

Name \_\_\_\_\_ Block: \_\_\_\_\_ Date: \_\_\_\_\_

Chemistry 12  
**ACID & BASE TITRATIONS**

KEY

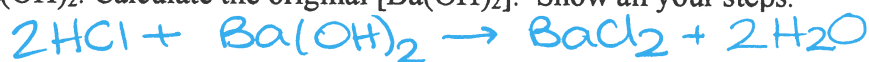
1. 13.45 mL of 0.200 M NaOH is required to titrate 25.0 mL of a solution which is known to have HCl. Calculate the original [HCl]. Show all your steps.  $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

$$\textcircled{1} \text{ mol NaOH} = \left( \frac{0.200 \text{ mol}}{\text{L}} \right) (0.01345 \text{ L}) = 2.69 \times 10^{-3} \text{ mol NaOH}$$

$$\textcircled{2} \text{ mol HCl} = \left( \frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} \right) (2.69 \times 10^{-3} \text{ mol NaOH}) = 2.69 \times 10^{-3} \text{ mol HCl}$$

$$\textcircled{3} [\text{HCl}] = \frac{2.69 \times 10^{-3} \text{ mol}}{0.025 \text{ L}} = \boxed{0.108 \text{ M HCl}}$$

2. 13.45 mL of 0.200 M HCl is required to titrate 25.0 mL of a solution which is known to have  $\text{Ba}(\text{OH})_2$ . Calculate the original  $[\text{Ba}(\text{OH})_2]$ . Show all your steps.



$$\textcircled{1} \text{ mol HCl} = \left( \frac{0.200 \text{ mol}}{\text{L}} \right) (0.01345 \text{ L}) = 2.69 \times 10^{-3} \text{ mol HCl}$$

$$\textcircled{2} \text{ mol Ba}(\text{OH})_2 = \left( \frac{1 \text{ mol Ba}(\text{OH})_2}{2 \text{ mol HCl}} \right) (2.69 \times 10^{-3} \text{ mol HCl}) = 1.345 \times 10^{-3} \text{ mol Ba}(\text{OH})_2$$

$$\textcircled{3} [\text{Ba}(\text{OH})_2] = \frac{(1.345 \times 10^{-3} \text{ mol})}{0.025 \text{ L}} = \boxed{5.38 \times 10^{-2} \text{ M Ba}(\text{OH})_2}$$

3. 13.45 mL of 0.200 M  $\text{Sr}(\text{OH})_2$  is required to titrate 25.0 mL of a solution which is known to have  $\text{HNO}_3$ . Calculate the original  $[\text{HNO}_3]$ . Show all your steps.



$$\textcircled{1} \text{ mol Sr}(\text{OH})_2 = \left( \frac{0.200 \text{ mol}}{\text{L}} \right) (0.01345 \text{ L}) = 2.69 \times 10^{-3} \text{ mol Sr}(\text{OH})_2$$

$$\textcircled{2} \text{ mol HNO}_3 = \left( \frac{2 \text{ mol HNO}_3}{1 \text{ mol Sr}(\text{OH})_2} \right) (2.69 \times 10^{-3} \text{ mol Sr}(\text{OH})_2) = 5.38 \times 10^{-3} \text{ mol HNO}_3$$

$$\textcircled{3} [\text{HNO}_3] = \frac{5.38 \times 10^{-3} \text{ mol}}{0.025 \text{ L}} = \boxed{0.215 \text{ M HNO}_3}$$

4. What volume of 0.100 M NaOH would be required to titrate 35.0 mL of a 0.231 M solution of H<sub>2</sub>C<sub>2</sub>O<sub>4</sub>. Show all your steps.



$$\textcircled{1} \text{ mol H}_2\text{C}_2\text{O}_4 = \left(0.231 \frac{\text{mol}}{\text{L}}\right) (0.035 \text{ L}) = 8.085 \times 10^{-3} \text{ mol H}_2\text{C}_2\text{O}_4$$

$$\textcircled{2} \text{ mol NaOH} = \left(\frac{2 \text{ mol NaOH}}{1 \text{ mol H}_2\text{C}_2\text{O}_4}\right) (8.085 \times 10^{-3} \text{ mol H}_2\text{C}_2\text{O}_4) = 1.617 \times 10^{-2} \text{ mol NaOH}$$

$$\textcircled{3} \text{ L NaOH} = (1.617 \times 10^{-2} \text{ mol}) \left(\frac{\text{L}}{0.100 \text{ mol}}\right) = \boxed{0.162 \text{ L NaOH or } 162 \text{ mL}}$$

5. Consider the following 0.100 M solutions:

I. HF    II. HBr    III. H<sub>2</sub>SO<sub>4</sub>

1:1 ratio w HF & HBr  
1:2 ratio w H<sub>2</sub>SO<sub>4</sub>

The equivalence point is reached when 10.00 mL of 0.100 M NaOH has been added to 10.00 mL of solutions

- A. II only    **B. I and II only**    C. II and III only    D. I, II and III

6. a) Write the *balanced formula equation* for the titration between sulphurous acid and potassium hydroxide.



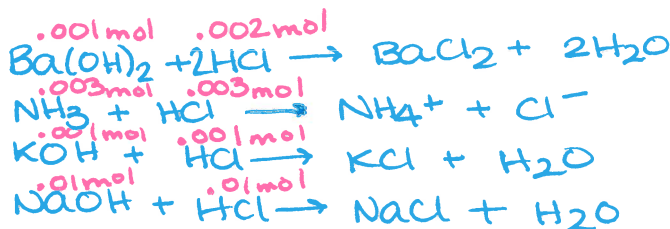
- b) Write the *balanced net-ionic equation* for the titration between sulphurous acid and potassium hydroxide. (1 mark)



7. Given the following data table:

Beaker	Volume	Contents
1	10.0 mL	0.1 M Ba(OH) <sub>2</sub>
2	15.0 mL	0.2 M NH <sub>3</sub>
3	20.0 mL	0.05 M KOH
4	50.0 mL	0.2 M NaOH

$$\text{mol} = \frac{\text{mol}}{\text{L}} \times \text{L}$$



- a) Which beaker would require the greatest volume of 0.1 M HCl for complete neutralization?

#4 (NaOH)

b) What volume of 0.1M HCl would be needed for the neutralization in (a)?



$$\textcircled{1} \text{ mol NaOH} = \left( \frac{0.2 \text{ mol}}{\text{L}} \right) (0.050 \text{ L}) = 0.010 \text{ mol NaOH}$$

$$\textcircled{2} \text{ mol HCl} = \left( \frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} \right) (0.010 \text{ mol NaOH}) = 0.010 \text{ mol HCl}$$

$$\textcircled{3} \text{ L HCl} = (0.010 \text{ mol}) \left( \frac{\text{L}}{0.1 \text{ mol}} \right) = \boxed{0.1 \text{ L HCl} \text{ or } 100 \text{ mL}}$$

c) Which beaker would require the least volume of 0.1M HCl for complete neutralization? #3 KOH

d) What volume of 0.1M HCl would be needed for the neutralization in (c)?



$$\textcircled{1} \text{ mol KOH} = \left( \frac{0.05 \text{ mol}}{\text{L}} \right) (0.020 \text{ L}) = 0.001 \text{ mol KOH}$$

$$\textcircled{2} \text{ mol HCl} = \left( \frac{1 \text{ mol HCl}}{1 \text{ mol KOH}} \right) (0.001 \text{ mol KOH}) = 0.001 \text{ mol HCl}$$

$$\textcircled{3} \text{ L HCl} = (0.001 \text{ mol}) \left( \frac{\text{L}}{0.1 \text{ mol}} \right) = \boxed{0.01 \text{ L HCl} \text{ or } 10 \text{ mL}}$$

8. Calculate the mass of NaOH which is required to neutralize 15.00 mL of 0.350 M H<sub>2</sub>SO<sub>4</sub>.



$$\textcircled{1} \text{ mol H}_2\text{SO}_4 = \left( \frac{0.350 \text{ mol}}{\text{L}} \right) (0.015 \text{ L}) = 5.25 \times 10^{-3} \text{ mol H}_2\text{SO}_4$$

$$\textcircled{2} \text{ mol NaOH} = \left( \frac{2 \text{ mol NaOH}}{1 \text{ mol H}_2\text{SO}_4} \right) (5.25 \times 10^{-3} \text{ mol H}_2\text{SO}_4) = 0.0105 \text{ mol NaOH}$$

$$\textcircled{3} \text{ m}_{\text{NaOH}} = (0.0105 \text{ mol}) \left( \frac{40.0 \text{ g}}{\text{mol}} \right) = \boxed{0.420 \text{ g NaOH}}$$

9. When a 0.1 M strong base titrates a 0.1 M weak monoprotic acid, it takes (less/more/the same)

the same

volume of the base as it would to titrate a 0.1 M strong monoprotic acid.

(ratio is the same!)