Chemistry Name: _____

Section _____ TITRATION WS Date: _____

Solve the following titration problems showing all equations, substitutions, cancellations, and work.

1 A 25.00 mL sample of NaOH was titrated with 27.54 mL of 0.3500 M standard $HCl_{(aq)}$. Find the concentration of the NaOH.

$V_B = 25.00$ mL
$V_A = 27.54$ mL
$M_A = 0.3500$ M
$M_B = ?$

$M_A V_A = M_B V_B$
$M_B = M_A V_A / V_B$
$= (0.3500 \text{ M})(27.54 \text{ mL}) / 25.00 \text{ mL}$
$= 0.3856$ M NaOH

2 What volume of 0.1025 M NaOH is required to completely neutralize 37.25 mL of 0.1240 M HCl?

$V_B = ?$
$M_B = 0.1025$ M
$V_A = 37.25$ mL
$M_A = 0.1240$ M

$M_A V_A = M_B V_B$
$V_B = M_A V_A / M_B$
$= (0.1240 \text{ M})(37.25 \text{ mL}) / 0.1025 \text{ M}$
$= 45.06$ mL NaOH

3 27.19 mL of 2.51 M NaOH was required to neutralize 15.54 mL of $HCl_{(aq)}$. Find the HCl concentration.

$V_B = 27.19$ mL
$M_B = 2.51$ M
$V_A = 15.54$ mL
$M_A = ?$

$M_A V_A = M_B V_B$
$M_A = M_B V_B / V_A$
$= (2.51 \text{ M})(27.19 \text{ mL}) / 15.54 \text{ mL}$
$= 4.39$ M HCl

4 A student delivered 25.00 mL of HCl using a pipet to a beaker. The acid was titrated to the endpoint with 19.75 mL of a 0.1000 M standard NaOH solution. What is the concentration of the HCl?

$V_A = 25.00$ mL
$V_B = 19.75$ mL
$M_B = 0.1000$ M
$M_A = ?$

$M_A V_A = M_B V_B$
$M_A = M_B V_B / V_A$
$= (0.1000 \text{ M})(19.75 \text{ mL}) / 25.00 \text{ mL}$
$= 0.07900$ M HCl

5 A bottle labeled HNO_3 concentration unknown was found in a chemistry stockroom. A 35.00 mL sample of the HNO_3 required 47.25 mL of 0.2000 M NaOH to reach the endpoint. What is the HNO_3 concentration?

$V_A = 35.00$ mL
$V_B = 47.25$ mL
$M_B = 0.2000$ M
$M_A = ?$

$M_A V_A = M_B V_B$
$M_A = M_B V_B / V_A$
$= (0.2000 \text{ M})(47.25 \text{ mL}) / 35.00 \text{ mL}$
$= 0.2700$ M HCl

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Created 21 March 2019

6 What volume of 0.25 M NaOH should be required to neutralize 45 mL of 0.15 M $HC_2H_3O_2$? What indicator should be used?

V_B = ?
M_B = 0.25 M
V_A = 45 mL
M_A = 0.15 M

$M_A V_A = M_B V_B$
$V_B = M_A V_A / M_B$
$= (0.15 M)(45 mL) / 0.25 M$
$= 27 mL NaOH$

strong base, weak acid → phenolphthalein

7 A 35.00 mL sample of 0.1000 M NaOH was titrated with 43.15 mL of an HCl solution. What is the concentration of the hydrochloric acid?

V_B = 35.00 mL
M_B = 0.1000 M
V_A = 43.15 mL
M_A = ?

$M_A V_A = M_B V_B$
$M_A = M_B V_B / V_A$
$= (0.1000 M)(35.00 mL) / 43.15 mL$
$= 0.08111 M HCl$

8 A bottle marked NaOH solution was found in a student drawer. A 20.00 mL sample required 22.54 mL of 0.1000 M standard $HCl_{(aq)}$ to reach the titration endpoint. Find the concentration of the NaOH.

V_B = 20.00 mL
V_A = 22.54 mL
M_A = 0.1000 M
M_B = ?

$M_A V_A = M_B V_B$
$M_B = M_A V_A / V_B$
$= (0.1000 M)(22.54 mL) / 20.00 mL$
$= 0.1127 M HCl$

9 A student wants to neutralize 250.0 mL of 2.50 M HCl before disposing of the sample down the sink. What volume of 6.0 M NaOH will be required to neutralize the acid?

V_B = ?
M_B = 6.0 M
V_A = 250.0 mL
M_A = 2.50 M

$M_A V_A = M_B V_B$
$V_B = M_A V_A / M_B$
$= (2.50 M)(250.0 mL) / 6.0 M$
$= 104 mL NaOH$

10 0.2500 g of primary standard KHP (a one proton acid with a gfm = 204.22 g/mol) was titrated to the equivalence point with 35.23 mL of NaOH solution. What is the concentration of the NaOH?

m_A = 0.2500 g
V_B = 0.03523 L
gfm_A = 204.22 g/mol
M_B = ?

$M_A V_A = M_B V_B = n_A = m_A \div gfm_A$
$M_B = (m_A \div gfm_A) \div V_B$
$= (0.2500 g \div 204.22 g/mol) \div 0.03523 L$
$= 0.03475 M NaOH$

$M_A V_A = moles_A = n_A$