Solutions of Electrolytes

15 Very Hard Multiple-Choice Questions

Theoretical Concepts + Calculation Problems

Format	Choose the single best answer (A-E).
Coverage	Electrolytes, colligative properties, Van't Hoff factor, dissociation, activity, isotonicity, cryoscopic method, NaCl equivalent, and White-Vincent method.
Answer key	Model answers are placed at the end of the file.

Questions

1. A strong electrolyte may be completely ionized yet show a smaller-than-expected depression in freezing point at relatively high concentration. Which explanation is most consistent with the chapter?

A) Strong electrolytes become weak electrolytes at high concentration.
B) The ions undergo chemical decomposition into nonelectrolytes.
C) Interionic attraction and ion-pair formation reduce the effective concentration of free ions.
D) The solvent becomes completely impermeable to ions.
E) The Van't Hoff factor must always equal unity at high concentration.

2. According to the Arrhenius theory presented in the chapter, which statement is most accurate?

A) Weak electrolytes remain partly ionized even at infinite dilution.
B) Strong electrolytes are fully ionized at all concentrations without interionic interactions.
C) Both strong and weak electrolytes are fully dissociated at infinite dilution, while at moderate concentrations they differ in their degree of dissociation.
D) Degree of dissociation can only be determined from osmotic pressure.
E) Strong electrolytes possess a degree of dissociation exactly equal to their Van't Hoff factor.

3. [Calculation] A 0.75 m solution of $CaCl_2$ has an experimentally observed Van't Hoff factor of 2.60 at 25°C. Using R = 0.082 $L{\cdot}atm{\cdot}mol^{-1}{\cdot}K^{-1}$, its osmotic pressure is approximately:

A) 15.9 atm
B) 23.8 atm
C) 31.8 atm
D) 47.7 atm
E) 63.6 atm

4. Which statement best distinguishes activity from the stoichiometric concentration of a strong electrolyte?

A) Activity is always greater than concentration because ionization produces additional particles.
B) Activity represents the effective concentration after accounting for electrostatic interactions between ions.
C) Activity becomes zero at infinite dilution.
D) Activity and concentration are unrelated quantities.
E) Activity is used only for nonelectrolytes.

5. For an ion in an extremely dilute solution, which relationship is expected?

A) $a > m$ and $\gamma > 1$
B) $a < m$ and $\gamma = 0$
C) $a = m$ and $\gamma = 1$
D) $a = 0$ and $\gamma = 1$
E) $a = m^2$

6. [Calculation] An electrolyte produces three ions upon complete dissociation. A 0.100 m solution has a freezing-point depression of 0.390°C. Given K_f = 1.86°C·kg/mol, what is the approximate degree of dissociation, α?

A) 9.7%
B) 27.4%
C) 38.7%
D) 54.8%
E) 109.7%

7. Which of the following pairs is correctly classified according to the chapter?

A) CH_3COOH - strong electrolyte; AgCl - strong electrolyte
B) NaOH - weak electrolyte; KCl - nonelectrolyte
C) HNO_3 - strong electrolyte; NH_3 - weak electrolyte
D) Sucrose - weak electrolyte; NaCl - nonelectrolyte
E) Urea - strong electrolyte; $CaCl_2$ - weak electrolyte

8. Two solutions have exactly the same osmolarity. Solution A contains only a nonpenetrating solute, whereas solution B contains a solute that can freely cross the biological membrane. Which conclusion is most appropriate?

A) Both solutions must be isotonic because they are isosmotic.
B) Solution B must have the greater osmotic pressure.
C) The solutions may be isosmotic but not necessarily isotonic.
D) Osmolarity accounts only for nonpenetrating solutes.
E) Tonicity is independent of membrane permeability.

9. Which statement concerning osmolarity and tonicity is correct?

A) Osmolarity considers only nonpenetrating solutes.
B) Tonicity considers both penetrating and nonpenetrating solutes equally.
C) Osmolarity is determined by membrane permeability, whereas tonicity is not.
D) Osmolarity considers all osmotically active particles, whereas tonicity depends mainly on nonpenetrating solutes.
E) Isosmotic solutions are always isotonic toward every biological membrane.

10. [Calculation] A 1% solution of a drug has a freezing-point depression of 0.12°C. How much NaCl should approximately be added to 100 mL of this solution to make it isotonic, assuming a 1% NaCl solution produces a freezing-point depression of 0.58°C and body fluids have ΔT_f = 0.52°C?

A) 0.21 g
B) 0.40 g
C) 0.52 g
D) 0.69 g
E) 0.90 g

11. In the cryoscopic method, the term $L = iK_f$ is mainly introduced because:

A) K_f varies with the molecular weight of every solute.
B) Electrolytes produce multiple osmotically active particles, requiring correction for dissociation.
C) L measures the density of the solvent.
D) L eliminates the need to know concentration.
E) L is used only for nonelectrolytes.

12. [Calculation] A new drug is a uni-univalent electrolyte with a molecular weight of 250. Using L_{iso} = 3.4, what is its approximate sodium chloride equivalent E?

A) 0.023
B) 0.116
C) 0.231
D) 0.340
E) 0.578

13. According to the L_{iso} table in the chapter, which electrolyte type would be expected to have an average L_{iso} value of approximately 4.8?

A) Nonelectrolyte
B) Weak electrolyte
C) Uni-univalent electrolyte
D) Di-univalent electrolyte
E) Tri-univalent electrolyte

14. The sodium chloride equivalent E of a drug is best defined as:

A) The grams of drug having the same molecular weight as 1 g NaCl.
B) The quantity of NaCl required to dissolve 1 g of drug.
C) The amount of NaCl having the same osmotic effect as 1 g of the drug.
D) The amount of drug required to make 100 mL of 0.9% NaCl.
E) The molar concentration of NaCl equivalent to one mole of the drug.

15. [Calculation] A pharmacist wants to prepare 60 mL of a 2% w/v drug solution. The NaCl equivalent of the drug is 0.18. According to the White-Vincent equation, $V = w \times E \times 111.1$, what volume of water should initially be used to produce an isotonic solution containing the drug before completing to the final volume with an isotonic diluting solution?

A) 12 mL
B) 18 mL
C) 24 mL
D) 36 mL
E) 60 mL

Model Answers

Correct answers are listed below. Calculation items include a compact numerical check.

Q	Answer	Correct option / result
1	**C**	Interionic attraction and ion-pair formation reduce the effective concentration of free ions.
2	**C**	Both strong and weak electrolytes are fully dissociated at infinite dilution; at moderate concentrations they differ in degree of dissociation.
3	**D**	47.7 atm $\pi = iRTm = 2.60 \times 0.082 \times 298 \times 0.75 \sim 47.7$ atm.
4	**B**	Activity is the effective concentration after accounting for electrostatic interactions.
5	**C**	$a = m$ and $\gamma = 1$
6	**D**	54.8% $i = 0.390/(1.86 \times 0.100) \sim 2.097$; $\alpha = (i - 1)/(3 - 1) \sim 0.548$.
7	**C**	HNO_3 is a strong electrolyte; NH_3 is a weak electrolyte.
8	**C**	The solutions may be isosmotic but not necessarily isotonic.
9	**D**	Osmolarity counts all osmotically active particles; tonicity depends mainly on nonpenetrating solutes.
10	**D**	0.69 g NaCl Additional $\Delta T_{(f)}$ needed = 0.52 - 0.12 = 0.40°C; NaCl = 0.40/0.58 ~ 0.69 g per 100 mL.
11	**B**	Electrolytes produce multiple osmotically active particles, so dissociation must be accounted for.
12	**C**	0.231 $E = 17L_{iso}/MW = 17 \times 3.4 / 250 \sim 0.231$.
13	**D**	Di-univalent electrolyte
14	**C**	The amount of NaCl having the same osmotic effect as 1 g of the drug.
15	**C**	24 mL w = 2 g/100 mL × 60 mL = 1.2 g; V = 1.2 × 0.18 × 111.1 ~ 24 mL.

End of Question Set