

A 1. In a titration, 5.0 mL of a 2.0 M NaOH(aq) solution exactly neutralizes 10.0 mL of an HCl(aq) solution. What is the concentration of the HCl(aq) solution?

- (A) 1.0 M B) 2.0 M C) 10. M D) 20. M

$$\begin{array}{l} \#1. \quad M_a \quad ? \qquad \qquad \qquad M_b \quad 2.0 \text{ M} \\ \qquad V_a \quad 10 \text{ mL} \qquad \qquad \qquad V_b \quad 5.0 \text{ mL} \\ \qquad H \quad 1 \qquad \qquad \qquad \qquad \qquad OH \quad 1 \end{array}$$

$$M_a(10) = (2.0)(5.0)$$

$$\frac{M_a(10)}{10} = \frac{10}{10}$$

$$M_a = 1 \text{ M}$$

A 2. In a titration, 20.0 milliliters of a 0.150 M NaOH(aq) solution exactly neutralizes 24.0 milliliters of an HCl(aq) solution. What is the concentration of the HCl(aq) solution?

- (A) 0.125 M B) 0.180 M  
C) 0.250 M D) 0.360 M

$$\begin{array}{l} \#2. \quad M_a \quad ? \qquad \qquad \qquad M_b \quad 0.150 \text{ M} \\ \qquad V_a \quad 24.0 \text{ mL} \quad V_b \quad 20.0 \text{ mL} \\ \qquad H \quad 1 \qquad \qquad \qquad \qquad \qquad OH \quad 1 \end{array}$$

$$M_a(24) = (0.150)(20)$$

$$\frac{M_a(24)}{24} = \frac{3}{24}$$

$$M_a = 0.125 \text{ M}$$

D 3. Which process is used to determine the concentration of an acid?

- A) chromatography B) distillation  
C) electrolysis D) titration

*definition question*

B 4. Which volume of 2.0 M NaOH(aq) is needed to completely neutralize 24 milliliters of 1.0 M HCl(aq)?

- A) 6.0 mL (B) 12 mL C) 24 mL D) 48 mL

B 5. How many milliliters of 0.600 M H<sub>2</sub>SO<sub>4</sub> are required to exactly neutralize 100. milliliters of 0.300 M Ba(OH)<sub>2</sub>?

- A) 25.0 mL B) 50.0 mL  
C) 100. mL D) 200. mL

C 6. The following data were collected by a student performing an acid-base titration:

Volume of the acid, HCl = 20.0 ml  
Molarity of the acid = 0.50 M  
Volume of the base, NaOH = 40.0 ml

From the collected data, the concentration of the base should be calculated as

- A) 1.0 M B) 2.0 M (C) 0.25 M D) 0.50

$$\begin{array}{l} \#5. \quad M_a \quad 0.600 \text{ M} \qquad \qquad M_b \quad 0.300 \text{ M} \\ \qquad V_a \quad ? \qquad \qquad \qquad V_b \quad 100. \text{ mL} \\ \qquad H \quad 2 \qquad \qquad \qquad \qquad \qquad OH \quad 2 \end{array}$$

$$(0.600)(2)(V_a) = (0.300)(100)(2)$$

$$\frac{1.200(V_a)}{1.2} = \frac{60}{1.2}$$

$$V_a = 50 \text{ mL}$$

$$\begin{array}{l} \#4. \quad M_a \quad 1.0 \text{ M} \qquad \qquad \qquad M_b \quad 2.0 \text{ M} \\ \qquad V_a \quad 24.0 \text{ mL} \qquad \qquad \qquad V_b \quad ? \\ \qquad H^+ \quad 1 \qquad \qquad \qquad \qquad \qquad OH^- \quad 1 \end{array}$$

$$(1.0)(24) = (2.0)V_b$$

$$\frac{24}{2.0} = \frac{2.0 V_b}{2.0}$$

$$12 \text{ mL} = V_b$$

$$\begin{array}{l} \#6. \quad M_a \quad 0.5 \text{ M} \quad M_b \quad ? \\ \qquad V_a \quad 20.0 \text{ mL} \quad V_b \quad 40.0 \text{ mL} \\ \qquad H \quad 1 \qquad \qquad \qquad \qquad \qquad OH \quad 1 \end{array}$$

$$(0.5)(20) = (M_b)(40)$$

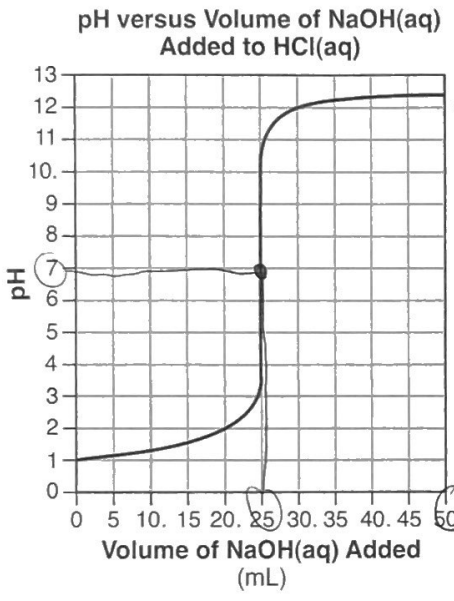
$$\frac{10}{40} = M_b \frac{40}{40}$$

$$M_b = 0.25 \text{ M}$$

Base your answers to questions 7 through 10 on the information below and on your knowledge of chemistry.

A student is to determine the concentration of an NaOH(aq) solution by performing two different titrations. In a first titration, the student titrates 25.0 mL of 0.100 M H<sub>2</sub>SO<sub>4</sub>(aq) with NaOH(aq) of unknown concentration.

In a second titration, the student titrates 25.0 mL of 0.100 M HCl(aq) with a sample of the NaOH(aq). During this second titration, the volume of the NaOH(aq) added and the corresponding pH value of the reaction mixture is measured. The graph below represents the relationship between pH and the volume of the NaOH(aq) added for this second titration.

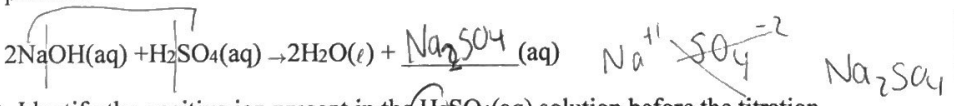


#7 pH ≈ 12.5  
Phenolphthalein = PINK

- State the color of phenolphthalein indicator if it were added after the HCl(aq) was titrated with 50. mL of NaOH(aq).
- Based on the graph, determine the volume of NaOH(aq) used to exactly neutralize the HCl(aq).
- Complete the equation below for the neutralization that occurs in the first titration by writing a formula of the missing product.

PINK

25 mL



# 9 = Na<sub>2</sub>SO<sub>4</sub>

- Identify the positive ion present in the H<sub>2</sub>SO<sub>4</sub>(aq) solution before the titration.

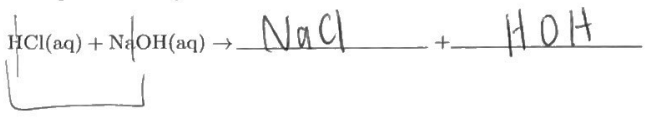
H<sup>+</sup> hydrogen ion

Base your answers to questions 11 and 12 on the information below and on your knowledge of chemistry.

A NaOH(aq) solution and an acid-base indicator are used to determine the molarity of an HCl(aq) solution. A 25.0-milliliter sample of the HCl(aq) is exactly neutralized by 15.0 milliliters of 0.20 M NaOH(aq).

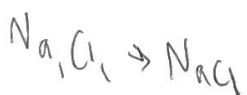
- Using the data, determine the concentration of the HCl(aq).
- Complete the equation for the neutralization reaction that occurs, by writing a formula for each product.

0.12M



$$(M_a)(V_a)(25) = (0.2)(15)(1)$$

$$\frac{M_a(25)}{25} = \frac{3}{25}$$



#11. M<sub>a</sub> ?  
V<sub>a</sub> 25.0 mL

M<sub>b</sub> 0.20 M  
V<sub>b</sub> 15.0 mL

H 1

OH 1

M<sub>a</sub> = 0.12M