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. $NaOH + HCl \rightarrow NaCl + H_2O$

① $\text{mol NaOH} = \left(\frac{0.200\text{mol}}{\text{L}}\right)(.01345\text{L}) = 2.69\times10^{-3}\text{mol NaOH}$

② $\text{mol HCl} = \left(\frac{1\text{mol HCl}}{1\text{mol NaOH}}\right)(2.69\times10^{-3}\text{mol NaOH}) = 2.69\times10^{-3}\text{mol HCl}$

③ $[HCl] = \frac{2.69\times10^{-3}\text{mol}}{0.025\text{L}} = 0.108\text{M HCl}$

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

$2HCl + Ba(OH)_2 \rightarrow BaCl_2 + 2H_2O$

① $\text{mol HCl} = \left(\frac{0.200\text{mol}}{\text{L}}\right)(.01345\text{L}) = 2.69\times10^{-3}\text{mol HCl}$

② $\text{mol } Ba(OH)_2 = \left(\frac{1\text{mol } Ba(OH)_2}{2\text{mol HCl}}\right)(2.69\times10^{-3}\text{mol HCl}) = 1.345\times10^{-3}\text{mol } Ba(OH)_2$

③ $[Ba(OH)_2] = \frac{(1.345\times10^{-3}\text{mol})}{0.025\text{L}} = 5.38\times10^{-2}\text{M } Ba(OH)_2$

3. 13.45 mL of 0.200 M $Sr(OH)_2$ is required to titrate 25.0 mL of a solution which is known to have HNO_3. Calculate the original $[HNO_3]$. Show all your steps.

$Sr(OH)_2 + 2HNO_3 \rightarrow Sr(NO_3)_2 + 2H_2O$

① $\text{mol } Sr(OH)_2 = \left(\frac{0.200\text{mol}}{\text{L}}\right)(.01345\text{L}) = 2.69\times10^{-3}\text{mol } Sr(OH)_2$

② $\text{mol } HNO_3 = \left(\frac{2\text{mol } HNO_3}{1\text{mol } Sr(OH)_2}\right)(2.69\times10^{-3}\text{mol } Sr(OH)_2) = 5.38\times10^{-3}\text{mol } HNO_3$

③ $[HNO_3] = \frac{5.38\times10^{-3}\text{mol}}{0.025\text{L}} = 0.215\text{M } HNO_3$

4. What volume of 0.100 M NaOH would be required to titrate 35.0 mL of a 0.231M solution of $H_2C_2O_4$. Show all your steps.

$H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$

① mol $H_2C_2O_4$ = $(0.231 \frac{mol}{L})(.035L) = 8.085 \times 10^{-3}$ mol $H_2C_2O_4$

② mol NaOH = $(\frac{2 \text{ mol NaOH}}{1 \text{ mol } H_2C_2O_4})(8.085 \times 10^{-3} \text{mol } H_2C_2O_4) = 1.617 \times 10^{-2}$ mol NaOH

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

5. Consider the following 0.100 M solutions:

I. HF II. HBr III. H_2SO_4

1:1 ratio w HF & HBr
1:2 ratio w H_2SO_4

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.

$H_2SO_3 + 2KOH \rightarrow K_2SO_3 + 2H_2O$

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

$2H^+_{(aq)} + 2OH^-_{(aq)} \rightarrow 2H_2O_{(l)}$

7. Given the following data table:

mol = mol/L x L

Beaker	*Volume*	*Contents*
1	10.0 mL	0.1 M $Ba(OH)_2$
2	15.0 mL	0.2 M NH_3
3	20.0 mL	0.05 M KOH
4	50.0 mL	0.2 M NaOH

.001mol .002mol
$Ba(OH)_2 + 2HCl \rightarrow BaCl_2 + 2H_2O$
.003mol .003mol
$NH_3 + HCl \rightarrow NH_4^+ + Cl^-$
.001mol .001mol
$KOH + HCl \rightarrow KCl + H_2O$
.01mol .01mol
$NaOH + HCl \rightarrow NaCl + H_2O$

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

#4 (NaOH)

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

$NaOH + HCl \rightarrow NaCl + H_2O$

① mol NaOH = $\left(0.2\frac{mol}{L}\right)(.050L) = 0.010 mol\ NaOH$

② mol HCl = $\left(\frac{1 mol\ HCl}{1 mol\ NaOH}\right)(.010 mol\ NaOH) = .010 mol\ HCl$

③ L HCl = $(0.010 mol)\left(\frac{L}{.1 mol}\right) =$ **0.1 L HCl or 100 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)?

$KOH + HCl \rightarrow KCl + H_2O$

① mol KOH = $\left(0.05\frac{mol}{L}\right)(.020L) = 0.001 mol\ KOH$

② mol HCl = $\left(\frac{1 mol\ HCl}{1 mol\ KOH}\right)(.001 mol\ KOH) = .001 mol\ KOH$

③ L HCl = $(.001 mol)\left(\frac{L}{.1 mol}\right) =$ **0.01 L or 10mL HCl**

8. Calculate the mass of NaOH which is required to neutralize 15.00 mL of 0.350 M H_2SO_4.

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

① mol H_2SO_4 = $\left(0.350\frac{mol}{L}\right)(.015L) = 5.25 \times 10^{-3} mol\ H_2SO_4$

② mol NaOH = $\left(\frac{2 mol\ NaOH}{1 mol\ H_2SO_4}\right)(5.25 \times 10^{-3} mol\ H_2SO_4) = 0.0105 mol\ NaOH$

③ $m_{NaOH} = (0.0105 mol)\left(\frac{40.0\ g}{mol}\right) =$ **0.420g 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!)