CHEMISTRY 12 ACIDS AND BASES REVIEW

**Part I:**

1. Which one of the following is the conjugate base of HPO42- ?

a) HPO4-

b) H2PO4-

c) H3PO4

d) PO43-

2. In the following equation, what is the correct order for Bronsted acids and bases ?

HS- + H2SO3 H2S + HSO3-

a) base + acid  acid + base

b) base + acid  base + acid

c) acid + base  acid + base

d) acid + base  base + acid

3. Which one of the following statements is true about the stronger of two acids ?

a) It more readily accepts protons.

b) It less readily accepts protons.

c) It more readily donates protons.

d) It less readily donates protons.

4. The following acids are all 1 M concentration. Which acid has the smallest hydronium ion (H3O+) concentration ?

a) HCl

b) HNO2

c) HNO3

d) H2SO4

5. What is the [H3O+] in an aqueous solution of 4.00 x 10-4 M NaOH ?

a) 2.5 x 10-12 M

b) 2.5 x 10-11 M

c) 2.5 x 10-10 M

d) 4.0 x 10-4 M

6. The indicator bromthymol blue has a Ka of 1.00 x 10-7. If a 2.00 x 10-3 M solution of the indicator is used, what will be the [H3O+] at the end point (transition point), at the intermediate colour between yellow and blue ?

a) 2.00 x 10-10 M

b) 1.00 x 10-7 M

c) 5.00 x 10-5 M

d) 3.16 x 10-4 M

7. What is the pH of a 0.0100 M hydrochloric acid (HCl) solution ?

a) 1.00 x 10-2

b) 0.0100

c) 2.000

d) 12.000

8. Which one of the expressions given below is the correct expression for calculating pOH ?

a) pOH = - log [OH-]

b) pOH = - log [OH-]2

c) pOH = - log (1/[OH-])

d) pOH = log [OH-]

9. What is the hydronium ion concentration, [H3O+], of an aqueous solution whose pH is 12.00 ?

a) 1.0 x 10-12 M

b) 1.0 x 10-2 M

c) 2.00 M

d) 12.0 M

10. Which one of the following is the conjugate base of H2PO4- ?

a) HPO42-

b) H3PO4

c) PO43-

d) H3PO3

11. The following equation represents the dissociation of an aqueous solution of the base methylamine, CH3NH2 :

CH3NH2 (aq) + H2O(l)  CH3NH3+(aq) + OH-(aq)

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

a) Kb = [CH3NH2][OH-] b) Kb = [CH3NH3+][CH3NH2][OH-]

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[CH3NH3+]

c) Kb = [CH3NH3+][CH3NH2] d) Kb = [CH3NH3+][OH-]

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[OH-] [CH3NH2]

12. Data : 1. HClO(aq) + H2O(l)  H3O+(aq) + OCl-(aq)

2. Ka (HClO) = 3.00 x 10-8

When the equilibrium concentration of a hypochlorous acid solution is

1.00 x 10-2 M , what is the pH of the solution ?

a) 2.000

b) 4.761

c) 9.239

d) 9.523

13. What is the Ka of a 0.200 M solution of a weak acid which is found to have a pH of 5.62 ?

a) 5.8 x 10-12

b) 8.7 x 10-11

c) 2.9 x 10-11

d) 1.2 x 10-5

14. In the equation NH4+ + H2O H3O+ + NH3 , how does the H2O act ?

a) As a Bronsted acid donating protons.

b) As a Bronsted acid accepting protons.

c) As a Bronsted base donating protons.

d) As a Bronsted base accepting protons.

15. Which one of the following is the correct order for Bronsted acids or bases in the equation HSO3- + HPO42-  H2PO4- + SO32- ?

a) acid + base acid + base

b) acid + base  base + acid

c) base + acid acid + base

d) base + acid  base + acid

16. Which one of the following is the weakest acid ?

a) 0.010 M HCl

b) 0.10 M HBr

c) 0.10 M HI

d) 0.10 M HF

17. Which one of the following equations shows the basic form of an indicator HIn reacting in an acidic solution?

a) In-(aq) + H3O+(aq)  HIn(aq) + H2O(l)

b) HIn(aq) + H3O+(aq)  H2In+(aq) + H2O(l)

c) In-(aq) + H2O(l) HIn(aq) + OH-(aq)

d) HIn(aq) + OH-(aq)  In-(aq) + H2O(l)

18. The indicator methyl red has a Ka of 4.00 x 10-6. If a 1.00 x 10-3 molar solution of the indicator is used, what will be the [H3O+] at the endpoint, where the colour is orange (i.e. intermediate between red and yellow) ?

a) 4.00 x 10-9 M

b) 4.00 x 10-6 M

c) 2.00 x 10-3 M

d) 4.00 x 10-3 M

19 Which one of the following statements about HNO3 and HNO2 is TRUE, given that HNO3 is a stronger acid than HNO2 ?

a) NO2- ion is a stronger base than NO3- ion.

b) NO3- ion is a better proton accepter than NO2- ion.

c) The bond between H and O in undissociated HNO3 is stronger than the

bond between H and O in undissociated HNO2.

d) A solution of 1 M HNO3 contains fewer particles than a solution of

1 M HNO2 if equal volumes are compared.

20. What is the hydronium ion concentration, [H3O+], of a solution whose pH is 6.00?

a) 1.0 x 10-8 M

b) 1.0 x 10-6 M

c) 6.0 M

d) 1.0 x 106 M

21. What is the pOH of a 0.012 M solution of sodium hydroxide, NaOH ?

a) 1.03

b) 1.9

c) 1.92

d) 12.08

22. The conjugate acid of HPO42- is

a) H+

b) PO43-

c) H3PO4

d) H2PO4-

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| **Refer to the following information when answering questions 37 & 38** |
| HNO2 (aq) + H2O (l)  H3O+(aq) + NO2-(aq) |
| Ka HNO2 = 5.1 x 10-4 |

23. What is the pH of an aqueous solution of nitrous acid, HNO2, when its equilibrium concentration is 1.0 x 10-3 M ?

a) 3.00

b) 3.15

c) 6.00

d) 6.29

23. What is Kb for the nitrite ion, NO2-, the conjugate base of nitrous acid ?

a) 2.0 x 10-11

b) 5.1 x 10-4

c) 2.0 x 10-3

d) 2.2 x 10-2

25. The following equation represents the dissociation of acetic acid, CH3COOH, in water : CH3COOH (aq) + H2O (l) H3O+(aq) + CH3COO-(aq)

Which one of the following is the expression for the Ka of acetic acid ?

a) Ka = [H3O+][CH3COO-] b) Ka = [H3O+][CH3COO-]

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[CH3COOH][H2O]

c) Ka = [CH3COOH][H3O+] d) Ka = [H3O+][CH3COO-]

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[CH3COO-] [CH3COOH]

26. Which of the following species is the weaker base in the equation

H2O2 (aq) + H2O (l) HO2-(aq) + H3O+(aq)

a) HO2-(aq)

b) H2O (l)

c) H2O2 (aq)

d) H3O+(aq)

27. Sn(OH)2 is insoluble in water but reacts with and is soluble in both dilute NaOH and dilute HCl. On the basis of this information, Sn(OH)2 could best be described as

a) basic

b) neutral

c) acidic

d) amphiprotic

28. Which one of the following orders is correct for the Bronsted acids and bases in the equation C6H5NH2 (aq) + H2O  C6H5NH3+ (aq) + OH-(aq)

a) acid + base  acid + base

b) acid + base  base + acid

c) base + acid  acid + base

d) base + acid  base + acid

29. Which of the following acids, at 1.0 M concentration, is LEAST ionized in solution ?

a) HCl

b) HNO2

c) H3PO4

d) CH3COOH

30. The indicator quinaldine red has a colourless acid form and a pink base form. Its Ka is 2.5 x 10-2. Which one of the following descriptions of an aqueous solution of quinaldine red at a pH of 7 is correct ?

a) The solution is pink.

b) The solution is colourless.

c) The [acid form] > [base form].

d) The [acid form] = [base form].

31. Which one of the following expressions is the correct expression for pKw ?

a) pKw = 1/Kw

b) pKw = (pH)(pOH)

c) pKw = pH + pOH

d) pKw = antilog Kw

32. An aqueous solution of the base hydrazine, N2H4 , is in equilibrium with its conjugate acid, N2H5+. If the Kb for N2H4 is 1.70 x 10-6 at 20oC, what is the Ka for N2H5+ ?

a) 5.88 x 10-9

b) 1.70 x 10-6

c) 5.88 x 105

d) 1.70 x 108

33. What is the pH of a 2.0 M solution of benzoic acid (C6H5COOH) ?

a) 1.94

b) 2.24

c) 3.88

d) 4.48

34. Water at 25oC has a pH of 7 and the equation for the dissociation is :

2 H2O (l) + 57.3 kJ H3O+(aq) + OH-(aq).

Water at 80oC could best be described as

a) basic. c) neutral with a pH less than 7.

b) acidic. d) neutral with a pH greater than 7.

35. A Bronsted base is a substance which is

a) a proton donor.

b) a proton acceptor.

c) an electron donor

d) an electron acceptor.

36. Which of the following species is a conjugate base of OH- ?

a) H+

b) O2-

c) OH

d) H2O

37. Which one of the following species is the strongest acid ?

a) H3BO3

b) NH4+

c) H2SO3

d) HS-

38. Which one of the following species is amphiprotic ?

a) H+

b) CO32-

c) H2CO3

d) HCO3-

39. An indicator changes colour in the pH range 8.0 - 10.0. Its Ka value would be approximately

a) -9

b) 10-9

c) 9

d) 109

40. Methyl orange, HMo, has a red acid form and a yellow base form. The yellow form would be represented by

a) H+

b) Mo-

c) HMo

d) H2Mo+

41. Consider the acid-base reaction :

HSO4-(aq) + CH3COO-(aq) SO42-(aq) + CH3COOH (aq)

In the above reaction, HSO4- acts as

a) a base donating protons

b) an acid donating protons

c) a base accepting protons

d) an acid accepting protons

42. The equation for the dissolving of formic acid in water is

HCOOH(aq) + H2O(l)  H3O+(aq) + HCOO-(aq)

Which one of the following is the correct Ka expression for HCOOH ?

a) [HCOOH] b) [H3O+][HCOO-]

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[H3O+][HCOO-] [HCOOH]

c) [HCOOH][H2O] d) [H3O+][HCOO-]

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[H3O+][HCOO-] [HCOOH][H2O]

43. The Ka value for nitrous acid is 5.1 x 10-4. Which of the following is the Kb value for the conjugate base of nitrous acid ?

a) 2.0 x 10-11

b) 5.1 x 10-4

c) 2.0 x 103

d) 5.1 x 1010

44. Which is the stronger acid in the reaction :

HNO2 (aq) + NH3 (aq) NH4+(aq) + NO2-(aq)

a) NH3 (aq)

b) NH4+(aq)

c) NO2-(aq)

d) HNO2 (aq45

45. What is the [H3O+] for a solution with a pH of 2.50 ?

a) 3.2 x 10-3 M

b) 3.9 x 10-1 M

c) 2.5 M

d) 3.2 x 102 M

46. A solution of strong acid has a pH of 3.00. What is the resulting pH if 1.0 L of the solution is diluted to 2.0 L with distilled water ?

a) 1.50

b) 2.70

c) 3.30

d) 6.00

47. Consider the following equation :

HNO2 (aq) + HCOO-(aq)  NO2-(aq) + HCOOH(aq)

Which of the following is an acid and conjugate base pair ?

a) HCOOH(aq) and HCOO-(aq)

b) HNO2 (aq) and HCOO-(aq)

c) NO2-(aq) and HCOO-(aq)

d) HNO2 (aq) and HCOOH(aq)

48. Which of the following substances is amphiprotic ?

a) CN-

b) HCl

c) HCO3-

d) H2SO4

49. In the reaction NH3 (aq) + H2O(l)  NH4+(aq) + OH-(aq),

the water molecule serves as a

a) weak base.

b) strong acid.

c) proton donor.

d) proton acceptor.

50. To change a water molecule into a hydronium ion requires

a) the addition of a proton.

b) the removal of a proton.

c) the addition of an electron.

d) the removal of an electron.

51. Which of the following solutions is the best conductor ?

a) 1.0 M HCl

b) 1.0 M HNO2

c) 1.0 M CH3COOH

d) 1.0 M H2CO3

52. Which of the following solutions would have the largest [H3O+] ?

a) 1.0 M HA Ka = 1.0 x 10-6

b) 1.0 M HB Ka = 1.0 x 10-3

c) 1.0 M HC Ka = 1.0 x 10-8

d) 1.0 M HD Ka = 1.0 x 10-12

53. As the strengths of the acids decrease, the strengths of their conjugate bases

a) decrease.

b) increase.

c) stay the same.

d) approach the strengths of the acids.

54. What is the [H3O+] of a 2.0 M solution of the weak acid, HA

HA(aq) + H2O(l)  H3O+(aq) + A-(aq) Ka = 1.8 x 10-7

a) 9.0 x 10-8 M

b) 7.2 x 10-5 M

c) 4.2 x 10-4 M

d) 6.0 x 10-4 M

55. Bromocreosol purple is yellow in its acid form and purple in its base form. The colour change occurs in a pH range of 5 to 7. The colour of bromocreosol purple in 0.010 M KOH will be

a) yellow.

b) purple.

c) intermediate.

d) colourless.

56. A solution is tested with four acid-base indicators. The following colours resulted with each indicator :

methyl red - yellow

alizarin yellow - yellow

phenol red - red

thymolphthalein - colourless

What is the pH of the solution ?

a) 5

b) 7

c) 9

d) 11

57. A strong acid differs from a weak acid in that a strong acid

a) is a weak electrolyte.

b) neutralizes a strong base.

c) has a high molar concentration.

d) is highly ionized in aqueous solutions.

58. The anion HCO3- is acting as an acid in which of the following ?

a) HCO3-(aq) + OH-(aq)  H2CO3 (aq) + O2-(aq)

b) HCO3-(aq) + H2O (l) H2CO3 (aq) + OH-(aq)

c) HCO3-(aq) + H2O (l)  CO32-(aq) + H3O+(aq)

d) HCO3-(aq) + H3O+(aq)  H2CO3 (aq) + H2O (l)

59. Which term BEST describes the process represented by the following equation : F-(aq) + H2O (l)  OH-(aq) + HF (aq)

a) Titration.

b) Hydrolysis.

c) Oxidation-reduction.

d) Neutralization.

60. A sample of peach juice has a pH of 3.50. What is the [H3O+] in this sample of juice ?

a) 2.9 x 10-15 M

b) 3.2 x 10-4 M

c) 5.4 x 10-1 M

d) 3.2 x 103 M

61. Which of the following solutions would have the lowest [H3O+] ?

a) 1.0 M HF

b) 1.0 M HCl

c) 1.0 M HNO2

d) 1.0 M CH3COOH

62.

a) 4.0 x 10-10 M

b) 2.5 x 10-5 M

c) 4.0 x 104 M

d) 2.5 x 109 M

63. Which of the following indicators will change colour at a pH of approximately 11?

a) Phenolphthalein.

b) Indigo carmine.

c) Thymolphthalein.

d) Alizarin yellow.

64. Results of adding three indicators to separate samples of the same aqueous solution are as follows :

orange IV - yellow

methyl red - red

methyl orange - yellow

The best approximation for the pH of the above solution is

a) 2.5

b) 3.2

c) 4.6

d) 6.5

65. Cr(OH)3 is insoluble in water but will dissolve in both acidic and basic solutions. This indicates that it is

a) amphiprotic.

b) diprotic.

c) isomeric.

d) polymorphic.

66. Which of the following is the conjugate acid of HS- ?

a) S2-

b) H2S-

c) H2S

d) H3S+

67. An acid-base indicator is generally defined as a substance which

a) changes colour when moles H+ = moles OH-

b) changes colour 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 colour within a definite pH range.

68 Which of the following indicators undergoes a colour change from red to yellow at [H3O+] = 3.2 x 10-4 M ?

a) Thymol blue.

b) Orange IV.

c) Methyl orange.

d) Alizarin yellow.

69. Which test result will occur with a solution of 0.10 M HCl ?

a) A pH reading of 7.00.

b) Reaction with Mg(s) to produce H2 (g) .

c) Bromthymol blue indicator turns green.

d) Precipitation reaction with 1.0 M Ba(NO3)2.

70. Which of the following is the strongest acid ?

a) HSO4-

b) HSO3-

c) H2SO3

d) H2SO4

71. H2O is added separately to each substance in the following pairs of solutions. With which pair does H2O display its amphiprotic nature?

a) HI and NH3

b) NaI and NH3

c) NaI and NaOH

d) NaOH and NH3

72. If LiOH is added to water at 25oC then the

a) [OH-] and the [H3O+] will both increase.

b) [OH-] and the [H3O+] will both decrease.

c) [OH-] will decrease while the [H3O+] will increase.

d) [OH-] will increase while the [H3O+] will decrease.

73. The Kb value for the dihydrogen citrate ion, H2C6H5O7- is

a) 1.1 x 10-11

b) 5.6 x 10-10

c) 1.8 x 10-5

d) 8.7 x 10-4

74. When neutral red is added to a sample of a solution, the colour of the solution is yellow-orange. When thymol blue is added to another sample of the same solution, the colour is yellow. What is the approximate [H3O+] in the solution ?

a) 6 x 10-12 M

b) 1 x 10-8 M

c) 1 x 10-6 M

d) 2 x 10-3 M

75. If the [OH-] = 5.2 x 10-3 M at 25oC, then the pH is

a) 2.28

b) 3.72

c) 10.52

d) 11.72

Part II:

76. Which one of the following equations represents a hydrolysis reaction ?

a) HI (g) + H2O (l)  I-(aq) + H3O+(aq)

b) CuSO4 (s) + 5 H2O (l) CuSO4.5H2O (s)

c) C6H5COOH (aq) + H2O (l)  C6H5COO-(aq) + H3O+(aq)

d) NH4+(aq) + H2O (l)  NH3 (aq) + H3O+(aq)

77. Which one of the following expressions best represent the equilibrium expression for the hydrolysis reaction of KNO2 ?

a) [HNO2] b) [HNO2][H2O]

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[NO2-][H3O+] [NO2-][H3O+]

c) [HNO2][OH-] d) [HNO2][OH-]

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[NO2-][H2O] [NO2-]

78. Which one of the following gases will give the most acidic solution on dissolving in water ?

a) CO2 (g)

b) HBr (g)

c) H2S (g)

d) NH3 (g)

79. If 0.100 M HNO3 is added dropwise to each of the solutions below (each containing two solutes and all at the same concentration), in which pair of solutions will the [H+] show the least change ?

a) NaBr and HBr

b) NaCl and HCl

c) NaF and HF

d) NaI and HI

80. 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 + H2O  Ascorbate- + H3O+

b) HCO3- + H2O  H3O+ + CO32-

c) HC2H3O2 + H2O  H3O+ + C2H3O2-

d) CO2 + H2O  H3O+ + HCO3-

81. Which one of the following equations represents a titration reaction ?

a) NaOH (aq) + HCl (aq)  H2O (l) + NaCl (aq)

b) CH3COOH (aq) + H2O (l)  H3O+(aq) + CH3COO-(aq)

c) CH3COONa (aq) + H2O (l)  CH3COOH (aq) + NaOH (aq)

d) NH4Cl (aq) + H2O (l)  NH3 (aq) + H3OCl (aq)

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

a) 2.00

b) 3.00

c) 9.90

d) 12.0

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

a) HCl + H2O  H3O+ + Cl-

b) HClO4 + H2O  H3O+ + ClO4-

c) H2SO4 + H2O H3O+ + HSO4-

d) HNO2 + H2O  H3O+ + NO2-

84. Which one of the following salts will show the greatest amount of hydrolysis in water if equal concentrations are used ?

a) NaI

b) NaNO2

c) Na3PO4

d) Na2SO4

85. Which one of the following sets shows the correct order of increasing pH of the aqueous solutions of the three salts if equal concentrations are used ?

a) NH4Cl, K2SO4, Na2CO3

b) K2SO4, NH4Cl, Na2CO3

c) Na2CO3, K2SO4, NH4Cl

d) NH4Cl, Na2CO3, K2SO4

86. 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

87. During the titration of 50.0 mL of a 0.200 M KOH solution with 0.200 M HNO3, 20.0 mL of the HNO3 is added. What is the pH at this point in the titration ?

a) 0.92

b) 1.07

c) 12.93

d) 13.08

88. In which of the following buffer solutions will the addition of H3O+ cause the equilibrium to shift to the left ?

(1) HF + H2O  H3O+ + F-

(2) H2PO4- + H3O+  H3PO4 + H2O

(3) HPO42- + OH-  PO43- + H2O

(4) HSO3- + OH-  SO32- + H2O

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

89. Which one of the following equations contains the conjugate acid-base pair form which a buffer solution can be prepared ?

a) HI(aq) + H2O(l)  H3O+(aq) + I-(aq)

b) HBr(aq) + H2O(l)  H3O+(aq) + Br-(aq)

c) H2SO4(aq) + H2O(l)  H3O+(aq) + HSO4-(aq)

d) H2CO3(aq) + H2O(l)  H3O+(aq) + HCO3-(aq)

90. Which one of the following equations could represent a titration reaction ?

a) CH3COOH(aq) + H2O(l)  H3O+(aq) + CH3COO-(aq)

b) 2 HBr(aq) + Cl2 (aq)  2 HCl(aq) + Br2(aq)

c) KHCO3(aq) + HBr(aq)  KBr(aq) + H2O(l) + CO2 (g)

d) 3Zn(s) + 2NO3-(aq) + 8H+(aq)  3Zn2+(aq) + 2NO2(g) + 4H2O(l)

91. What is the pH of a 0.0025 M solution of lime water, Ca(OH)2 ?

a) 2.30

b) 2.60

c) 11.40

d) 11.70

921. A dilute solution of Na2S will contain

a) undissociated Na2S.

b) more HS-(aq) than S2-(aq).

c) more H3O+(aq) than OH-(aq).

d) strongly hydrolyzed Na+(aq).

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

a) The endpoint and the 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.

94. 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) 7 < pH < 14

95. In a titration, 20.0 mL of 0.50 M NaOH solution reacts completely with 30.0 mL of H2SO4 solution. What is the initial concentration of the H2SO4 solution ?

a) 0.17 M

b) 0.33 M

c) 0.40 M

d) 0.67 M

96. 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) 0.00

b) 1.0

c) 7.0

d) 13.0

97. Which of the following salts will produce a basic solution when it dissolves in water ?

a) KClO4

b) Fe(NO3)3

c) NaCH3COO

d) AlBr3

98. Which of the following is the best definition for a standard solution ?

a) A solution of known volume.

b) A solution of known concentration.

c) A solution prepared at STP conditions.

d) A solution prepared at 25oC and standard pressure.

99. 25 mL of 0.20 M HCl solution are added to 50.0 mL of 0.20 M KOH solution. What is the pH of the resulting solution ?

a) 1.18

b) 7.00

c) 12.82

d) 13.30

100. A Ba(OH)2 solution is titrated with a solution of HNO3 to the stoichiometric point. Which of the following conditions exists at the stoichiometric point ?

a) The mixture is highly acidic.

b) The mixture is highly basic.

c) Moles of Ba(OH)2 originally present equals moles of HNO3 added.

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

101. A buffer solution could be prepared by mixing a 1.0 M solution of Na2CO3 with an equal volume of a 1.0 M solution of

a) NaCl b) NaOH c) NaHCO3 d) Na2SO4

102. Which of the following 1.0 M solutions is basic ?

a) KCl

b) NH4NO3

c) NaClO4

d) Na2CO3

103. A titration of 0.1 M HCl with 0.2 M NaOH will reach an equivalance point when

a) the volume of the base equals twice the volume of the acid.

b) the mass of the acid equals the mass of the base.

c) the number of moles of acid equals the number of moles of base.

d) the volume of acid equals the volume of base.

104. In a titration, 20.0 mL of 0.50 M NaOH solution reacts completely with 30.0 mL of H2SO4 solution. What is the initial concentration of the H2SO4 solution ?

a) 0.17 M

b) 0.33 M

c) 0.40 M

d) 0.67 M

105. What is the pOH of a 0.15 M solution of RbOH ?

a) -0.82

b) 0.41

c) 0.82

d) 13.18

106. Which of the following pairs of chemicals could be used to prepare a buffer solution ?

a) HCl and NaCl

b) CH3COOH and NaCl

c) NaCl and NaCH3COO

d) CH3COOH and NaCH3COO

107. Which of the following 0.10 M solutions will have the highest [OH-] ?

a) NaCl

b) K3PO4

c) Cr(NO3)3

d) CH3COOH

108. 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, H2C2O4

b) 50.0 mL of sulphuric acid, H2SO4

c) 75.0 mL of hydrochloric acid, HCl

d) 90.0 mL of acetic acid, CH3COOH

109 When 20.0 mL of 0.200 M HCl is added to 40.0 mL of 0.100 M NaOH, the [H3O+] in the resulting solution is

a) 0.100 M

b) 0.0333 M

c) 1.00 x 10-7 M

d) 0.00 M

110. What volume of 0.0200 M Ca(OH)2 solution is required to neutralize 25.0 mL of 0.0100 M HCl ?

a) 6.25 mL

b) 12.5 mL

c) 25.0 mL

d) 50.0 mL

111. HPO42- in water will act as

a) a base since its Kb < its Ka

b) a base since its Kb > its Ka

c) an acid since its Kb < its Ka

d) an acid since its Kb > its Ka

112. Which of the following best explains why the equivalence point is above pH 7 for the neutralization of 0.2 M C6H5COOH with 0.3 M NaOH ?

a) NaOH is a stronger base than C6H5COOH.

b) C6H5COOH is a stronger acid than NaOH.

c) The [NaOH] is greater than the [C6H5COOH].

d) The salt solution formed undergoes hydrolysis to form OH- ions.

113. Which compound forms an acid when dissolved in water ?

a) ZnO

b) MgO

c) ClO2

d) Na2O

114. Which of the following indicators is most suitable for the titration of 0.10 M NH3 with 0.10 M HCl ?

a) Indigo carmine

b) Alizarin yellow

c) Phenolphthalein

d) Bromcresol green

115. A water solution of the salt RbNO2 will be

a) basic

b) acidic

c) neutral

d) amphiprotic

116. In the net ionic equation showing the complete neutralization of Mg(OH)2 by HCl, one of the products is

a) H2O (l)

b) H3O+(aq)

c) MgCl2 (s)

d) OH-(aq)

117. Which of the following best describes the [CH3COO-] of a buffer solution containing 1.0 M NaCH3COO(aq) and 1.0 M CH3COOH(aq) ?

a) exactly equal to 2.0 M

b) slightly less than 1.0 M

c) slightly larger than 2.0 M

d) slightly larger than 1.0 M

118. Which of the following compounds will form a basic solution when dissloved in water ?

a) BaO

b) SO2

c) ClO2

d) P2O5

119. The pH of a 0.10 M solution of NaHSO3 is approximately

a) 1

b) 4

c) 7

d) 10

WRITTEN RESPONSE QUESTIONS

Your steps and assumptions leading to a solution must be written. In questions involving calculation, full marks will not be given for providing only an answer. Students will be expected to communicate the knowledge and understanding of chemical principles in a clear and logical manner.

**Part 1:**

1. Calculate Kb for H2BO3-, the conjugate base for boric acid, H3BO3. (2 marks)

2. A 0.10 M solution of a weak acid HX has a pH of 4.26. Calculate the value of Ka for HX. (3 marks)

3. Write the equilibrium equation for the reaction of the HS- ion with water to produce a basic solution. State whether the reactants or products are favoured.

(2 marks)

4. A 0.60 M solution of the weak acid HX is found to have a pH = 4.30. Determine Ka for this acid. (3 marks)

5. Calculate the [H3O+] of a solution with a pOH of 3.86. (2 marks)

6. Determine the [H+] in 2.4 M HF. (2 marks)

7. 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 your results ? (2 marks)

8. a) Compare the ease with which the first hydrogen ion (proton) is removed from a

diprotic acid in relation to the ease of removal of the second hydrogen ion.

(1 mark)

b) Use an example from the table of acids to illustrate the above situation.

(1 mark)

9. The weak acid, HClO, has a Ka of 3.24 x 10-8. Calculate the pH of a 0.076 M solution of HClO. (3 marks)

10. A solution with a pH of 4.20 is found to contain twice as much conjugate base as acid. Calculate the value of the acid dissociation constant (Ka) for this monoprotic acid. (3 marks)

11. Identify each substance in the following equation as either an acid or a base, and then state whether the position of equilibrium favours the reactants or products.

(3 marks)

HOOCCOO-(aq) + H2PO4-(aq)  HOOCCOOH (aq) + HPO42- (aq)

12. Calculate the pH of a 0.40 M solution of benzoic acid, C6H5COOH.

Ka for C6H5COOH is 6.6 x 10-5. (3 marks)

**Part 2:**

13. a) Write the equation for the acid-base equilibrium reaction that occurs when

aqueous solutions containing equal concentrationsof HCO3- and SO32- are

mixed. (2 marks)

b) What acid in the above equilibrium will be present in the greatest

concentration ? (1 mark)

14. Write the net ionic equation for the following reaction: potassium hydroxide neutralized by acetic acid. (2 marks)

15. Calculate the pH of a solution made by dissolving 3.75 g of RbOH in 79.8 mL of 0.18 M HNO3. Assume no volume change. (5 marks)

16. The Ka and Kb values for the HPO42- ion in water are given below :

HPO42-(aq) Ka = 4.4 x 10-13

HPO42-(aq) Kb = 1.6 x 10-7

Indicate whether an aqueous solution of Na2HPO4 is basic or acidic, and explain your answer with reference to the Ka and Kb values given above. (2 marks)

17. Calculate the mass of NaOH(s) that would have to be added to10.0 mL of a

2.00 M HNO3 solution to obtain a pH of 1.00. (4 marks)

18. What is the function of a buffer in a chemical system ? (1 mark)

19. Combustion of coal which contains sulphur produces a gaseous sulphur compound. This compound, when released into the atmosphere, undergoes a series of reactions eventually forming "acid rain". Explain this process, and support your answer with appropriate equations. (3 marks)

20. In an acid-base titration, it was found that 18.4 mL of 0.200 M NaOH was required to neutralize a 0.22 g sample of a monoprotic acid. What is the mass of one mole of this acid ? (3 marks)

21. 25.0 mL of 0.025 M Ca(OH)2 is completely neutralized by 28.3 mL of HCl solution. What is the concentration of the HCl solution ? (3 marks)

Ca(OH)2 + 2 HCl CaCl2 + 2 H2O

22. Write a balanced equation showing the formation of a basic aqueous solution using the metal oxide SrO. (1 mark)

23. SO2 is a waste product in some industrial processes. State the environmental problem associated with SO2 (g), write the equation that accounts for this problem, and give one effect on the natural environment. (2 marks)

CHEMISTRY 12 ACID-BASE REVIEW ANSWERS

1. D 31. C 61. D 91. D

2. A 32. A 62. A 92. B

3. C 33. A 63. D 93. A

4. B 34. C 64. C 94. B

5. B 35. B 65. A 95. A

6. B 36. B 66. C 96. B

7. C 37. C 67. D 97. C

8. A 38. D 68. C 98. B

9. A 39. B 69. B 99. C

10. A 40. B 70. D 100. D

11. D 41. B 71. A 101. C

12. B 42. B 72. D 102. D

13. C 43. A 73. A 103. C

14. D 44. D 74. B 104. A

15. A 45. A 75. D 105. C

16. D 46. C 76. D 106. D

17. A 47. A 77. D 107. B

18. B 48. C 78. B 108. B

19. A 49. C 79. C 109. C

20. B 50. A 80. D 110. A

21. C 51. A 81. A 111. B

22. D 52. B 82. A 112. D

23. B 53. B 83. D 113. C

24. A 54. D 84. C 114. D

25. D 55. B 85. A

26. B 56. C 86. B 115. A

27. D 57. D 87. C 116. A

28. C 58. C 88. D 117. D

29. D 59. B 89. D 118. A

30. A 60. B 90. C 119. C

Written responses

1. 1.4 x 10-5

2. 3.0 x 10-8

3. HS-(aq) + H2O (l)  H2S (aq) + OH- (aq)

Reactants

4. 4.2 x 10-9

5. 7.2 x 10-11 M

6. 2.9 x 10-2 M

7. Use a pH indicator or meter. A lower pH indicates a higher [H+] which means greater dissociation which means stronger acid.

8. a) It's much easier to remove first proton.

b) H2SO4  H+ + HSO4- Ka very large

HSO4-  H+ + SO42- Ka not as large

9. 4.30

10. 1.3 x 10-4

11. base, acid, acid, base

reactants

12. 2.29

13. a) HCO3-(aq) + SO32-(aq)  CO32-(aq) + HSO3-(aq)

b) HCO32-

14. H+(aq) + OH-(aq)  H2O (l)

15. 13.44

16. basic because Kb > Ka

17. 0.76 grams

1 8. to prevent rapid changes in pH due to addition of H+ or OH- ions.

19. S (s) + O2 (g)  SO2 (g)

2SO2 (g) + O2 (g)  2SO3 (g)

SO3 (g) + H2O (l)  H2SO4 (l)

20. 60 g/mol

21. 0.044 M

22. SrO (s) + H2O (l)  Sr2+(aq) + 2 OH-(aq)

23. SO2 produces acid rain. This acidifies lakes which kills fish. (It also destroys plant roots and damages leaves.)

SO2 (g) + H2O (l)  H2SO3 (aq) or

2 SO2 (g) + O2 (g) + 2 H2O (l)  2 H2SO4 (aq)