Name: _____

Period: ____ Subject: AP Chem

Date: _____

Stoich: Acid/Base Reactions

Please make sure that you ***show all work!*** (italics, bold and underlined – get it?) Some problems include points for intermediate steps as well as the final answer. If the intermediate step isn't shown, the points aren't given! Be sure to write your name and period above.

1. What volume of 0.200 M HNO_3 solution is required to neutralize 30.0 mL of 0.350 M NaOH?

$M_A V_A = M_B V_B$

$0.200\ M \cdot V_A = 0.350\ M \cdot 30.0\ mL$

$V_A = (0.350\ M \cdot 30.0\ mL)/0.200\ M =$ **52.5 mL**

2. 35.0 mL of 0.300 M HCl and 48.0 mL of 0.460 M KOH are mixed together. Calculate the amount of water produced and the concentration of excess H^+ or OH^- remaining after the reaction is complete.

$0.035\ L\ HCl \cdot 0.300\ M\ HCl = 0.0105\ mol\ HCl$ (limiting)
$0.048\ L\ KOH \cdot 0.460\ M\ KOH = 0.02208\ mol\ KOH$ (excess)

$35.0\ mL + 48.0\ mL = 83.0\ mL = 0.0830\ L$ (total solution volume after mixing)

excess $OH^- = 0.02208 - 0.0105 = 0.01158\ mol\ OH^-$
$[OH^-] = 0.01158\ mol\ OH^- / 0.0830\ L = 0.13951807\ M =$ **[excess OH^-] = 0.140 M**

$HCl + KOH \Rightarrow KCl + H_2O$ (Balanced equation)

$0.0105\ mol\ HCl \cdot \frac{1\ mol\ H_2O}{1\ mol\ HCl} =$ **0.0105 mol H_2O**

3. 3.62 g of solid HCl is dissolved in water to make 400.0 mL of solution. It takes 120.0 mL of sodium hydroxide solution to neutralize the acidic solution. What is the concentration of the sodium hydroxide solution?

$$3.62 \text{ g HCl} \cdot \frac{1 \text{ mol HCl}}{36.4609 \text{ g HCl}} = 0.099284439 \text{ mol HCl}$$

$$M_{NaOH} \cdot 120.0 \text{ mL} = 0.099284439 \text{ mol NaOH}$$

$$M_{NaOH} = \frac{0.099284439 \text{ mol NaOH}}{0.1200 \text{ L NaOH}} = 0.82737032 \text{ M NaOH} =$$

0.827 M NaOH

4. Write the molecular, ionic, and net ionic equations for the following acid-base reactions:

a) $HClO_4$ (*aq*) + $Al(OH)_3$ (*s*) =>

b) $Ca(OH)_2$ (*aq*) + HNO_3 (*aq*) =>

c) $HC_2H_3O_2$ (*aq*) + NaOH (*aq*) =>

a) $3HClO_4$ (*aq*) + $Al(OH)_3$ (*aq*) => $Al(ClO_4)_3$ (*aq*) + $3H_2O$ (*l*)
$3H^+$ (*aq*) + $3ClO_4^-$ (*aq*) + $Al(OH)_3$ (*s*) => Al^{3+} (*aq*) + $3ClO_4^-$ (*aq*) + $3H_2O$ (*l*)
$3H^+$ (*aq*) + $Al(OH)_3$ (*s*) => Al^{3+} (*aq*) + $3H_2O$ (*l*)

b) $Ca(OH)_2$ (*aq*) + $2HNO_3$ (*aq*) => $Ca(NO_3)_2$ (*aq*) + $2H_2O$ (*l*)
Ca^{2+} (*aq*) + $2OH^-$ (*aq*) + $2H^+$ (*aq*) + $2NO_3^-$ (*aq*) => Ca^{2+} (*aq*) + $2NO_3^-$ (*aq*) + $2H_2O$ (*l*)
H^+ (*aq*) + OH^- (*aq*) => H_2O (*l*)

c) $HC_2H_3O_2$ (*aq*) + NaOH (*aq*) => $NaC_2H_3O_2$ (*aq*) + H_2O (*l*)
H^+ (*aq*) + $C_2H_3O_2^-$ (*aq*) + Na^+ (*aq*) + OH^- (*aq*) => Na^+ (*aq*) + $C_2H_3O_2^-$ (*aq*) + H_2O (*l*)
H^+ (*aq*) + OH^- (*aq*) => H_2O (*l*)

5. An aqueous solution of sodium bicarbonate (baking soda) is mixed with hydrochloric acid to produce carbon dioxide bubbles, water, and sodium chloride. Write the molecular, ionic, and net ionic equations for this reaction.

$NaHCO_3$ (*aq*) + HCl (*aq*) => CO_2 (*g*) + H_2O (*l*) + NaCl (*aq*)
Na^+ (*aq*) + HCO_3^- (*aq*) + H^+ (*aq*) + Cl^- (*aq*) => CO_2 (*g*) + H_2O (*l*) + Na^+ (*aq*) + Cl^- (*aq*)
HCO_3^- (*aq*) + H^+ (*aq*) => CO_2 (*g*) + H_2O (*l*)

What volume of 1.5 M baking soda solution would be required to neutralize 150.0 mL of a 0.50 M solution of hydrochloric acid?

$M_AV_A = M_BV_B$

$1.5\ M \cdot V_A = 0.50\ M \cdot 150\ mL$

$V_A =$ 50 mL of 1.5 M baking soda