

Review for Unit Test 6: 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 ₂ SO ₃				
HCHO ₂				
HPO ₄ ²⁻				
H ₂ O				
NH ₄ ¹⁺				
HCO ₃ ¹⁻				
H ₂ SO ₄				
C ₅ H ₅ NH ⁺				

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

Base	Ionization Reaction	Conjugate Acid	Ka	Kb
ClO ⁻				
N ₂ H ₄ (aq)				
CH ₃ COO ⁻				
HPO ₄ ²⁻				
F ¹⁻				
H ₂ O				
NH ₂ OH				
NH ₃				
C ₅ H ₅ N				
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 H₃PO₄ HI H₃PO₃

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



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

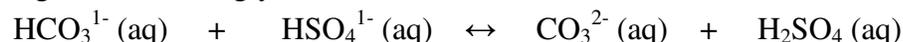
8. Calculate the pH of the following solutions:

- 15.4 g of potassium hydroxide in a total volume of 600.0 mL solution (13.660, 3 decimal places)
- 125 mL of 15.0 M of nitric acid diluted to 1.00 litre of solution (-0.273, 3 decimal places)
- a 0.0125 M solution of magnesium hydroxide (12.398, 3 decimal places)
- a 1.35 M solution of acetic acid (2.31, 2 decimal places from K_a)
- a 2.00 M solution of pyridine (C₅H₅N) (9.77, 2 decimal places from K_b)
- 0.555 M solution of hypobromite ion (from sodium hypobromite) (11.15, 2 decimals from K_a)
- 100.0 mL of 18.0 M H₂SO₄ 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 ₃ O ⁺]	[OH ⁻]	acid/base/neutral
1.25				
		4.63 x 10 ⁻¹⁰		
	9.10			
			0.750	
	5.00			

10. The following reaction strongly favours the reactants:



- 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 K_a 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) NaCH₃COO _____
- b) NH₄Cl _____
- c) Li₂O _____
- d) Sr(NO₃)₂ _____
- e) HBrO (HOBr) _____
- f) CoBr₂ _____
- g) Cr(NO₃)₂ _____
- h) Na₃PO₄ _____
- i) HSCN _____
- j) CaC₂O₄ _____
- k) Mg(ClO₃)₂ _____
- l) K₃BO₃ _____
- m) SnCl₄ _____

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

- a) NaCl and NaClO _____
- b) H₂O and Li₂O _____
- c) HClO₂ and HClO₃ _____
- d) H₂S and Na₂S _____
- 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) + CH₃COOH (aq) →
- b) NaOH (aq) + Ba (s) →
- c) HBrO₃ (aq) + K₂CO₃ (s) →
- d) K₂O (s) + H₂O (l) →

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. ($K_a = 0.023$)
2. Butanoic acid, $\text{C}_3\text{H}_7\text{COOH}$, 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. ($K_a = 1.7 \times 10^{-5}$)
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 $\text{N}_2\text{H}_5\text{Cl}$ (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 c) concentration of H_3O^+ > concentration of OH^-
b) taste sour 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 c) III only
b) I and IV 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 c) potassium sulfate
b) calcium hydroxide 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) $\text{Mg}(\text{OH})_2$
III) NH_3
IV) $\text{Fe}(\text{OH})_3$
a) I only c) II and IV only
b) I and III only d) I, II, III and IV
6. Which of the following aqueous solutions will have the highest pH?
a) MgSO_4 (aq) c) $\text{Na}_2\text{C}_2\text{O}_4$ (aq)
b) $(\text{NH}_4)_2\text{SO}_4$ (aq) d) HClO_2 (aq)

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) HBrO₂ (aq) HBrO₃ (aq)
 a) HBr (aq) > HBrO (aq) > HBrO₂ (aq) > HBrO₃ (aq)
 b) HBrO (aq) > HBrO₂ (aq) > HBrO₃ (aq) > HBr (aq)
 c) HBr (aq) > HBrO₃ (aq) > HBrO₂ (aq) > HBrO (aq)
 d) HBrO₃ (aq) > HBrO₂ (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 x 10⁻¹¹ M c) 11 M d) - 1.0 x 10¹¹
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 (NaC₆H₅COO) is the salt of benzoic acid, C₆H₅COOH. 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 25°C?
 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) CH₃OH b) Ca(NO₃)₂ c) HCl d) NH₄OH
48. Which salt is not neutral?
 a) MgCl₂ b) LiClO₂ c) Ba(NO₃)₂ d) CsBr
49. Which one of the following is a strong electrolyte?
 a) H₂O b) HF c) KF d) HNO₂
50. The pOH of a solution of NaOH is 11.30. What is the [H⁺] for this solution?
 a) 2.0 x 10⁻³ b) 5.0 x 10⁻¹² c) 2.5 x 10⁻³ d) 4.0 x 10⁻¹²
51. The [H₃O⁺] in a 0.050 M solution of Ba(OH)₂ is:
 a) 1.0 x 10⁻⁵ M c) 5.0 x 10⁻² M
 b) 1.0 x 10⁻¹³ M d) 5.0 x 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 $\text{Ca}(\text{OH})_2$?
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 $[\text{H}^+] = 1 \times 10^{-8}$ 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 $(\text{CH}_3)_3\text{N}$?
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 c) 0.2 M hypochlorous acid
b) 0.2 M ammonia 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