g) Advanced pH and pOH Calculations

i) Example: 50.0ml of 0.200 M NaOH is reacted with 30.0ml of 0.250 M HCl. What is the pH of the resulting solution?

① $NaOH + HCl \rightarrow NaCl + H_2O$

moles of acid or base in *excess* will determine the pH

② moles NaOH present = 0.200M x 0.0500L = 0.0100 moles
moles HCl present = 0.250M x 0.0300L = 0.00750 moles

③ NaOH is in excess by: 0.0100 – 0.00750 = 0.00250 moles

④ $[NaOH] = [OH^-]$ = 0.00250 moles / (0.0300L + 0.0500L) = 0.0312 M

⑤ pOH = -log[0.0312M] = 1.506

⑥ pH = 14 – pOH = 14 - 1.506 = **12.494**

ii) Example: Calculate the pH if 1.25 L of 0.300 M KOH is added to 0.500 L of 0.0900 M H_2SO_4.

① $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

moles of acid or base in *excess* will determine the pH

② moles $[OH^-]$ present = 0.300M x 1.25L = 0.375 moles
moles $[H_3O^+]$ present = 0.0900M x 0.500L x **2** = 0.0900 moles

↑
cause each H_2SO_4
produces two H_3O^+ 's

③ $[OH^-]$ is in excess by: 0.375 – 0.0900 = 0.285 moles

④ $[OH^-]$ = 0.285 moles / (1.25L + 0.500L) = 0.163 M

⑤ pOH = -log[0.163M] = 0.788

⑥ pH = 14 – 0.788 = **13.212**

iii) Example: Calculate the pOH if 0.0300 L of 0.400 M $Ca(OH)_2$ is added to 0.250 L of 0.125 M HBr.

① $2HBr + Ca(OH)_2 \rightarrow CaBr_2 + 2H_2O$

moles of acid or base in *excess* will determine the pH

② moles $[OH^-]$ present = 0.400M x 0.0300L x 2 = 0.0240 moles
moles $[H_3O^+]$ present = 0.125M x 0.250L = 0.0312 moles

③ $[H_3O^+]$ is in excess by: 0.0312 – 0.0240 = 0.00720 moles

④ $[H_3O^+]$ = 0.00720 moles / (0.250L + 0.0300L) = 0.0257 M

⑤ pH = -log[0.0257M] = 1.590

⑥ pOH = 14 – 1.590 = **12.410**

iv) Example: How many grams of NaOH must be added to 0.800 L of 0.0400 M HBr to change the pH to 7.00? *(Assume no volume change from adding NaOH)*

① $NaOH + HBr \rightarrow NaBr + H_2O$

② want $[H_3O^+] = 10^{-7}$ = 0.0000001 M

③ current $[H_3O^+]$ = 0.0400 M

④ change in $[H_3O^+]$ = 0.0400 – 0.0000001 = 0.0399 M

⑤ $[H_3O^+] = [OH^-]$ = 0.0399 M

⑥ 0.0399 M x 0.800 L = 0.0320 moles NaOH

⑦ 0.0320 moles x 40 g/mol = **1.28 g NaOH**

Do Questions: # 58-68 page 143-144