NAME: HONORS CHEMISTRY

SECTION: Review Sheet: Acids, Bases and Salts

After studying chapter 16, you should be able to:

- List properties of acids and bases.
- Classify a solution as neutral, acidic, or basic, given the hydrogen ion or hydroxide ion concentration.
- Calculate the pH of a solution given the hydrogen-ion or hydroxide-ion concentration.
- Calculate the hydrogen-ion or hydroxide-ion concentration given the pH of a solution.
- Define and give examples of Arrhenius acids and bases.
- Classify substances as acids or bases, and identify conjugate acid-base pairs in acid-base reactions according to Bronsted-Lowry theory.
- Classify substances as acids or bases and write equations for the formation of complex ions according to Lewis theory.
- Distinguish between strong and weak acids and bases using the extent of ionization and the dissociation constants.
- Derive and use ionization constants.
- Compute the percent ionization of a weak electrolyte.
- List the components of a buffer and explain why buffer systems resist changes in pH.
- Write balanced equations for acid-base neutralization reactions.
- State the principles of titration.
- Describe the titration curve for a titration of a strong acid with a strong base.
- Explain the process of titration.
- Perform calculations using data from titrations.

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1. Complete the following table comparing the three key acid-base theories.

Theory	**Acid Definition**	**Base Definition**
	H+ producer	
Bronsted-Lowry		
		Electron-pair donor

2. Compare the properties of acids and bases by completing the following table:

Category	Acids	Bases
Effect on litmus		
Effect on phenolphthalein		
pH		
Taste		
Reaction with metals		

3. Write the formula for the conjugate base of each of the acids listed.

a) H_2O

b) HNO_3

c) HF

d) HC_2H3O_2

4. Write the formula for the conjugate acid of each of the bases listed.
   a) NH_3
   b) HSO_4-
   c) HS-

5. In the following reaction, which species behave as Bronsted acids? As Bronsted bases? Complete the reactions, then label the conjugate acid-base pairs.

   H_2SO_4 (aq) + H_2O(l) ⇌ HSO_4^-(aq) + H_3O+(aq)

   a. H_2SO_3
   b. H_2SO_4
   c. NaOH
   d. $Ca(OH)_2$
   e. HNO_3

6. What is an amphiprotic substance?

7. Consider the following table of K_a values for several acids. Which is the strongest acid on the list? Which is the weakest acid? Explain how you arrived at your answer.

Acid	K_a
H_3PO_4	7.5×10^{-3}
HCO_3^-	5.6×10^{-11}
HF	3.5×10^{-4}
HNO_2	4.6×10^{-4}

   Which of these is amphoprotic?

8. Identify the Lewis acid and the Lewis base in the reaction of Ni^{2+} with four water ligands:

   $Ni^{2+}(aq) + 2\ H_2O(l) \rightarrow Ni(H_2O)_4^{2+}(aq)$

9. What is the value of K_b for NH_3(aq) if a 0.1250 M solution has the following equilibrium concentrations: $[NH_4^+] = [OH^-] = 1.478 \times 10^{-3}$ M, $[NH_3] = 0.1235$ M?

   $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

10. What is the hydronium ion concentration of 0.250 M acetic acid if the K_a is 1.76×10^{-5}?

11. What is the hydronium ion concentration in a 0.0885 M solution of formic acid (a monoprotic acid) if the K_a is 1.78×10^{-4}?

12. Find the percent of ionization of a 0.375 M solution of HClO, hypochlorous acid, if the hydronium ion concentration , $[H_3O^+]$ is 7.50×10^{-3} M.

13. Find the percent of ionization of propanoic acid, CH_3CH_2COOH, which has a $K_a = 1.34 \times 10^{-5}$. The concentration of the propanoic acid is 0.100 M.

14. Find the pH of a 0.075 M HCN solution that ionizes 0.00907%.

15. Find the pH of solutions with the following H_3O^+ concentrations.
    a) 1.15×10^{-6} M
    b) 5.75×10^{-8} M
    c) 7.44×10^{-11} M

16. Find the $[H_3O^+]$ and the pOH of the following solutions.
    a) pH = 3
    b) pH = 9.35
    c) pH = 6.34

17. What is the hydroxide ion concentration in a solution with $[H_3O^+] = 7.67 \times 10^{-9}$ M?

18. What is the hydronium ion concentration in a solution with $[OH^-] = 4.35 \times 10^{-2}$ M?

19. Write complete balanced equations for the following neutralization reactions:
    a) $HBr + Mg(OH)_2 \rightarrow$
    b) $Ca(OH)_2 + H_3PO_4 \rightarrow$
    c) $H_3BO_3 + KOH \rightarrow$
    d) $Al(OH)_3 + H_2SO_3 \rightarrow$

20. In a titration, 34.0 mL of 1.40 M NaOH neutralized 52.0 mL of a solution of perchloric acid, $HClO_4$. What is the molarity of the perchloric acid solution? Start with a balanced equation.

21. What volume of 0.120 M H_2SO_4 is needed to titrate 40. mL of 0.15M NaOH to the equivalence point? Start with a balanced equation.

22. Which of the following mixtures would act as a buffered solution? (Refer to your table of relative acid strengths as needed)
    a) KCl and KOH
    b) NH_3 and NH_4Cl
    c) HBr and NaBr
    d) $HClO_2$ and $KClO_2$

Answers to selected problems:

3. a) OH^- b) NO_3^- c) F^- d) $C_2H_3O_2^-$
4. a) NH_4^+ b) H_2SO_4 c) H_2S
7. strongest H_3PO_4 (highest K_a); weakest HCO_3^- (smallest K_a) HCO_3^- is amphoteric.
9. 1.77×10^{-5}
10. 2.10×10^{-3} M
11. 3.97×10^{-3} M
12. 2.00% ionization
13. 1.16% ionization
14. pH = 5.16
15. a) pH = 5.94 b) pH = 7.24 c) pH = 10.1
16. a) $[H_3O^+] = 1.00 \times 10^{-3}$ M pOH = 11 b) $[H_3O^+] = 4.47 \times 10^{-10}$ M pOH = 4.65 c) $[H_3O^+] = 4.57 \times 10^{-7}$ pOH = 7.66
18. $[H_3O^+] = 2.30 \times 10^{-13}$ M
20. 0.915 M
21. 21. 25 mL