

Acid-Base #2 (Titrations)

Part One: Multiple Choice - circle the best response

1. The stoichiometric point of a titration is reached when 35.50 mL 0.40 M HBr is added to a 25.00 mL sample of LiOH. The original [LiOH] is

A. 0.014 M

B. 0.024 M

C. 0.28 M

D. 0.57 M



$$0.40 \frac{\text{mol}}{\text{L}} \text{HBr} \times 0.03550 \text{ L} = 0.0142 \text{ mol HBr}$$

$$0.0142 \text{ mol HBr} \times \frac{1 \text{ mol LiOH}}{1 \text{ mol HBr}} = 0.0142 \text{ mol LiOH}$$

$$[\text{LiOH}] = \frac{0.0142 \text{ mol}}{0.02500 \text{ L}}$$

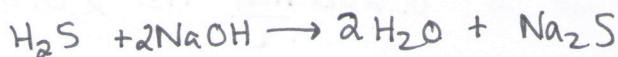
2. A 25.0 mL sample of the weak acid H_2S is titrated with 31.8 mL of 0.30 M NaOH (a strong base). What is the concentration of the acid?

A. 0.19 M

B. 0.24 M

C. 0.38 M

D. 0.76 M



$$0.30 \frac{\text{mol}}{\text{L}} \text{NaOH} \times 0.0318 \text{ L} = 0.00954 \text{ mol NaOH}$$

$$0.00954 \text{ mol NaOH} \times \frac{1 \text{ mol H}_2\text{S}}{2 \text{ mol NaOH}} = 0.00477 \text{ mol H}_2\text{S}$$

$$[\text{H}_2\text{S}] = \frac{0.00477 \text{ mol}}{0.0250 \text{ L}}$$

3. Which of the following acid solutions would require the smallest volume to completely neutralize 10.00 mL of 0.100 M NaOH ? COMPLETE Neutralization

- A. $0.100 \text{ M HCl} \rightarrow \text{H}^+ + \text{Cl}^-$
 B. $0.100 \text{ M H}_3\text{PO}_4 \rightarrow 3\text{H}^+ + \text{PO}_4^{3-}$
 C. $0.100 \text{ M H}_2\text{C}_2\text{O}_4 \rightarrow 2\text{H}^+ + \text{C}_2\text{O}_4^{2-}$
 D. $0.100 \text{ M CH}_3\text{COOH} \rightarrow \text{H}^+ + \text{CH}_3\text{COO}^-$

~~0.100 mol~~ $0.100 \frac{\text{mol}}{\text{L}} \text{ NaOH} \times 0.0100 \text{ L} = 0.0010 \text{ mol NaOH}$

$0.0010 \text{ mol NaOH} \times \frac{\text{mol H}^+}{\text{mol NaOH}} =$

vs. A. $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ $0.0010 \text{ mol NaOH} \times \frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} = 0.0010 \text{ mol HCl}$
 B. $\text{H}_3\text{PO}_4 + 3\text{NaOH} \rightarrow \text{Na}_3\text{PO}_4 + 3\text{H}_2\text{O}$ $0.0010 \text{ mol NaOH} \times \frac{1 \text{ mol H}_3\text{PO}_4}{3 \text{ mol NaOH}} = 3.3 \times 10^{-5} \text{ mol H}_3\text{PO}_4$

* it takes less H_3PO_4 to react with NaOH than HCl ~~minimum~~

4. The volume of 0.200 M $\text{Sr}(\text{OH})_2$ needed to neutralize 50.0 mL of 0.200 M HI is

- A. 10.0 mL
 B. 25.0 mL
 C. 50.0 mL
 D. 100.0 mL



$0.200 \frac{\text{mol}}{\text{L}} \text{ HI} \times 0.050 \text{ L} = 0.010 \text{ mol HI}$

$0.010 \text{ mol HI} \times \frac{1 \text{ mol Sr}(\text{OH})_2}{2 \text{ mol HI}} = 0.0050 \text{ mol Sr}(\text{OH})_2$

$0.0050 \text{ mol NaOH} \times \frac{1 \text{ L}}{0.200 \text{ mol}} = 0.025 \text{ L}$

5

A 1.15 g sample of solid oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$) is titrated with 28.0 mL of NaOH solution. How many grams of NaOH reacted?

- A. 0.256 g
 B. 0.456 g
 C. 0.511 g
 (D) 1.02 g



$$1.15 \text{ g H}_2\text{C}_2\text{O}_4 \times \frac{1 \text{ mol}}{90 \text{ g}} = 0.0127 \text{ mol H}_2\text{C}_2\text{O}_4$$

$$0.0127 \text{ mol H}_2\text{C}_2\text{O}_4 \times \frac{2 \text{ mol NaOH}}{1 \text{ mol H}_2\text{C}_2\text{O}_4} = 0.0255 \text{ mol NaOH}$$

$$0.0255 \text{ mol NaOH} \times \frac{40 \text{ g NaOH}}{1 \text{ mol NaOH}}$$

6

A 25.0 mL sample of a diprotic weak acid is titrated with 20.2 mL of 0.10 M NaOH. What is the concentration of the acid?

- (A) 0.040 M
 B. 0.080 M
 C. 0.16 M
 D. 0.12 M



$$0.10 \frac{\text{mol}}{\text{L}} \text{ NaOH} \times 0.0202 \text{ L} = 0.00202 \text{ mol NaOH}$$

$$0.00202 \text{ mol NaOH} \times \frac{1 \text{ mol H}_2\text{A}}{2 \text{ mol NaOH}} = 0.00101 \text{ mol H}_2\text{A}$$

$$[\text{H}_2\text{A}] = \frac{0.00101 \text{ mol}}{0.025 \text{ L}}$$

Part Two: Long Answer - write response in space provided. Remember sig figs & units

(3 marks)

1. In three separate trials, 10.00 mL samples of H_2SO_4 were titrated with 0.40 M NaOH and the results are tabulated below.

Trial	Volume of 0.40 M NaOH
1	18.20 mL
2	16.90 mL
3	17.10 mL

too far away from others
(must be within 0.1 mL)

$$\text{Volume} = \frac{16.90 + 17.10 \text{ mL}}{2} = 17.00 \text{ mL}$$

Calculate the concentration of the H_2SO_4 .



$$0.40 \frac{\text{mol NaOH}}{\text{L}} \times 0.01700 \text{ L} = 0.0068 \text{ mol NaOH}$$

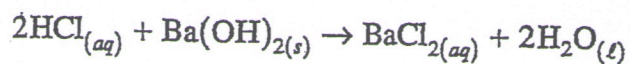
$$0.0068 \text{ mol NaOH} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} = 0.0034 \text{ mol H}_2\text{SO}_4$$

$$[\text{H}_2\text{SO}_4] = \frac{0.0034 \text{ mol}}{0.0100 \text{ L}}$$

$$[\text{H}_2\text{SO}_4] = 0.34 \text{ M}$$

2.

Consider the following reaction:



When 3.16 g samples of $\text{Ba}(\text{OH})_2$ were titrated to the equivalence point with an HCl solution, the following data were recorded:

	Volume of HCl added
Trial 1	37.80 mL
Trial 2	35.49 mL
Trial 3	35.51 mL

$$\begin{aligned} \text{volume HCl} &= \frac{35.49 + 35.51}{2} \\ &= 35.50 \text{ mL} \end{aligned}$$

Using the data above, calculate the original [HCl].

(4 marks)

$$3.16 \text{ g Ba}(\text{OH})_2 \times \frac{1 \text{ mol Ba}(\text{OH})_2}{171.3 \text{ g Ba}(\text{OH})_2} = 0.0184 \dots \text{ mol Ba}(\text{OH})_2$$

$$0.0184 \text{ mol Ba}(\text{OH})_2 \times \frac{2 \text{ mol HCl}}{1 \text{ mol Ba}(\text{OH})_2} = 0.0368 \dots \text{ mol HCl}$$

$$\begin{aligned} [\text{HCl}] &= \frac{0.0368 \dots \text{ mol}}{0.03550 \text{ L}} \\ &= 1.04 \text{ M} \end{aligned}$$