

## 6.6 - Indicators, Neutralizations, and Titrations.notebook

### 6.6 Indicators, Neutralizations and Titrations Assignment

1. What is the approximate pH of a solution that is:

- a. yellow in methyl red, yellow in phenol red, and yellow in alizarin yellow?

6.0-6.8

- b. yellow in methyl red, red in phenol red, and red in alizarin yellow?

① > 6.0

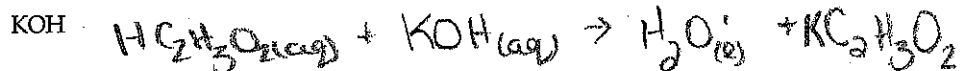
③ > 12

∴ pH ≥ 12.0

② > 8.0

2. Write balanced neutralization reactions for the following:

- a. the reaction between acetic acid,  $\text{HC}_2\text{H}_3\text{O}_2$  and potassium hydroxide,



- b. the reaction between nitric acid,  $\text{HNO}_3$  and calcium hydroxide,  $\text{Ca}(\text{OH})_2$



3. If 25.00 mL of a 0.100 M NaOH solution is required to neutralize 15.00 mL of a solution of HCl, what is the molarity of the acid?

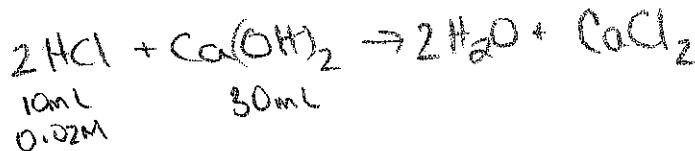


$$M_A V_A = M_B V_B$$

$$M_A (0.025\text{L}) = (0.1\text{M})(0.025\text{L})$$

$$M_A = 0.167\text{M}$$

4. What is the concentration of a calcium hydroxide solution,  $\text{Ca}(\text{OH})_2$ , if 30.00 mL of the base is completely neutralized by 10.0 mL of 0.0200 M HCl?



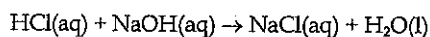
$$1M_A V_A = 2M_B V_B$$

$$(0.02)(0.01) = 2M_B(0.03)$$

$$M_B = 0.00333\text{M}$$

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5. What is the molarity of a 25 mL solution of HCl that is titrated to an end point by 10 mL of a 0.200 M solution of NaOH?



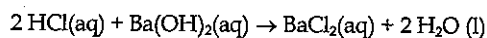
25 mL      10 mL  
             0.2 M

$$M_A V_A = M_B V_B$$

$$M_A (0.025 \text{ L}) = (0.2 \text{ M}) (0.01 \text{ L})$$

$$M_A = 0.080 \text{ M}$$

6. What is the molar concentration of a 50-mL solution of  $\text{Ba(OH)}_2$  that is titrated to an end point by 15 mL of a 0.00300 M solution of HCl?



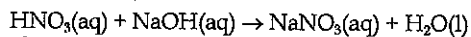
15 mL      50 mL  
0.003

$$M_A V_A = 2 M_B V_B$$

$$(0.003 \text{ M}) (0.015 \text{ L}) = 2 M_B (0.05 \text{ L})$$

$$M_B = 4.5 \times 10^{-4}$$

7. What is the molarity of a 21 mL nitric acid solution that completely neutralizes 25.0 mL of a 0.300 M solution of NaOH?



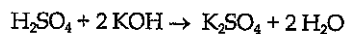
21 mL      25 mL  
             0.30 M

$$M_A V_A = M_B V_B$$

$$M_A (0.021 \text{ L}) = (0.30 \text{ M}) (0.025 \text{ L})$$

$$M_A = 0.36 \text{ M}$$

8. What is the molar concentration of a 45.0 mL solution of KOH that is completely neutralized by 15.0 mL of a 0.500 M  $\text{H}_2\text{SO}_4$  solution?



15 mL      45 mL  
0.5 M

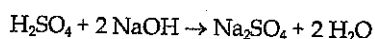
$$2 M_A V_A = M_B V_B$$

$$2 (0.5 \text{ M}) (0.015 \text{ L}) = M_B (0.045 \text{ L})$$

$$M_B = 0.333 \text{ M}$$

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9. A neutral solution is produced when 42.00 mL of a 0.150 M NaOH solution is used to titrate 50.00 mL of a sulfuric acid ( $\text{H}_2\text{SO}_4$ ) solution. What is the concentration of the sulfuric acid solution before titration?

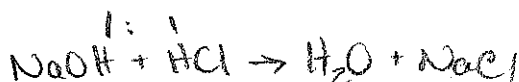


$$0.05\text{L} \quad 0.15\text{M} \\ 0.042\text{L}$$

$$M_A V_A = M_B V_B$$

$$2M_A(0.05\text{L}) = (0.15)(0.042)$$

$$M_A = 6.30 \times 10^{-2} \text{M}$$

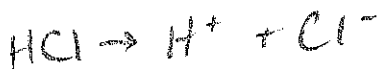


10. 0.080 moles of solid NaOH are added to 0.1L of a 1M HCl solution. Which reactant is in excess? Determine the  $[\text{H}^+]$  and  $[\text{OH}^-]$  at equilibrium.

$$\text{moles acid: } n = MV = (0.1\text{L})(1\text{M}) = 0.1 \text{ moles}$$

$$\therefore \text{acid is in excess } (0.1 > 0.08)$$

$$\text{acid in excess: } 0.1 - 0.08 \text{ moles} = 0.02 \text{ moles}$$



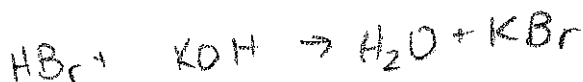
$$[\text{HCl}] = \frac{n}{V} = \frac{0.02 \text{ mol}}{0.1\text{L}} = 0.2 \text{ M} = [\text{H}^+]$$

$$K_w = [\text{H}^+][\text{OH}^-] \\ 1.0 \times 10^{-14} = (0.2\text{M})([\text{OH}^-]) \rightarrow [\text{OH}^-] = 5 \times 10^{-14}$$

11. Calculate the pOH resulting from mixing 75.0mL of 0.200M HBr with 225.0 mL of 0.150M KOH.

$$\text{moles acid: } n = MV = (0.075\text{L})(0.2\text{M}) = 0.015 \text{ mol HBr}$$

$$\text{base: } n = MV = (0.225\text{L})(0.15\text{M}) = 0.03375 \text{ KOH}$$



$$\therefore \text{base is in excess}$$

$$0.03375 - 0.015 = 0.01875 \text{ mol}$$

$$[\text{KOH}] = M = \frac{n}{V} = \frac{0.01875 \text{ mol}}{0.3\text{L}} = 0.0625 \text{ M} = [\text{OH}^-]$$

$$\text{pOH} = -\log[\text{OH}^-] = -\log(0.0625\text{M})$$

$$\boxed{\text{pOH} = 1.20}$$