$$

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