

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.

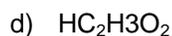
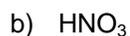
1. Complete the following table comparing the three key acid-base theories.

Theory	Acid Definition	Base Definition
	H <sup>+</sup> 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		

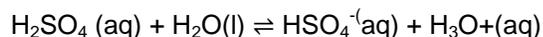
3. Write the formula for the conjugate base of each of the acids listed.



4. Write the formula for the conjugate acid of each of the bases listed.

- a)  $\text{NH}_3$
- b)  $\text{HSO}_4^-$
- c)  $\text{HS}^-$

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



- a.  $\text{H}_2\text{SO}_3$
- b.  $\text{H}_2\text{SO}_4$
- c.  $\text{NaOH}$
- d.  $\text{Ca}(\text{OH})_2$
- e.  $\text{HNO}_3$

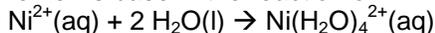
6. What is an amphiprotic substance?

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.

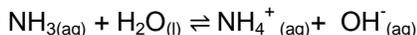
Acid	$K_a$
$\text{H}_3\text{PO}_4$	$7.5 \times 10^{-3}$
$\text{HCO}_3^-$	$5.6 \times 10^{-11}$
$\text{HF}$	$3.5 \times 10^{-4}$
$\text{HNO}_2$	$4.6 \times 10^{-4}$

Which of these is amphiprotic?

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



9. What is the value of  $K_b$  for  $\text{NH}_3(\text{aq})$  if a 0.1250 M solution has the following equilibrium concentrations:  $[\text{NH}_4^+] = [\text{OH}^-] = 1.478 \times 10^{-3} \text{ M}$ ,  $[\text{NH}_3] = 0.1235 \text{ M}$ ?



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

11. What is the hydronium ion concentration in a 0.0885 M solution of formic acid (a monoprotic acid) if the  $K_a$  is  $1.78 \times 10^{-4}$ ?
12. Find the percent of ionization of a 0.375 M solution of HClO, hypochlorous acid, if the hydronium ion concentration,  $[H_3O^+]$  is  $7.50 \times 10^{-3}$  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)  $1.15 \times 10^{-6}$  M
  - b)  $5.75 \times 10^{-8}$  M
  - c)  $7.44 \times 10^{-11}$  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  $[\text{OH}^-] = 4.35 \times 10^{-2} \text{ M}$ ?
19. Write complete balanced equations for the following neutralization reactions:
- $\text{HBr} + \text{Mg}(\text{OH})_2 \rightarrow$
  - $\text{Ca}(\text{OH})_2 + \text{H}_3\text{PO}_4 \rightarrow$
  - $\text{H}_3\text{BO}_3 + \text{KOH} \rightarrow$
  - $\text{Al}(\text{OH})_3 + \text{H}_2\text{SO}_3 \rightarrow$
20. In a titration, 34.0 mL of 1.40 M NaOH neutralized 52.0 mL of a solution of perchloric acid,  $\text{HClO}_4$ . What is the molarity of the perchloric acid solution? Start with a balanced equation.
21. What volume of 0.120 M  $\text{H}_2\text{SO}_4$  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)
- KCl and KOH
  - $\text{NH}_3$  and  $\text{NH}_4\text{Cl}$
  - HBr and NaBr
  - $\text{HClO}_2$  and  $\text{KClO}_2$

Answers to selected problems:

- $\text{OH}^-$
  - $\text{NO}_3^-$
  - $\text{F}^-$
  - $\text{C}_2\text{H}_3\text{O}_2^-$
- $\text{NH}_4^+$
  - $\text{H}_2\text{SO}_4$
  - $\text{H}_2\text{S}$
- strongest  $\text{H}_3\text{PO}_4$  (highest  $K_a$ ); weakest  $\text{HCO}_3^-$  (smallest  $K_a$ )  $\text{HCO}_3^-$  is amphoteric.
- $1.77 \times 10^{-5}$
- $2.10 \times 10^{-3} \text{ M}$
- $3.97 \times 10^{-3} \text{ M}$
- 2.00% ionization
- 1.16% ionization
- pH = 5.16
- pH = 5.94
  - pH = 7.24
  - pH = 10.1
- $[\text{H}_3\text{O}^+] = 1.00 \times 10^{-3} \text{ M}$  pOH = 11
  - $[\text{H}_3\text{O}^+] = 4.47 \times 10^{-10} \text{ M}$  pOH = 4.65
  - $[\text{H}_3\text{O}^+] = 4.57 \times 10^{-7}$  pOH = 7.66
- $[\text{H}_3\text{O}^+] = 2.30 \times 10^{-13} \text{ M}$
- 0.915 M
21. 25 mL