

**Worksheet 10.5: Titration**

1. When titrating an acid with a base, how do you see that you have reached the end of the titration?

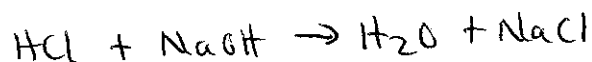
Indicator changes color

2. What indicator is clear in an acid and pink in a base?

phenolphthalein

3. A student pours exactly 26.9 mL of HCl acid of unknown molarity into a beaker. The student then adds 2 drops of the indicator spelled correctly in question #4 above and titrates the acid to neutrality using 43.7 mL of 0.13 M NaOH base.

- a. Write and balance the neutralization reaction of the acid and base.



- b. What is the molarity of the acid?

$$\begin{aligned} M_a &= x & 26.9 \cdot x &= 43.7 \cdot .13 \\ V_a &= 26.9 \text{ ml} & & \\ M_b &= .13 \text{ M} & x &= .21 \text{ M HCl} \\ V_b &= 43.7 \text{ ml} & & \end{aligned}$$

4. A student makes an acid by dissolving 34 grams of  $\text{KHSO}_4$  in 150 mL of water.

- a. Calculate the molarity of the  $\text{KHSO}_4$  acid

$$\begin{aligned} 34 \text{ g KHSO}_4 \cdot \frac{1 \text{ mole}}{136 \text{ g KHSO}_4} &= .25 \text{ moles KHSO}_4 & 150 \text{ ml} \cdot \frac{1 \text{ L}}{1000 \text{ ml}} &= \\ & & .150 \text{ L} & \\ M &= \frac{\text{moles}}{\text{L}} = \frac{.25}{.150 \text{ L}} = 1.67 \text{ M KHSO}_4 \end{aligned}$$

- b. The student then uses 32.6 mL of the  $\text{KHSO}_4$  acid to titrate 12.1 mL of a KOH base of unknown molarity. Calculate the molarity of the KOH base solution

$$\begin{aligned} M_a &= 1.67 & 1.67 \times 32.6 &= x \times 12.1 \\ M_b &= x & & \\ V_a &= 32.6 & 4.50 \text{ M KOH} &= x \\ V_b &= 12.1 & & \end{aligned}$$

5. In a laboratory, you make a base by adding 75 grams of NaOH to 380 mL of water.
- Calculate the molarity of the NaOH base

4.9M NaOH

- Then you titrate 15 mL of your base using a nitric acid ( $\text{HNO}_3$ ) that is 2.2 M. How many mL of the 2.2 M  $\text{HNO}_3$  acid will be required to titrate the 15-mL of base?

33.4ml  $\text{HNO}_3$

6. A student makes a standard acid by dissolving 4 grams of  $\text{KHSO}_4$  in 250 mL of water.
- What is the molarity of the standardized acid?

0.118M  $\text{KHSO}_4$

- The student then uses 45 mL of the standard acid to titrate 20 mL of NaOH. What is the molarity of the base?

0.2655M NaOH

- Using the base from part (b) to titrate 20 mL of an 0.32 M HCl would require how many mL of the base?

24.1ml NaOH