Chemistry 101 – Unit 10
Answers to Problems

1. If 20.00 mL of H_2SO_4 are neutralized by 32.81 mL of 0.1124 M NaOH, what is the molarity of the sulfuric acid solution?

$$\mathbf{H_2SO_4\ (aq) + 2\ NaOH\ (aq) \rightarrow Na_2SO_4\ (aq) + 2\ HOH\ (l)}$$

$$\mathbf{32.81\ mL\ NaOH \times \frac{0.1124\ mol\ NaOH}{1000\ mL\ NaOH} \times \frac{1\ mol\ H_2SO_4}{2\ mol\ NaOH} \times \frac{1}{20.00\ mL\ H_2SO_4} \times \frac{1000\ mL}{1\ L} = 0.09220\ M}$$

2. If 25.00 mL of 0.0973 M HCl are neutralized by 30.20 mL of NaOH, what is the molarity of the NaOH solution?

$$\mathbf{HCL\ (aq) + NaOH\ (aq) \rightarrow NaCl\ (aq) + NaOH\ (l)}$$

$$\mathbf{25.00\ mL\ HCl \times \frac{0.0973\ mol\ HCl}{1000\ mL\ HCL} \times \frac{1\ mol\ NaOH}{1\ mol\ HCL} \times \frac{1}{30.20\ mL\ NaOH} \times \frac{1000\ mL}{1\ L} = 0.0906\ M}$$

3. A student finds that 34.8 mL of 0.483 M KOH are required to neutralize a 10.0 mL sample of a certain H_3PO_4 solution. What is the molarity of the H_3PO_4 solution?

$$\mathbf{H_3PO_4\ (aq) + 3\ KOH\ (aq) \rightarrow K_3PO_4\ (aq) + 3\ HOH\ (l)}$$

$$\mathbf{34.8\ mL\ KOH \times \frac{0.483\ mol\ KOH}{1000\ mL\ KOH} \times \frac{1\ mol\ H_3PO_4}{3\ mol\ KOH} \times \frac{1}{10.0\ mL\ H_3PO_4} \times \frac{1000\ mL}{1\ L} = 0.560\ M}$$

4. A student finds that 20.0 mL of 0.395 M HNO_3 are required to neutralize a 29.7 mL sample of a certain KOH solution. What is the molarity of the KOH solution?

$$\mathbf{HNO_3\ (aq) + KOH\ (aq) \rightarrow KNO_3\ (aq) + HOH\ (aq)}$$

$$\mathbf{20.0\ mL\ HNO_3 \times \frac{0.395\ mol\ HNO_3}{1000\ mL\ HNO_3} \times \frac{1\ mol\ KOH}{1\ mol\ HNO_3} \times \frac{1}{29.7\ mL\ KOH} \times \frac{1000\ mL}{1\ L} = 0.266\ M}$$

5. A student finds that 15.0 mL of 0.186 M H_2SO_4 are required to neutralize a 26.3 mL sample of a certain NaOH solution. What is the molarity of the NaOH solution?

$$\mathbf{H_2SO_4\ (aq) + 2\ NaOH\ (aq) \rightarrow 2\ H_2O\ (aq) + Na_2SO_4\ (aq)}$$

$$\mathbf{15.0\ mL\ H_2SO_4 \times \frac{0.186\ mol\ H_2SO_4}{1000\ mL\ H_2SO_4} \times \frac{2\ mol\ NaOH}{1\ mol\ H_2SO_4} \times \frac{1}{26.3\ mL\ NaOH} \times \frac{1000\ mL}{1\ L} = 0.212\ M}$$

6. A student finds that 46.1 mL of 0.244 M NaOH are required to neutralize a 25.0 mL sample of a certain $H_2C_2O_4$ solution. What is the molarity of the $H_2C_2O_4$ solution?

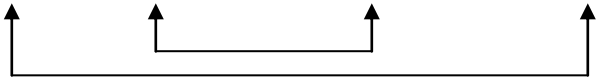
$$\mathbf{H_2C_2O_4\ (aq) + 2\ NaOH\ (aq) \rightarrow 2\ HOH\ (l) + Na_2C_2O_4\ (aq)}$$

$$\mathbf{46.1\ mL\ NaOH \times \frac{0.244\ mol\ NaOH}{1000\ mL\ NaOH} \times \frac{1\ mol\ H_2C_2O_4}{2\ mol\ NaOH} \times \frac{1}{25.0\ mL\ H_2C_2O_4} \times \frac{1000\ mL}{1\ L} = 0.225\ M}$$

7. Identify the conjugate acid and base pairs in each of the following:

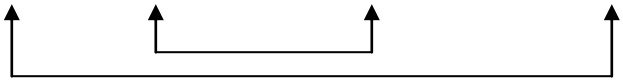
a. $HCN + H_2O \leftrightarrow H_3O^+ + CN^-$

acid base conj. acid conj. base



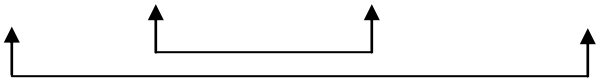
b. $H_2CO_3 + H_2O \leftrightarrow H_3O^+ + HCO_3^-$

acid base conj. acid conj. base



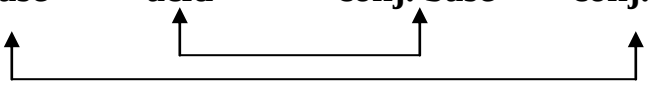
c. $OH^- + HSO_4^- \leftrightarrow SO_4^{2-} + H_2O$

base acid conj. base conj. acid



d. $HCO_3^- + H_2PO_4^- \leftrightarrow HPO_4^{2-} + H_2CO_3$

base acid conj. base conj. acid



8. Fill in the following table:

Conjugate Acid	Conjugate Base
HI	**I^-**
HClO	ClO^-
HS^-	**S^{2-}**
$HC_3H_5O_2$	**$C_3H_5O_2^-$**
$HC_2O_4^-$	$C_2O_4^{2-}$
NH_4^+	NH_3

9. a. If $HClO_4$ is a strong acid, is ClO_4^- a weak or strong base?
ClO_4^- is a weak base.

b. If HF is a weak acid, is F^- a weak or strong base?
F^- is a strong base.

10. Given the pH values, classify each of the following solutions as **acidic**, **basic** or **neutral**:

a. pH = 8.69 **basic**

b. pH = 3.27 **acidic**

c. pH = 7.00 **neutral**

d. pH = 5.41 **acidic**

e. pH = 11.38 **basic**

f. pH = 13.24 **basic**

11. Which solution is more acidic, one whose pH = 2.58 or one whose pH = 4.95?
pH = 2.58 more acidic

12. Which solution is more basic (less acidic), one whose pH = 8.62 or whose pH = 12.85?
pH = 12.85 more basic

13. Match the following terms and definitions:

a. **B** proton donor

b. **E** produces H_3O^+ in solution

c. **H** acid formed when base gains hydrogen ion

d. **G** base formed when acid loses hydrogen ion

e. **A** proton acceptor

f. **C** measure of relative acidity

g. **D** produces OH^- in solution

h. **F** pH meter

i. **F** indicators (pH paper)

j. **I** pH of a solution

A. Bronsted–Lowry Base B. Bronsted–Lowry Acid C. pH Scale

D. Arrhenius Base E. Arrhenius Acid F. Method of determining pH

G. Conjugate Base H. Conjugate Acid I. Determined by H^+ concentration