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+ producer |  |
| Bronsted-Lowry |  |  |
|  |  | Electron-pair donor |

1. 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 |  |  |

1. Write the formula for the conjugate base of each of the acids listed.
2. H2O
3. HNO3
4. HF
5. HC2H3O2
6. Write the formula for the conjugate acid of each of the bases listed.
7. NH3
8. HSO4-
9. HS-
10. In the following reaction, which species behave as Bronsted acids? As Bronsted bases? Complete the reactions with water (as shown in the example), then label the conjugate acid-base pairs.

H2SO4 (aq) + H2O(l) ⇌ HSO4-(aq) + H3O+(aq)

* 1. H2SO3
  2. H2SO4
  3. NH3
  4. N2H4
  5. HNO3

1. What is an amphiprotic substance?
2. Consider the following table of Ka 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 | Ka |
| H3PO4 | 7.5 x 10-3 |
| HCO3- | 5.6 x 10-11 |
| HF | 3.5 x 10-4 |
| HNO2 | 4.6 x 10-4 |

Which of these is amphiprotic? Explain why.

1. Identify the Lewis acid and the Lewis base in the reaction of Ni2+ with four water ligands:

Ni2+(aq) + 2 H2O(l) 🡪 Ni(H2O)42+(aq)

1. What is the value of Kb for NH3(aq) if a 0.1250 M solution has the following equilibrium concentrations: [NH4+] = [OH-] = 1.478 x 10-3 M, [NH3] = 0.1235 M?

NH3(aq) + H2O(l) ⇌ NH4+ (aq)+OH-(aq)

1. What is the hydronium ion concentration of 0.250 M acetic acid if the Ka is 1.76 x 10-5?
2. What is the hydronium ion concentration in a 0.0885 M solution of formic acid (a monoprotic acid) if the Ka is 1.78 x 10-4?

Revisit these problems…change at least one to a classic Ka problem…given pH…find Ka…

1. Find the percent of ionization of a 0.375 M solution of HClO, hypochlorous acid, if the hydronium ion concentration , [H3O+] is 7.50 x 10-3 M.
2. Find the percent of ionization of propanoic acid, CH3CH2COOH, which has a Ka = 1.34 x 10-5. The concentration of the propanoic acid is 0.100 M.
3. Find the pH of a 0.075 M HCN solution that ionizes 0.00907%.
4. Find the pH of solutions with the following H3O+ concentrations.
5. 1.15 x 10-6 M
6. 5.75 x 10-8 M
7. 7.44 x 10-11 M
8. Find the [H3O+] and the pOH of the following solutions.
9. pH = 3
10. pH = 9.35
11. pH = 6.34
12. What is the hydroxide ion concentration in a solution with [H3O+] = 7.67 x 10-9 M?
13. What is the hydronium ion concentration in a solution with [OH-] = 4.35 x 10-2 M?
14. Write complete balanced equations for the following neutralization reactions:
15. HBr + Mg(OH)2 →
16. Ca(OH)2 + H3PO4 →
17. H3BO3 + KOH →
18. Al(OH)3 + H2SO3 →
19. In a titration, 34.0 mL of 1.40 M NaOH neutralized 52.0 mL of a solution of perchloric acid, HClO4. What is the molarity of the perchloric acid solution? Start with a balanced equation.
20. What volume of 0.120 M H2SO4 is needed to titrate 40. mL of 0.15M NaOH to the equivalence point? Start with a balanced equation.
21. Which of the following mixtures would act as a buffered solution? (Refer to your table of relative acid strengths as needed)
22. KCl and KOH
23. NH3 and NH4Cl
24. HBr and NaBr
25. HClO2 and KClO2

Answers to selected problems:

* 1. a) OH- b) NO3- c) F- d) C2H3O2-
  2. a) NH4+ b) H2SO4 c) H2S

7. strongest H3PO4 (highest Ka); weakest HCO3- (smallest Ka) HCO3- is amphoteric.

1. 1.77 x 10-5
2. 2.10 x 10-3 M
3. 3.97 x 10-3 M
4. 2.00% ionization
5. 1.16% ionization
6. pH = 5.16
7. a) pH = 5.94 b) pH = 7.24 c) pH = 10.1
8. a) [H3O+] = 1.00 x 10-3 M pOH = 11 b) [H3O+] = 4.47 x 10-10 M pOH = 4.65 c) [H3O+] = 4.57 x 10-7 pOH = 7.66
9. [H3O+] = 2.30 x 10-13 M
   * 1. 0.915 M
     2. 25 mL
     3. Mixtures B and D