

科目：分析化學(1005)

校系所組：中央大學化學學系

交通大學應用化學系 (甲組)

清華大學化學系

清華大學材料科學工程學系 (丙組)

一、單選題(76%)：每題 4 分

() 1. Which of the following descriptions is true?

- (A) Quantitative analysis reveals the identity of the elements and compounds in a sample.
- (B) Replication improves the quality of the results in terms of the accuracy.
- (C) A buret equipped with a glass stopcock is suitable for the delivery of basic solution.
- (D) Formal concentration is the molar concentration of a particular species in a solution at equilibrium.
- (E) To convert 2.33 g of Na_2CO_3 (106.0 g/mol) to Ag_2CO_3 , 7.47g of AgNO_3 (169.9 g/mol) is needed.

() 2. Which of the following descriptions is NOT true?

- (A) The mean of a set of replicate data is their average value.
- (B) Accuracy describes the nearness to the true value and precision refers to reproducibility.
- (C) Standard deviation, variance, and coefficient of the variation are widely used to describe the accuracy of a set of replicate data.
- (D) Random errors affect the precision of measurements, while systematic errors affect the accuracy of results.
- (E) An outlier is an occasional result in replicate measurements that differ significantly from the rest of the results.

() 3. Which of the following descriptions is NOT true?

- (A) For the following set of data: 19.4, 19.5, 19.6, 19.8, 20.1, and 20.3, the median is 19.7.
- (B) 9.2500×10^4 contains five significant figures
- (C) If the uncertainty in each reading is 0.03 mL, the uncertainty in volume delivered by a buret is ± 0.04 mL
- (D) The $[\text{H}^+]$ of a solution with $\text{pH} = 5.21 \pm 0.03$ is $6.2 (\pm 0.4) \times 10^{-6}$ M.
- (E) For a normal (Gaussian) distribution, the confidence interval corresponding to a 95% confidence level is from -1.64σ to $+1.64\sigma$, where σ is standard deviation of the distribution.

() 4. For the data set of lead concentration in blood: 0.752, 0.756, 0.752, 0.751, and 0.760 ppm, which of the following descriptions is true?

- (A) The mean is 0.745 ppm Pb.
- (B) The standard deviation is 0.04 ppm Pb.
- (C) The variance is 1.4×10^{-6} .
- (D) The relative standard deviation in part per thousand (ppt) is 0.5 ppt.
- (E) The spread is 0.009 ppm Pb.

注意：背面有試題

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- () 5. Which of the following descriptions is NOT true?
- (A) In null hypothesis testing, type II error occurs when null hypothesis is rejected although it is actually true.
 - (B) The measure of a student's weight yielded the following data: 55.95, 56.00, 56.04, 56.08, and 56.23 kg. Q-test suggests that under 95 % confidence level the last value is not an outlier and needs to be retained. (Q_{critical} for five observations at 95% confidence level is 0.710)
 - (C) An internal standard is a reference species, chemically and physically similar to the analyte, that is added to samples, standards and blanks. The ratio of the response of the analyte to that of the internal standard is plotted versus the concentration of analyte.
 - (D) Calibration sensitivity is just the slope of the calibration curve.
 - (E) Detection limit (DL) can be expressed as $DL = ks_b/m$, where m is the slope of the calibration curve, s_b is the standard deviation of the blank and k is a confidence factor.
- () 6. Which of the following descriptions is true?
- (A) The pH value for a 0.200 M aqueous NaOH at 25 °C is 14.7.
 - (B) At 25 °C, 0.178 g of $Ba(IO_3)_2$ (487 g/mol) can be dissolved in 500 mL of water. (K_{sp} of $Ba(IO_3)_2$: 1.57×10^{-9})
 - (C) At 25 °C, the molar solubility of $Ba(IO_3)_2$ in a solution that is 0.0200 M in $Ba(NO_3)_2$ is 1.60×10^{-4} M.
 - (D) The pH of a solution that is 0.400 M in HCOOH and 1.00 M in HCOONa is 5.14. (K_a of HCOOH: 1.80×10^{-4})
 - (E) The buffer capacity of a buffer is the number of moles of a strong acid or a strong base that causes 1.00 Kg of the buffer to undergo a 1.00-unit change in pH.
- () 7. Which of the following descriptions is true?
- (A) The ionic strength of a solution that is 0.05M in KNO_3 and 0.1 M in Na_2SO_4 is 0.45 M.
 - (B) At constant temperature, thermodynamic equilibrium constant varies with ionic strength of the solution, whereas concentration equilibrium constant does not.
 - (C) In gravimetric methods of analysis, larger relative super saturation typically results in colloidal precipitate, while smaller one leads to crystalline solid.
 - (D) Increasing the electrolyte concentration has the effect of increasing the volume of the counter-ion layer, thereby decreasing the chances for coagulation.
 - (E) The $[OH^-]$ must be greater than 3×10^{-13} M but smaller than 8.4×10^{-6} M in order to separate Fe^{3+} and Mg^{2+} quantitatively as hydroxides. (K_{sp} of $Fe(OH)_3$ and $Mg(OH)_2$ are 2.0×10^{-39} and 7.1×10^{-12} , respectively)

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- () 8. Titration of 20.00 mL of 0.1000 M H_2A with 0.1000 M NaOH is shown below (Figure 1). The K_{a1} and K_{a2} of H_2A are 1.00×10^{-3} and 1.00×10^{-7} , respectively. According to the plot, which of the following descriptions is NOT correct?
- (A) In zone X, pH of the solution is dominated by the buffer solution of H_2A and HA^- .
 - (B) In zone Y, pH of the solution is dominated by the buffer solution of HA^- and A^{2-} .
 - (C) In zone Z, pH of the solution is dominated by the buffer solution of H_2A and A^{2-} .
 - (D) The dominant species in zone W is NaHA.
 - (E) Indicators themselves are weak acids or weak bases that react with analyte or titrant in the titration. Therefore, they can cause error if too much is used.

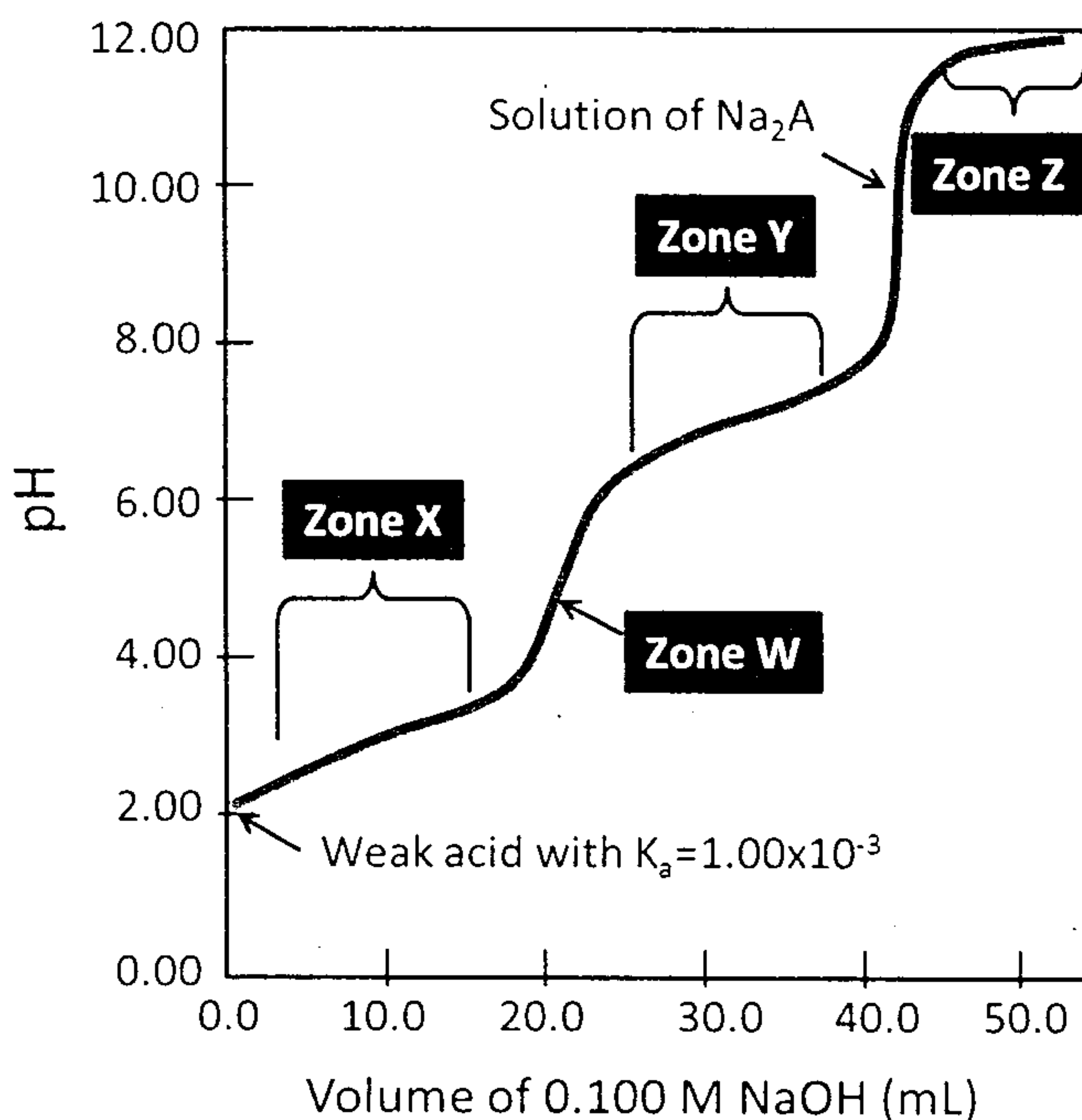


Figure 1. Titration of 20.00 mL of 0.1000 M H_2A with 0.1000 M NaOH.

- () 9. Which of the following descriptions is NOT true?
- (A) Formal potential is the electrode potential when the ratio of activity of reactants and products of a half-reaction is exactly 1.00.
 - (B) When a cell is at equilibrium, both cell half-reactions occur at the same rate, and the cell voltage is zero.
 - (C) Salt bridges are widely used to prevent mixing of the electrolyte solutions in the two half-cells making up the electrochemical cell.
 - (D) The cathode in an electrochemical cell is the electrode where reduction occurs.
 - (E) In standard hydrogen electrode, the partial pressure of hydrogen gas is 1.0 atm.

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- () 10. The measurement characteristic "frequency" is in data-domain
(A) Physical domain. (B) Digital domain.
(C) Time domain. (D) Analog domain.
(E) Chemical domain.
- () 11. Perform the "7 x 3" calculation and express result in binary arithmetic
(A) 1010. (B) 10101. (C) 11001. (D) 11011. (E) None of above.
- () 12. Which of the following communication standards is parallel?
(A) IEEE-488. (B) RS-232. (C) USB. (D) Ethernet. (E) IEEE-1394.
- () 13. What is the effect on thermal noise of decreasing the response time of an instrument from 1 s to 1 μ s?
(A) 10^6 . (B) 10^5 . (C) 10^4 . (D) 10^3 . (E) 10^2 .
- () 14. Which of the following instrumentations uses "polarization of radiation" phenomenon?
(A) UV-VIS. (B) GFAA. (C) XRF. (D) FTIR. (E) MS.
- () 15. Which of the following descriptions is true regarding the sample introduction process into a flame in FAA?
(A) Nebulization/Desolvation/Volatization/Excitation/Ionization.
(B) Volatization/Desolvation/Nebulization/Ionization/Excitation.
(C) Nebulization/Volatization/Desolvation/Ionization/Excitation.
(D) Desolvation/Nebulization/Ionization/Excitation/ Volatization.
(E) Volatization/ Nebulization/ Desolvation/Ionization/Excitation.
- () 16. Which of the following interferences is applicable to ^{61}Ni during ICPMS measurement?
(A) ArO. (B) CaO. (C) ArNa. (D) NaK. (E) CaOH.
- () 17. Which of the following sources used in optical spectrometers covers UV/Vis/NIR region?
(A) Hollow cathode lamp. (B) Ar lamp.
(C) D₂ lamp. (D) H₂ lamp.
(E) Tungsten lamp.
- () 18. Which of the following sources MS ionization sources could potentially yield multiply charged dimer species in protein analysis?
(A) EI. (B) CI. (C) MALDI. (D) ESI. (E) FAB.

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- () 19. Which of the following processes involved in *van Deemter* equation does not affect by mobile phase flow rate?
- (A) Mass transfer in mobile phase.
 - (B) Mass transfer to and from stationary phase.
 - (C) Longitudinal diffusion.
 - (D) Multiple flow paths.
 - (E) None of above.

二、問答題(24%)

1. For the following points $(x,y) = (1,2), (3,3), (4,4),$ and $(6,5)$, use the method of least squares to find (a) the slope and (b) the y-intercept of the regression line. (4%)
2. Write down the following equations with a brief explanation of symbols used.
 - (A) Henderson-Hasselbalch equation (1%)
 - (B) Debye-Hückel equation (1%).
 - (C) Nernst Equation (1%)
 - (D) van Deemter equation (1%)
3. A 100.0 mL solution containing 0.0500 M Fe^{2+} is titrated with 0.100 M Ce^{4+} . The equivalence point occurs when the volume of titrant, $V_{\text{Ce}^{4+}}$, equals 50.0 mL. Find the cell voltage at $V_{\text{Ce}^{4+}} =$ (a) 20.0 mL, (b) 50.0 mL, and (c) 51.0 mL. (6%)
($E^0(\text{Ce}^{4+}|\text{Ce}^{3+})=1.70\text{V}$; $E^0(\text{Fe}^{3+}|\text{Fe}^{2+})=0.767\text{V}$)
4. Briefly explain gradient elution and temperature programming used in chromatography. (10%)

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