Review for Unit Test 7: Acids, Bases and Salts (Chapter 8)

Objectives:

1. Write definitions for, or explain the meaning of: Bronsted-Lowry acid and base, neutral, strong acid, strong base, weak acid, weak base, concentrated, dilute, ionization, dissociation, hydrolysis, pH, K_w, K_a and K_b.
2. Understand what is meant by the terms: salt, hydrolyze, percent dissociation, conjugate acid-base pair, parent acid, parent base, amphiprotic (amphoteric), monoprotic and polyprotic.
3. Does the H+ ion exist in aqueous solution? Explain why or why not.
4. Know the general chemical and physical properties of acids and bases.
5. Be able to recognize acids, bases and salts from their chemical formulas.
6. Be able to name common acids and bases, using an ion chart.
7. Be able to recognize strong acids and bases, from their names or chemical formulas.
8. Identify or describe chemical and physical properties that could be used to distinguish between:
   a) acids, bases and salts
   b) strong and weak acids
   c) strong and weak bases
9. Be able to predict the products of the following types of reactions:
   a) acids and metals
   b) acids and carbonates
   c) acids and bases
   d) Group I and II metal oxides in water
10. Be able to identify conjugate acid/base pairs.
11. Be able to write the ionization reactions of weak acids and bases, and their conjugate partners, in water.
12. Be able to write and use the K_a and K_b expressions of weak acids and bases. What factor(s) affect the value of K_a and K_b?
13. Be able to predict whether a salt will dissolve in water to form an acidic, basic or neutral solution. Write any ionization (hydrolysis) reactions that may take place.
14. Know, and be able to apply, the relationships between the following:
   a) pH and pOH
   b) $[H_3O^+]$ and $[OH^-]$
   c) K_a, K_b and K_w
15. Be able to calculate the pH of solutions of:
   a) strong acids
   b) strong bases
   c) weak acids and acid salts
   d) weak bases and basic salts
16. Be able to calculate K_a or K_b given:
   a) the initial concentration of an acid or base and the pH of the final solution
   b) the K_a or K_b for its conjugate partner
17. Be able to calculate percent dissociation (ionization) for weak acids and bases.

Sample Questions: Review for Acids, Bases and Salts

1. Acids are proton _____. Complete the following chart for these **acids**:

Acid	Ionization Reaction in Water	Conjugate Base	Ka	Kb
H_2SO_3				
$HCHO_2$				
HPO_4^{2-}				
H_2O				
NH_4^{1+}				
HCO_3^{1-}				
H_2SO_4				
$C_5H_5NH^+$				

2. Bases are proton _____. Complete the following chart for these **bases**:

Base	Ionization Reaction	Conjugate Acid	Ka	Kb
ClO-				
N_2H_4 (aq)				
CH_3COO^-				
HPO_4^{2-}				
F^{1-}				
H_2O				
NH_2OH				
NH_3				
C_5H_5N				
HCO_3^{1-}				

3. For nitrogen compounds, how can you recognize when they will behave as bases? As acids?

4. As a general rule for weak acids and bases, negative ions in solution will behave as _____.

5. Using your knowledge of trends for acid strengths, arrange the following acids in order from highest to lowest strength: HCl H_3PO_4 HI H_3PO_3

6. Using Ka values, arrange the following acids in order from highest to lowest strength:

HNO_2 H_3PO_4 HF HCH_3COO H_2S H_2SO_3 H_2CO_3

7. Which of the acids in Q6 has the strongest conjugate base? _____

8. Calculate the pH of the following solutions:

a) 15.4 g of potassium hydroxide in a total volume of 600.0 mL solution (13.660, 3 decimal places)

b) 125 mL of 15.0 M of nitric acid diluted to 1.00 litre of solution (-0.273, 3 decimal places)

c) a 0.0125 M solution of magnesium hydroxide (12.398, 3 decimal places)

d) a 1.35 M solution of acetic acid (2.31, 2 decimal places from K_a)

e) a 2.00 M solution of pyridine (C_5H_5N) (9.77, 2 decimal places from K_b)

f) 0.555 M solution of hypobromite ion (from sodium hypobromite) (11.15, 2 decimals from K_a)

g) 100.0 mL of 18.0 M H_2SO_4 diluted to 500.0 mL of solution (-0.556, 3 decimal places)

9. Complete the following chart. Include the correct number of sig digs in your answers:

pH	pOH	$[H_3O^+]$	[OH-]	acid/base/neutral
1.25				
		4.63×10^{-10}		
	9.10			
			0.750	
	5.00			

10. The following reaction strongly favours the reactants:

$$HCO_3^{1-}(aq) + HSO_4^{1-}(aq) \leftrightarrow CO_3^{2-}(aq) + H_2SO_4(aq)$$

a) the strongest acid in this system is: _____

b) the strongest base in this system is: _____

c) Will this reaction have a large or small value of K_{eq}? _____ Explain.

11. The pH of a 0.16 M solution of phenolic acid is 3.20.

a) What is the Ka for phenolic acid? ($K_a = 2.5 \times 10^{-6}$)

b) What is the percent dissociation of the acid in this solution? (only 0.39% dissociated)

12. Name the following substances and then predict whether their solutions will be acidic, basic or neutral:

a) $NaCH_3COO$ _____

b) NH_4Cl _____

c) Li_2O _____

d) $Sr(NO_3)_2$ _____

e) HBrO (HOBr) _____

f) $CoBr_2$ _____

g) $Cr(NO_3)_2$ _____

h) Na_3PO_4 _____

i) HSCN _____

j) CaC_2O_4 _____

k) $Mg(ClO_3)_2$ _____

l) K_3BO_3 _____

m) $SnCl_4$ _____

13. What are two tests or properties you could distinguish between the following solutions?

a) NaCl and NaClO _____

b) H_2O and Li_2O _____

c) $HClO_2$ and $HClO_3$ _____

d) H_2S and Na_2S _____

e) $Ca(OH)_2$ and $Co(OH)_2$ _____

14. Write the products of the following reactions (if any) and then balance each reaction:

a) $Mg(s) + CH_3COOH(aq) \rightarrow$

b) $NaOH(aq) + Ba(s) \rightarrow$

c) $HBrO_3(aq) + K_2CO_3(s) \rightarrow$

d) $K_2O(s) + H_2O(l) \rightarrow$

Long Calculation Questions: Be prepared to write out full solutions to questions such as:

1. The pH of a 0.10 M solution of periodic acid, HIO_4, is 1.42. Calculate the K_a for periodic acid. (Ka = 0.023)

2. Butanoic acid, C_3H_7COOH, is found in small quantities in human perspiration and is responsible for the foul odour often associated with locker rooms. A 0.0010 mol/L solution of butanoic acid has a pH of 3.91 at 25°C. Calculate the acid dissociation constant (K_a) of butanoic acid. ($Ka = 1.7 \times 10^{-5}$)

3. What is the percent ionization of a 0.18 M solution of cyanic acid, HOCN? (4.4%)

4. What is the percent ionization of 0.20 M CH_3NH_2 (aq) if the pH of the solution is 11.90? (4.0%)

5. Calculate the pH of a 0.040 M solution of CsBrO (aq). (pH = 10.58)

6. Calculate the pH of a 1.00 M solution of N_2H_5Cl (aq). (pH = 4.06)

Practice Multiple Choice Questions: Acids, Bases and Salts

1. Which of the following is typical of bases?

a) conduct electric current in solution
b) taste sour
c) concentration of H_3O^+ > concentration of OH^-
d) turns litmus red

2. Which of the following is/are properties of strong acids?
   I) they react with carbonates to produce hydrogen gas
   II) they have very high pH
   III) they are good electrolytes
   IV) they turn phenolphthalein pink

a) I, II and III only
b) I and IV only
c) III only
d) II and III only

3. A student tests a solution. It is colourless with phenolphthalein, green with bromothymol blue and a good electrolyte. This solution is probably:

a) hydrofluoric acid
b) calcium hydroxide
c) potassium sulfate
d) ammonium nitrate

4. Which of the following substances will have the highest percent dissociation (ionization)?

a) H_2S b) H_2SO_4 c) H_2SO_3 d) H_3PO_4

5. Which of the following substances will ionize in water?
   I) CH_3COOH
   II) $Mg(OH)_2$
   III) NH_3
   IV) $Fe(OH)_3$

a) I only
b) I and III only
c) II and IV only
d) I, II, III and IV

6. Which of the following aqueous solutions will have the highest pH?

a) $MgSO_4$ (aq)
b) $(NH_4)_2SO_4$ (aq)
c) $Na_2C_2O_4$ (aq)
d) $HClO_2$ (aq)

7. Which of the following substances would be classified as salts?
   I) $NaHCO_3$
   II) K_3PO_4
   III) $LiHC_2O_4$
   IV) NH_4SCN

a) I, II, III and IV
b) I, II and III
c) II and IV only
d) II only

8. Which of the following is/are polyprotic, strong acids?
   I) HNO_3
   II) $HClO_4$
   III) H_2SO_4
   IV) H_3PO_4

a) I, II, III and IV
b) II and III only
c) III and IV only
d) III only

9. Which of the following will have the lowest electrical conductivity?
a) 1.00 M H_2SO_4 (aq)
b) 1.00 M H_3PO_4 (aq)
c) 1.00 M HNO_3 (aq)
d) 1.00 M HCl (aq)

10. The conjugate base of $H_2PO_4^-$ is
a) HPO_4^{-2} b) HPO_4^{-3} c) H_3PO_4 d) OH^-

11. The value of K_b for $H_2PO_4^-$ is
a) 1.4×10^{-12} b) 6.2×10^{-8} c) 1.6×10^{-7} d) 7.5×10^{-3}

12. What is the pH of a 0.10 M $Sr(OH)_2$ solution?
a) 0.20 b) 0.70 c) 13.30 d) 13.00

13. Which of the species below is/are present in a reagent bottle labelled 1.0M H_2SO_4?
   I) H_2SO_4 (aq)
   II) HSO_4^{1-} (aq)
   III) SO_4^{2-} (aq)

a) I only
b) I and II only
c) II and III only
d) I, II and III

14. A 0.20 M solution of hydrobromic acid is best described as:
a) strong and dilute
b) weak and concentrated
c) strong and concentrated
d) weak and dilute

15. Which of the following statements is/are **true** about neutralization reactions?
a) the products of all neutralization reactions are neutral
b) when strong acids are neutralized with strong bases, the reaction goes to completion
c) when strong acids are neutralized with weak bases, the reaction does not go to completion
d) all of the above

16. Which of the following is the relationship between $[H_3O^+]$ and $[OH^-]$ in any aqueous solution?
a) $[H_3O^+] + [OH^-] = 1.0 \times 10^{-14}$
b) $[H_3O^+] + [OH^-] = 14$
c) $[H_3O^+]\,[OH^-] = 1.0 \times 10^{-14}$
d) $[H_3O^+]\,[OH^-] = 14$

17. Which of the following tests could be used to distinguish between HI (aq) and HIO_3 (aq)?
    I) the rate of reaction with magnesium metal
    II) pH
    III) the reaction with blue litmus paper
    IV) the reaction with phenolphthalein

a) I and II only
b) III and IV only
c) I, II, III and IV
d) none of these tests will distinguish these substances

18. What are the two Bronsted-Lowry bases in this equilibrium?

$$HSO_3^{-1}(aq) + H_2PO_4^{-}(aq) \leftrightarrow SO_3^{-2}(aq) + H_3PO_4(aq)$$

a) HSO_3^{-1} (aq) and $H_2PO_4^{-}$ (aq)
b) $H_2PO_4^{-}$ (aq) and H_3PO_4 (aq)
c) SO_3^{-2} (aq) and HSO_3^{-1} (aq)
d) $H_2PO_4^{-}$ (aq) and SO_3^{-2} (aq)

19. What is the pH of a solution of $NiCl_3$ and what ion determines this?
a) solution is basic because of Ni^{3+} (aq)
b) solution is basic because of Cl^{1-} (aq)
c) solution is acidic because of Ni^{3+} (aq)
d) solution is acidic because of Cl^{1-} (aq)

20. Which of the following solutions has a pH less than 7.00?
a) NH_4NO_3 (aq)
b) NaCl (aq)
c) LiOH (aq)
d) KCH_3COO (aq)

21. Which of the following ions will hydrolyze?
a) NO_3^{1-} (aq)
b) I^{1-} (aq)
c) F^{1-} (aq)
d) ClO_3^{1-} (aq)

22. The amphiprotic ions are:
a) I and II only
b) II and III only
c) I and III only
d) I, II and III

I.	HCO_3^-
II.	$H_2PO_4^-$
III.	CH_3COO^-

23. What is the pH of a solution of $(NH_4)_2SO_4$ and what ion determines this?
a) solution is basic because of NH_4^{1+} (aq)
b) solution is basic because of SO_4^{2-} (aq)
c) solution is acidic because of NH_4^{1+} (aq)
d) solution is acidic because of SO_4^{2-} (aq)

24. Which of the following solutions will have the lowest electrical conductivity?
a) 0.1M $NaHSO_3$ (aq)
b) 0.1M H_2SO_3 (aq)
c) 0.1M NaF (aq)
d) 0.1M HF (aq)

25. The conjugate acid of $HAsO_4^{2-}$ is:
a) $H_2AsO_4^{-}$ aq)
b) AsO_4^{3-} (aq)
c) H_3AsO_4 (aq)
d) H_3O^+ (aq)

26. Which of the following 1.0M solutions would have a pH greater than 7.00?
a) $NaCH_3COO$ (aq)
b) HCN (aq)
c) NH_4Cl (aq)
d) KNO_3 (aq)

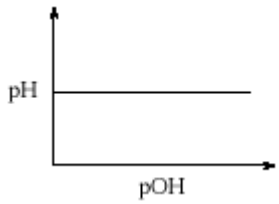
27. The relationship shown to the far right is the
a) K_b for $H_3P_2O_7^{-}$ (aq)
b) K_a for $H_3P_2O_7^{-}$ (aq)
c) K_a for $H_2P_2O_7^{-}$ (aq)
d) K_b for $H_2P_2O_7^{-}$ (aq)

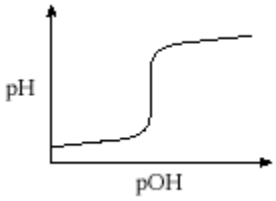
$$\frac{[H_2P_2O_7^{2-}][H_3O^+]}{[H_3P_2O_7^-]}$$

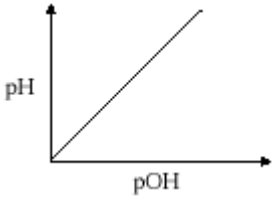
28. The value of K_b for HPO_4^{2-} is

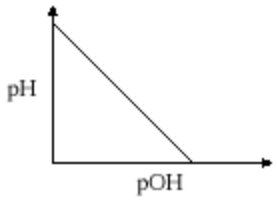
a) 2.1×10^{-2}
b) 6.2×10^{-8}
c) 2.2×10^{-13}
d) 1.6×10^{-7}

29. Which of the following graphs describes the relationship between pH and pOH?

a)


b)


c)


d)


30. The value of K_b for hydrogen oxalate ($HC_2O_4^-$) is:

a) 6.7×10^{-11}
b) 5.6×10^{-2}
c) 1.8×10^{-13}
d) 1.5×10^{-4}

31. The K_b expression for HSe^- is

a) $K_b = \dfrac{[H_2Se][OH^-]}{[HSe^-]}$

b) $K_b = \dfrac{[HSe^-][H_3O^+]}{[H_2Se]}$

c) $K_b = \dfrac{[HSe^-][OH^-]}{[Se^{2-}]}$

d) $K_b = \dfrac{[Se^{2-}][H_3O^+]}{[HSe^-]}$

32. The K_b expression for the reaction of $HC_2O_4^-$ with water is:

a) $K_b = \dfrac{[HC_2O_4^-]}{[C_2O_4^{2-}][OH^-]}$

b) $K_a = \dfrac{[C_2O_4^{2-}][H_3O^+]}{[HC_2O_4^-]}$

c) $K_a = \dfrac{[HC_2O_4^-][H_3O^+]}{[C_2O_4^{2-}]}$

d) $K_b = \dfrac{[H_2C_2O_4][OH^-]}{[HC_2O_4^-]}$

33. Which species is/ are amphiprotic?

a) I and II only
b) II and III only
c) I and III only
d) I, II and III

I.	H_2O
II.	NH_4^+
III.	HCO_3^-

34. Which of the following represents the ionization of water?

a) $H_2O \rightleftarrows \frac{1}{2}O_2 + 2H^+ + 2e^-$
b) $2H_2O + O_2 \rightleftarrows 2H_2O_2$
c) $2H_2O \rightleftarrows H_3O^+ + OH^-$
d) $H_2O \rightleftarrows H_2 + \frac{1}{2}O_2$

35. The relationship shown is the expression for: $\dfrac{[H_3BO_3][OH^-]}{[H_2BO_3^-]}$

a) K_b for H_3BO_3
b) K_b for $H_2BO_3^-$
c) K_a for H_3BO_3
d) K_a for $H_2BO_3^-$

36. Which of the following represents the reaction between MgO and H_2O?

a) $MgO + H_2O \rightarrow Mg(OH)_2$
b) $2MgO + H_2O \rightarrow 2MgOH + \frac{1}{2}O_2$
c) $MgO + H_2O \rightarrow Mg + H_2O_2$
d) $MgO + H_2O \rightarrow MgH_2 + O_2$

37. The salt produced by the reaction of HSCN (aq) and $Mg(OH)_2$ (s) will be:
a) neutral b) acidic c) basic d) no such reaction will occur

38. Arrange the following 0.10 M solutions in order from highest to lowest pH:

HBr (aq) HBrO (aq) $HBrO_2$ (aq) $HBrO_3$ (aq)

a) HBr (aq) > HBrO (aq) > $HBrO_2$ (aq) > $HBrO_3$ (aq)
b) HBrO (aq) > $HBrO_2$ (aq) > $HBrO_3$ (aq) > HBr (aq)
c) HBr (aq) > $HBrO_3$ (aq) > $HBrO_2$ (aq) > HBrO (aq)
d) $HBrO_3$ (aq) > $HBrO_2$ (aq) > HBrO (aq) > HBr (aq)

39. Calculate the $[OH^{-1}]$ of a solution if the pH = 11.00:
a) 0.0010 M b) 1.0×10^{-11} M c) 11 M d) -1.0×10^{11}

40. Calculate the pH of a solution if it contains 0.22 mol/L $Ba(OH)_2$
a) 0.44 b) 0.36 c) 13.64 d) 13.34

41. Sodium benzoate (NaC_6H_5COO) is the salt of benzoic acid, C_6H_5COOH. It is commonly used as a food preservative. A solution of this salt is:
a) acidic b) basic c) neutral d) insoluble in water

42. What is the percent ionization of a 0.95 M solution of HF at 25ºC?
a) 95% b) 0.063% c) 2.6% d) 6.0%

43. 25.0 mL of 12.0 M HCl is diluted to a final volume of 500.0 mL. What is the concentration of the solution?
a) 0.600 M b) 0.00600 M c) 2.40 M d) 9.60 M

44. 32.5 g of $Fe(SCN)_2$ are dissolved in 2.00 L of solution. What is the molar concentration?
a) 0.143 M b) 0.189 M c) 0.0945 M d) 0.378 M

45. 6.75 g of solid calcium hydroxide is dissolved in 250.0 mL of solution. What is the $[OH^-]$?
a) 0.364 M b) 0.473 M c) 0.946 M d) 0.729 M

46. How many grams of NaOH must be dissolved in 1.00 L of solution to make a final concentration of 0.10 M NaOH?
a) 40.0 g b) 4.00 g c) 0.400 g d) 1.00 g

47. Which of these 1.00 M solutions will have the highest pH?
a) CH_3OH b) $Ca(NO_3)_2$ c) HCl d) NH_4OH

48. Which salt is not neutral?
a) $MgCl_2$ b) $LiClO_2$ c) $Ba(NO_3)_2$ d) CsBr

49. Which one of the following is a strong electrolyte?
a) H_2O b) HF c) KF d) HNO_2

50. The pOH of a solution of NaOH is 11.30. What is the $[H^+]$ for this solution?
a) 2.0×10^{-3} b) 5.0×10^{-12} c) 2.5×10^{-3} d) 4.0×10^{-12}

51. The $[H_3O^+]$ in a 0.050 M solution of $Ba(OH)_2$ is:
a) 1.0×10^{-5} M c) 5.0×10^{-2} M
b) 1.0×10^{-13} M d) 5.0×10^{-10} M

52. What is the approximate pH of a solution labeled 6×10^{-5} M HBr?
a) 4.2 b) 5.8 c) 4.5 d) 9.8

53. What is the pH of 500.0 mL of solution containing 0.0124 grams of $Ca(OH)_2$?
a) 11.04 b) 2.96 c) 9.68 d) 10.83

54. The pH of a solution is 4.80. What is the concentration of hydroxide ions in this solution?
a) 4.2×10^{-9} M b) 3.6×10^{-12} M c) 1.6×10^{-5} M d) 6.3×10^{-10} M

55. A solution in which $[H^+] = 1 \times 10^{-8}$ M has a pOH of ___ and is _____:
a) 8.0, acidic b) 8.0, basic c) 6.0, acidic d) 6.0, basic

56. A 0.020 M solution of an unknown weak acid has a pH of 3.70. What is the K_a of this acid?
a) 2.0×10^{-6} b) 6.3×10^{-4} c) 1.3×10^{-5} d) 1.6×10^{-3}

57. What is the approximate pH of a solution labelled 0.05 M HClO?
a) 5.1 b) 4.3 c) 3.9 d) 2.1

58. What is the pH of a solution labelled 0.3 M $(CH_3)_3N$?
a) 9.5 b) 9.2 c) 10.8 d) 11.6

59. Which of the following solutions has the lowest pH at 25°C?
a) 0.2 M sodium hydroxide
b) 0.2 M ammonia
c) 0.2 M hypochlorous acid
d) 0.2 M benzoic acid

60. A 0.10 M solution of a weak acid, HX, is 0.059% ionized. Evaluate K_a for the acid.
a) 3.5×10^{-8} b) 7.0×10^{-6} c) 6.5×10^{-7} d) 4.2×10^{-6}

61. What is the percent ionization of an 1.2 M HF solution?
a) 2.3 % b) 0.84 % c) 4.2 % d) 0.22 %

62. Which of the following weak acids ionizes to give the strongest conjugate base?
a) HClO b) HF c) CH_3COOH d) HCN

63. What is K_b for the cyanide ion, CN^-.
a) 1.6×10^{-5} b) 6.2×10^{-10} c) 1.0×10^{-7} d) 8.4×10^{-9}

64. What is the pH of a 0.50 M solution of $NaNO_2$?
a) 7.00 b) 1.82 c) 5.52 d) 8.48

65. What is the concentration of a sodium acetate solution if the pH of the solution is 9.19?
a) 0.30 M b) 2.1 M c) 0.43 M d) 0.068 M

66. What is the pH of 0.060 M NH_4Cl?
a) 5.06 b) 5.18 c) 5.12 d) 5.24

67. What is the concentration of ammonium chloride in a solution if its pH is 4.80?
a) 0.25 M b) 0.45 M c) 0.30 M d) 0.60 M