Chem12 Buffer/Titration : Probs - 250

1) Which equation represents an acid-base titration ?

a) $Na^+(aq) + OH^-(aq) + H^+(aq) + Cl^-(aq) \rightarrow H_2O(l) + Na^+(aq) + Cl^-(aq)$
b) $CH_3COOH(l) + H_2O(l) \rightarrow H_3O^+(aq) + CH_3COO^-(aq)$
c) $3Cu(s) + 2NO_3^-(aq) + 8H^+(aq) \rightarrow 3Cu^{2+}(aq) + 2NO(g) + 4H_2O(l)$
d) $Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$

2) 100. mL of a 0.100 M NaOH solution are titrated with 200. mL of a 0.0500 M HCl solution. The approximate pH of the resulting solution is :

a) 5.00 b) 6.00 c) 7.00 d) 8.00

3) During a titration reaction 80.0 mL of a 0.100 M HCl solution are added to 100.0 mL of a 0.100 M NaOH solution. The $[OH^-]$ of the resulting solution is :

a) 11.1 M b) 1.11×10^{-2} M c) 1.11×10^{-1} M d) 1.11×10^{2} M

4) Data : $NaOH(aq) + KHC_8H_4O_4(aq) \rightarrow KNaC_8H_4O_4(aq) + H_2O(l)$
(Formula mass for $KHC_8H_4O_4$ = 204 g/mol)

0.500 g of an impure sample of potassium hydrogen phthalate, $KHC_8H_4O_4$, is titrated with a standardized NaOH solution. 10.0 mL of the 0.100 M NaOH solution is required to react completely with the impure sample. The percentage of pure $KHC_8H_4O_4$ in the sample is :

a) 40.8 % b) 20.4% c) 4.08 % d) 2.04 %

5) An aqueous solution of aniline, $C_6H_5NH_2$ is in equilibrium with its conjugate acid $C_6H_5NH_3^+$. If the numerical value of K_b for aniline is 4.30×10^{-10}. The value of K_a for its conjugate acid $C_6H_5NH_3^+$ is :

a) 4.30×10^{4} b) 2.33×10^{-5} c) 5.38×10^{-10} d) 4.30×10^{-10}

6) An aqueous solution of acetic acid $HC_2H_3O_2$ is in equilibrium with its conjugate base $C_2H_3O_2^-$. If the numerical value of K_a for $HC_2H_3O_2$ is 1.80×10^{-5}, the value of K_b for its conjugate base $C_2H_3O_2^-$ is :

a) 1.80×10^{-5} b) 5.56×10^{-10} c) 3.24×10^{-10} d) 1.80×10^{9}

7) Data : $NH_3(aq) + H_2O(l) <-> NH_4^+(aq) + OH^-(aq)$
(K_b for $NH_3 = 1.8x10^{-5}$)

The equilibrium concentration of an ammonia (NH_3) solution is 0.500 M. The pOH of the solution is :

a) 11.5 b) 8.95 c) 2.52 d) 2.00

8) Which one of the following equations contains the conjugate acid-base pair from which a buffer can be prepared ?

a) $HCN(aq) + H_2O(l) <-> H_3O^+(aq) + CN^-(aq)$
b) $HCl(aq) + H_2O(l) <-> H_3O^+(aq) + Cl^-(aq)$
c) $HNO_3(aq) + H_2O(l) <-> H_3O^+(aq) + NO_3^-(aq)$
d) $HClO_4(aq) + H_2O(l) <-> H_3O^+(aq) + ClO_4^-(aq)$
e) $H_2SO_4(aq) + H_2O(l) <-> H_3O^+(aq) + HSO_4^-(aq)$

9) Which one of the following equations contains the conjugate acid-base pair from which a buffer solution can be prepared ?

a) $HC_2H_3O_2 + H_2O <-> H_3O^+ + C_2H_3O_2^-$
b) $H_2SO_4 + H_2O <-> H_3O^+ + HSO_4^-$
c) $HI + H_2O <-> H_3O^+ + I^-$
d) $HBr + H_2O <-> H_3O^+ + Br^-$
e) $HClO_4 + H_2O <-> H_3O^+ + ClO_4^-$

10) What is the $[H_3O^+]$ in a buffer solution containing a mixture of 100.0 mL of 0.800 M $NaC_2H_3O_2$ and 300. mL of 0.400 M $HC_2H_3O_2$? (K_a for $HC_2H_3O_2 = 1.80x10^{-5}$)

a) $4.5x10^{-5}$ M b) $1.2x10^{-5}$ M c) $6.0x10^{-6}$ M d) $2.7x10^{-5}$ M

11) What is the $[H_3O^+]$ in a buffer solution containing a mixture of equal volumes of 0.100 M HF and 0.200 M NaF ? (K_a for HF = $6.8x10^{-4}$)

a) $1.36x10^{-3}$ M b) $6.8x10^{-4}$ M c) $3.4x10^{-4}$ M d) $6.8x10^{-5}$ M

12) Given the following electronegativities,

K = 0.8 Ca = 1.0 As = 2.0 Se = 2.4 Br = 2.8

Which element will have the most basic hydroxide ?

a) K b) Ca c) As d) Se e) Br

13) The indicator bromthymol blue has a K_a of 1.00×10^{-7}. If a 2.00×10^{-3} M solution of the indicator is used, what will be the $[H_3O^+]$ at the endpoint, at the intermediate color between yellow and blue ?

a) 2.00×10^{-10} M b) 1.00×10^{-7} M c) 5.00×10^{-5} M d) 3.16×10^{-4}M

14) Which one of the following equations contains the conjugate acid-base pair from which a buffer solution can be prepared ?

a) $HCl + H_2O <-> H_3O^+ + Cl^-$ b) $HClO_4 + H_2O <-> H_3O^+ + ClO_4^-$
c) $H_2SO_4 + H_2O <-> H_3O^+ + HSO_4^-$ d) $HNO_2 + H_2O <-> H_3O^+ + NO_2^-$

15) If 0.100 M HNO_3 is added drop by drop to each of the solutions below (each containing two solutes and all at the same concentration), in which pair of solutions will the $[H_3O^+]$ show the least change ?

a) NaBr and HBr b) NaCl and HCl c) NaF and HF d) NaI and HI

16) If a person breathes too deeply and too rapidly, hyperventilation may occur, in which the pH of the blood becomes too high. A cure for this condition is to breathe several times into a paper bag held tightly over the mouth and nose. In this situation, which one of the following buffer reactions is responsible for bringing the pH of the blood back to its normal level of about 7.3 ?

a) Ascorbic acid + water <-> $Ascorbate^- + H_3O^+$
b) $HCO_3^- + H_2O <-> H_3O^+ + CO_3^{2-}$
c) $HC_2H_3O_2 + H_2O <-> C_2H_3O_2^- + H_3O^+$
d) $CO_2 + 2H_2O <-> H_3O^+ + HCO_3^-$

17) Which one of the following equations represents a titration reaction ?

a) $NaOH(aq) + HCl(aq) -> H_2O(l) + NaCl(aq)$
b) $CH_3COOH(l) + H_2O(l) -> H_3O^+(aq) + CH_3COO^-(aq)$
c) $CH_3COONa(aq) + H_2O(l) -> CH_3COOH(aq) + NaOH(aq)$
d) $NH_4Cl(aq) + H_2O(l) -> NH_3(aq) + H_3OCl(aq)$

18) Data : $NaHCO_3(s) + HCl(aq) -> NaCl(aq) + CO_2(g) + H_2O(l)$
Formula mass $NaHCO_3$ = 84.0 g/mol

A 0.500 g impure sample of sodium bicarbonate ($NaHCO_3$) is titrated with a standardized 0.200 M hydrochloric acid (HCl) solution. 25.0 mL of the standardized acid solution are required to react completely with the sample. The impurities do not react with the HCl. Calculate the percentage of $NaHCO_3$ in the impure sample.

a) 16.0 % b) 42.0 % c) 84.0 % d) 96.0 %

19) If 50.0 mL of a 1.00 M NaOH solution are titrated with 51.0 mL of a 1.00 M HCl solution, what is the pH of the resulting solution ?

a) 2.00 b) 3.00 c) 9.90 d) 12.0

20) The following equation represents the dissociation of an aqueous solution of the base methylamine, CH_3NH_2 :

$$CH_3NH_2(aq) + H_2O(l) <-> CH_3NH_3^+(aq) + OH^-(aq)$$

Which one of the following is the correct expression for the K_b of methylamine ?

a) $\{[CH_3NH_2][OH^-]\}/[CH_3NH_3^+]$
b) $\{[CH_3NH_3^+][OH^-]\}/\{[CH_3NH_2][H_2O]\}$
c) $\{[CH_3NH_3^+][CH_3NH_2]\}/[OH^-]$
d) $\{[CH_3NH_3^+][OH^-]\}/[CH_3NH_2]$

21) Write the net ionic equation for the following reaction : potassium hydroxide neutralized by acetic acid.

22) A buffer solution is prepared by adding 0.25 mole of $NH_4NO_3(s)$ to 850 mL of 1.0 M NH_3. Assume there is no change in volume. Calculate the pH.

23) What is the pH of the solution which results when 100.0 mL of a 0.050 M solution of NaOH is titrated with 200.0 mL of a 0.025 M solution of HCl ?

a) 6.00 b) 7.00 c) 8.00 d) 9.00

24) During the titration of 50.0 mL of a 0.200 M KOH solution with 0.200 M HNO_3, 20.0 mL of the HNO_3 is added. What is the pH at this point of the titration ?

a) 0.920 b) 1.07 c) 12.9 d) 13.1

25) In which of the following buffer solutions will the addition of H_3O^+ cause the equilibrium to shift to the left ?

1) $HF + H_2O <-> H_3O^+ + F^-$ 2)$H_2PO_4^- + H_3O^+ <-> H_3PO_4 + H_2O$
3) $HPO_4^{2-} + OH^- <-> PO_4^{3-} + H_2O$ 4) $HSO_3^- + OH^- <-> SO_3^{2-} + H_2O$

a) 1 only b) 2 only c) 3 and 4 only d) 1,3, and 4

26) What is the K_b for nitrite ion, NO_2^-, the conjugate base of nitrous acid ?

a) $2.2x10^{-11}$ b) $5.1x10^{-4}$ c) $2.2x10^{-3}$ d) $2.2x10^{-2}$

27) What is the pH of an aqueous solution of nitrous acid, HNO_2, when its equilibrium concentration is $1.0x10^{-3}$ M ?

a) 3.00 b) 3.15 c) 6.00 d) 6.29

28) Which one of the following equations contains the conjugate acid-base pair from which a buffer solution can be prepared ?

a) $HI(aq) + H_2O(l) <-> H_3O^+(aq) + I^-(aq)$
b) $HBr(aq) + H_2O(l) <-> H_3O^+(aq) + Br^-(aq)$
c) $H_2SO_4(aq) + H_2O(l) <-> H_3O^+(aq) + HSO_4^-(aq)$
d) $H_2CO_3(aq) + H_2O(l) <-> H_3O^+(aq) + HCO_3^-(aq)$

29) Formic acid (HCOOH) has a K_a of $2.0x10^{-4}$. Which pair of solutions below will make a buffer solution of pH = 4.0 when mixed ?

a) Equal volumes of 0.10 M HCOOH and 0.20 M HCOONa
b) Equal volumes of 0.40 M HCOOH and 0.20 M HCOONa
c) 20.0 mL of 0.20 M HCOOH and 30.0 mL of 0.50 M HCOONa
d) Equal volumes of $2.0x10^{-4}$ M HCOOH and $2.0x10^{-4}$ M HCOONa

30) Which one of the following equations could represent a titration reaction ?

a) $CH_3COOH(aq) + H_2O(l) <-> H_3O^+(aq) + CH_3COO^-(aq)$
b) $2HBr(aq) + Cl_2(g) <-> 2HCl(aq) + Br_2(g)$
c) $KHCO_3(aq) + HBr(aq) <-> KBr(aq) + H_2O(l) + CO_2(g)$

d) $3Zn(s) + 2NO_3^-(aq) + 8H^+(aq) <-> 3Zn^{2+}(aq) + 2NO(g) + 4H_2O(l)$

31) Calculate the pH of a solution made by dissolving 3.75 g of RbOH in 79.9 mL of 0.180 M HNO_3. Assume no volume change.

32) When selecting an indicator for any titration, how should the indicator endpoint compare to the titration stoichiometric point ?

a) the endpoint and stoichiometric point should coincide
b) the endpoint should be before the stoichiometric point
c) the endpoint should be after the stoichiometric point
d) the endpoint and stoichiometric point should both be at pH 9

33) Which one of the following describes the pH at the stoichiometric point in the titration of a strong acid with a strong base ?

a) pH = 0 b) pH = 7 c) 0 < pH < 7 d) pH > 7

34) 30.0 mL of 0.50 M HCl solution are titrated with 20.0 mL of 0.50 M NaOH solution. What is the pH of the resulting solution ?

a) 0.0 b) 1.0 c) 7.0 d) 13

35) Which one of the following equations represents an acid-base titration ?

a) $Ba^{2+}(aq) + SO_4^{2-}(aq) <-> BaSO_4(s)$
b) $CH_3COOK(s) + H_2O(l) <-> K^+(aq) + CH_3COO^-(aq)$
c) $Zn(s) + 2H^+(aq) + SO_4^{2-}(aq) <-> Zn^{2+}(aq) + SO_4^{2-}(aq) + H_2(g)$
d) $K^+(aq) + OH^-(aq) + H^+(aq) + NO_3^-(aq) <-> H_2O(l) + K^+(aq) + NO_3^-(aq)$

36) In a titration 20.0 mL of 0.50 M NaOH solution reacts completely with 30.0 mL of H_2SO_4 solution. What is the initial concentration of the H_2SO_4 solution ?

a) 0.17 M b) 0.33 M c) 0.40 M d) 0.67 M

37) An acid buffer is a solution containing

a) a strong acid and its salt

b) a strong acid and a strong base
c) a weak acid and a strong acid
d) a weak acid and a salt of its conjugate base

38) Which of the following occurs when NaF(s) is added to a 0.25 M HF solution ?

a) the pH of the HF solution decreases
b) the pH of the HF solution remains the same
c) the pH of the HF solution increases

39) A buffer solution is prepared by mixing 0.50 mol $CH_3COONa(s)$ with 0.50 mol $CH_3COOH(l)$ and diluting the mixture to 2.0 L with distilled water. What is the pH of the resulting solution ?

a) 4.74 b) 5.05 c) 7.00 d) 9.26

40) Which of the following equations represents an acid-base titration?

a) $NaOH(s) + H_2O(l) \rightarrow Na^+(aq) + OH^-(aq) + H_2O(l)$
b) $HCl(aq) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$
c) $Fe(H_2O)_6^{3+}(aq) + H_2O(l) \rightarrow Fe(H_2O)_5OH^{2+}(aq) + H_3O^+(aq)$
d) $Na^+(aq) + OH^-(aq) + H^+(aq) + Br^-(aq) \rightarrow Na^+(aq) + H_2O(l) + Br^-(aq)$

41) Which of the following is the best definition for a standard solution?

a) a solution of known volume
b) a solution of known concentrations.
c) a solution prepared at STP conditions
d) a solution prepared at 25°C and standard pressure

42) 25 mL of 0.20 M HCl solution are added to 50. mL of 0.20 M KOH solution. What is the pH of the resulting mixture ?

a) 1.18 b) 7.00 c) 12.82 d) 13.30

43) A $Ba(OH)_2$ solution is titrated with a solution of HNO_3 to the stoichiometric point. Which of the following conditions exists at the stoichiometric point (Equivalence point). ?

a) the mixture is highly acidic b) the mixture is highly basic
c) moles of $Ba(OH)_2$ originally present equals moles of HNO_3 added

d) moles of H^+ from the acid equals moles of OH^- from the base

44) 0.01 mol of NaOH(s) are added to a buffer consisting of 1.0 mol weak acid in equilibrium with 1.0 mol of its conjugate base. Which of the following statements describes how the equilibrium and the pH are affected ?

a) the equilibrium shifts to the side with the conjugate base and the pH undergoes a large increase
b) the equilibrium shifts to the side with the weak acid and the pH undergoes a large decrease
c) the equilibrium shifts to the side with the conjugate base and the pH undergoes no detectable change
d) the equilibrium shifts to the side with the weak acid and the pH undergoes no detectable change

45) What is the pH of a 1.0 L buffer solution containing 1.0 mol $NaCH_3COO$ and 2.0 mol CH_3COOH ?

a) 4.44 b) 4.74 c) 5.05 d) 7.00

46) A buffer solution could be prepared by mixing a 1.0 M solution of Na_2CO_3 with an equal volume of a 1.0 M solution of

a) NaCl b) NaOH c) $NaHCO_3$ d) Na_2SO_4

47) 20.0 mL of 2.00 M NaOH is required to react completely with a 2.0 g sample of impure oxalic acid, HOOCCOOH. Oxalic acid is diprotic and it is the only chemical in the sample that will react with NaOH. Calculate the percentage of oxalic acid in the impure sample.

48) Calculate the mass of NaOH(s) that would have to be added to 10.0 mL of a 2.00 M HNO_3 solution to obtain a pH of 1.00.

49) A titration of 0.10 M HCl with 0.20 M NaOH will reach an equivalence point when :

a) the volume of base equals twice the volume of acid
b) the mass of acid equals the mass of base

c) the number of moles of HCl equals the moles of NaOH
d) the volume of acid equals the volume of base

50) In a titration, 20.0 mL of 0.50 M NaOH solution reacts completely with 30.0 mL of H_2SO_4 solution. What is the initial concentration of the H_2SO_4 solution ?

a) 0.17 M b) 0.33 M c) 0.40 M d) 0.67 M

51) What is the pOH of a 0.15 M solution of RbOH ?

a) -0.82 b) 0.41 c) 0.82 d) 13.18

52) Which of the following pairs of chemicals could be used to prepare a buffer solution ?

a) HCl and NaCl
b) CH_3COOH and NaCl
c) NaCl and $NaCH_3COO$
d) CH_3COOH and $NaCH_3COO$

53) 30.0 mL of 0.50 M HCl solution is added to 20.0 mL of 0.50 M NaOH solution. Find the pH.

a) 1.00 b) 5.00 c) 7.00 d) 13.00

54) Bromcresol purple is yellow in its acid form and purple in its base form. The color change occurs in the pH range of 5 to 7. The color of bromcresol purple in 0.010 M KOH will be

a) yellow b) purple c) intermediate d) colorless

55) A solution is tested with four acid-base indicators. The following colors resulted with each indicator :

methyl red - yellow
phenol red - red
alizarin yellow - yellow
thymolphthalein - no color

The pH of the solution is

a) 5 b) 7 c) 9 d) 11

56) What is the function of a buffer in a chemical system ?

57) What is the hydronium ion concentration in a buffer solution containing a mixture of 20.0 mL of 0.100 M HF and 20.0 mL of a 0.200 M NaF ?

58) A small amount of a strong base is added to a large volume of buffer at pH 5.00. Which of the following is most the likely pH value for the new solution ?

a) 3.00 b) 4.98 c) 5.01 d) 7.00

59) Which of the following indicators will change color at a pH of approximately 11 ?

a) phenolphthalein b) indigo carmine
c) thymolphthalein d) alizarin yellow

60) Which of the following equations best represents an acid-base titration ?

a) $CaC_2(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + C_2H_2(g)$
b) $Mg(s) + 2H^+(aq) + 2Cl^-(aq) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq) + H_2(g)$
c) $Ca(OH)_2(s) + 2H^+(aq) + 2NO_3^-(aq) \rightarrow Ca^{2+}(aq) + 2NO_3^-(aq) + 2H_2O$
d) $MnO_2(s) + 4H^+(aq) + 2Cl^-(aq) \rightarrow Mn^{2+}(aq) + Cl_2(g) + 2H_2O(l)$

61) Each of the following 1.00 M acids is titrated with 1.00 M NaOH. Which sample requires the greatest volume of NaOH for complete reaction ?

a) 45.0 mL of oxalic acid b) 50.0 mL of sulfuric acid
c) 75.0 mL of HCl d) 90.0 mL of acetic acid

62) When 20.0 mL of 0.200 M HCl is added to 40.0 mL of 0.100 NaOH, the $[H_3O^+]$ in the resulting solution is

a) 0.100 M b) 0.0333 M c) 1.00×10^{-7} M d) 0.00 M

63) If you were given two unknown acids of equal concentration, briefly describe how you would identify the stronger acid. What testing material or instrument would you use, and how would you interpret the results ?

64) In an acid-base titration, it was found that 18.4 mL of 0.200 M NaOH was required to neutralize a 0.220 g sample of a monoprotic acid. What is the mass of one mole of the acid ?

65) When water is added to an acid solution, the pH changes. Explain why the pH does not change when water is added to a buffer solution.

66) An acid-base indicator is generally defined as a substance that :

a) changes color when moles H^+ = moles OH^-
b) changes color when the pH of the solution is 7
c) is used to detect whether the test solution contains an excess of positive or negative ions
d) changes color within a definite pH range

67) What volume of 0.0200 M $Ca(OH)_2$ solution is required to neutralize 25.0 mL of 0.0100 M HCl solution ?

a) 6.25 mL b) 12.5 mL c) 25.0 mL d) 50.0 mL

Answers : 1) a, 2) c, 3) b, 4) a, 5) b, 6) b, 7) c, 8) a, 9) a, 10) d, 11) c, 12) a, 13) b, 14) d, 15) c, 16) d, 17) a, 18) c, 19) a, 20) d, 21) $H_3O^+ + OH^- \rightarrow 2H_2O$, 22) 9.8, 23) b, 24) c, 25) d, 26) a, 27) b, 28) d, 29) a, 30) c, 31) 13.4, 32) a, 33) b, 34) b, 35) d, 36) a, 37) d, 38) c, 39) a, 40) d, 41) b, 42) c, 43) d, 44) c, 45) a, 46) c, 47) 90.%, 48) 0.760 grams, 49) c, 50) a, 51) c, 52) d, 53) a, 54) b, 55) c, 56) A buffer maintains a constant pH when small amounts of an acid or a base are added to the system., 57) 1.8×10^{-4}, 58) c, 59) d, 60) c, 61) b, 62) c, 63) Do a titration with NaOH. See how much NaOH solution is required to reach the equivalence point for each acid. Use an indicator(s) to find the pH when the equivalence point is reached. The lower the pH at the equivalence point, the stronger the acid. 64) 59.8 grams, 65) $K_a = \{[base][H_3O^+]\}/[acid]$. If water is added, the base and acid concentrations change equally. Since K_a is constant, $[H_3O^+]$ and the pH are unchanged. 66) d, 67) a.