Potentiometric Titration - Hard Multiple-Choice Questions

Instructions: Circle the correct answer. Choose one option only for each question.

Name: _____ Date: _____

1. In a potentiometric measurement, the measured cell potential is best represented by:

A. $E_{cell} = E_{ref} - E_{ind}$
B. $E_{cell} = E_{ind} - E_{ref} + E_j$
C. $E_{cell} = E_{ind} + E_{ref} - E_j$
D. $E_{cell} = E_j - E_{ind} - E_{ref}$

2. Which property is essential for an ideal reference electrode?

A. Its potential changes rapidly with analyte concentration.
B. Its potential is constant and independent of analyte activity.
C. It selectively responds to hydrogen ions.
D. It must contain a silica membrane.

3. KCl is commonly used in the salt bridge mainly because:

A. K^+ and Cl^- react completely with the analyte.
B. KCl increases the potential of the indicator electrode.
C. K^+ and Cl^- have nearly equal ionic mobilities, minimizing junction potential.
D. KCl prevents all ions from passing through the junction.

4. The potential developed across the glass membrane of a pH electrode mainly results from:

A. Electron transfer through the silica glass.
B. A difference in hydrogen-ion interaction between the inner and outer hydrated layers.
C. Oxidation of silica by the sample solution.
D. Precipitation of AgCl on the external glass surface.

5. Why is an internal Ag/AgCl electrode placed inside the glass electrode?

A. Glass is not an electronic conductor and requires an internal reference system.

B. Ag/AgCl directly neutralizes hydrogen ions.

C. It prevents dilution of the unknown acid.

D. It eliminates the need for calibration buffers.

6. During titration of a weak monoprotic acid with a strong base, the condition at the half-equivalence point is:

A. [HA] = 0

B. $[A^-] = 0$

C. $[HA] = [A^-]$ and $pH = pK_a$

D. pH = 7 for all weak acids

7. A weak acid is titrated with 0.100 M NaOH. The equivalence point occurs at 7.25 mL. At what approximate titrant volume should the pH equal the acid's pK_a?

A. 1.81 mL

B. 3.63 mL

C. 7.25 mL

D. 14.50 mL

8. Which statement correctly describes the first-derivative titration plot?

A. It plots pH against the total solution volume.

B. It plots Delta V / Delta pH against the initial NaOH volume.

C. It plots Delta pH / Delta V against the average of two successive titrant volumes.

D. Its minimum value identifies the equivalence point.

9. Two consecutive NaOH volumes are 7.0 mL and 7.5 mL, with corresponding pH values of 6.20 and 9.40. What point should be plotted on the first-derivative graph?

A. V_{avg} = 7.00 mL, Delta pH / Delta V = 3.20

B. V_{avg} = 7.25 mL, Delta pH / Delta V = 6.40

C. V_{avg} = 7.50 mL, Delta pH / Delta V = 1.60

D. V_{avg} = 7.25 mL, Delta pH / Delta V = 3.20

10. The equivalence point on a first-derivative curve corresponds to:

A. The lowest pH value.

B. The maximum value of Delta pH / Delta V.

C. The point where Delta pH / Delta V = 0.

D. The point where the volume of acid equals the total solution volume.

11. Adding 50 mL of distilled water to 10 mL of the unknown acid before titration will:

A. Increase the number of moles of acid.

B. Decrease the equivalence volume of NaOH.

C. Dilute the acid but leave the moles of acid and equivalence volume essentially unchanged.

D. Convert the weak acid into a strong acid.

12. A 10.0 mL sample of a monoprotic weak acid requires 7.25 mL of 0.100 M NaOH to reach equivalence. What is the acid concentration before adding distilled water?

A. 0.00725 M

B. 0.0121 M

C. 0.0725 M

D. 0.725 M

13. Why are smaller NaOH increments, such as 0.2 mL, used near the potential jump?

A. To increase the acid concentration.

B. To reduce the pH of the NaOH solution.

C. To locate the equivalence point with greater precision.

D. To prevent formation of the conjugate base.

14. Which statement concerning the equivalence point of a weak-acid-strong-base titration is correct?

A. The pH must always equal 7.00.

B. The pH is usually greater than 7 because the conjugate base undergoes hydrolysis.

C. The solution contains only unreacted weak acid.

D. The buffer capacity is at its maximum exactly at equivalence.

15. An unknown weak acid gives pH = 4.80 at half of the equivalence-point volume. Which conclusion is most appropriate?

A. The acid has pK_a approximately 4.80, suggesting it may be acetic acid.

B. The acid has pK_a approximately 9.60.

C. The acid concentration must be 4.80 M.

D. The equivalence-point pH must be exactly 4.80.

Model Answer Key

1. B	2. B	3. C
4. B	5. A	6. C
7. B	8. C	9. B
10. B	11. C	12. C
13. C	14. B	15. A

End of Questions