pH titration practice:

1) 0.30 M KOH w/ 60mL of a 0.25M HNO_3

a) 0 mL KOH added

- all you have is the 60mL of 0.25M HNO_3
- HNO_3 is a strong acid

∴ pH = -log [.25] = **.60**

b) 17 ml KOH added

- find # moles acid

$M = \frac{mol}{L}$ $\quad .25M = \frac{x\ mol}{.060L}$ $\quad x = .015$ moles HNO_3

- find # moles base

$M = \frac{mol}{L}$ $\quad .30M = \frac{x\ mol}{.017L}$ $\quad x = .0051$ moles KOH

- find $[H_3O^+] = \frac{\text{moles acid}}{\text{total vol, L}}$

$[H_3O^+] = \frac{.015 \text{ moles } HNO_3 - .0051 \text{ moles KOH}}{.017L + .060L}$

$[H_3O^+] = .129$

∴ pH = -log [.129] = **.89**

"notice that you have to subtract the # moles of Base from the # moles of acid because the Base will neutralize the acid!

1)

c) 45 mL KOH added

- # moles acid = .015 moles HNO_3

- # moles Base

$$M = \frac{mol}{L} = .30\,M = \frac{X\,mol}{.045\,L} \qquad X = .0135$$

$$[H_3O^+] = \frac{.015 \text{ moles } HNO_3 - .0135 \text{ moles } KOH}{.045\,L + .060\,L}$$

$[H_3O^+] = .0143$

$\therefore$ pH = $-\log[.0143]$ = **1.85**

D) 50 mL KOH added

- # moles acid = .015 moles HNO_3

- # moles Base

$$M = \frac{mol}{L} \qquad .30\,M = \frac{X \text{ moles}}{.050\,L} \qquad X = .015 \text{ moles KOH}$$

- notice that # moles Base = # moles acid
- must be equivalence pt!

pH = 7

1) E) 62 mL KOH added

we have gone past the equivalence point & now we will have an excess of OH^-

∴ we are now solving for $[OH^-]$

- # moles acid = .015 moles HNO_3

- # moles Base

$$M = \frac{mol}{L} \qquad .30\,M = \frac{x \text{ moles}}{.062\,L} \qquad x = .0186 \text{ mols KOH}$$

$$[OH^-] = \frac{.0186 \text{ moles KOH} - .015 \text{ moles } HNO_3}{.062\,L + .06\,L}$$

$$[OH^-] = .0295$$

$$k_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$$

$$[H_3O^+] = \frac{1 \times 10^{-14}}{[OH^-]} = \frac{1 \times 10^{-14}}{.0295} = 3.39 \times 10^{-13}$$

∴ $pH = -\log 3.39 \times 10^{-13} = \boxed{12.47}$

1) F) 100mL KOH added

- # moles acid = .015 moles HNO_3
- # moles Base

$M = \frac{mol}{L}$ $\quad .30M = \frac{x\ mol}{.100L}$ $\quad x = .03$ moles KOH

$[OH^-] = \frac{.03 \text{ moles KOH} - .015 \text{ moles } HNO_3}{.100L + .060L}$

$[OH^-] = .09375$

$[H_3O^+] = \frac{K_w}{[OH^-]} = \frac{1 \times 10^{-14}}{.09375} = 1.067 \times 10^{-13}$

$\therefore$ pH = $-\log 1.067 \times 10^{-13}$ = **12.97**

2) .04M HCl titrated w/ 50 mL of a .05 M NaOH

a) 0 mL HCl added

- all you have is Base, a strong Base

∴ $k_w = [H_3O^+][OH^-]$

$[H_3O^+] = \frac{k_w}{[OH^-]} = \frac{1 \times 10^{-14}}{.05} = 2 \times 10^{-13}$

$pH = -\log 2 \times 10^{-13} = \boxed{12.70}$

b) 20 mL HCl added

① # moles Base

$M = \frac{mol}{L}$ $\quad .05M = \frac{x \text{ moles}}{.050L}$ $\quad X = .0025$ moles NaOH

② # moles acid

$M = \frac{mol}{L}$ $\quad .04M = \frac{x \text{ moles}}{.020L}$ $\quad X = .0008$ moles HCl

note that you have more moles of Base

∴ you are solving for $[OH^-]$

$[OH^-] = \frac{.0025 \text{ moles NaOH} - .0008 \text{ moles HCl}}{.020L + .050L}$

total volume, L →

$[OH^-] = .0243$

$K_w = [OH^-][H_3O^+]$

$[H_3O^+] = \frac{k_w}{[OH^-]} = \frac{1 \times 10^{-14}}{.0243} = 4.12 \times 10^{-13}$

∴ $pH = -\log 4.12 \times 10^{-13} = \boxed{12.39}$

c) 40 mL HCl added

- # moles Base = .0025 moles NaOH
- # moles acid

$M = \frac{mol}{L}$ $\quad .04\,M = \frac{X \text{ moles}}{.040\,L}$ $\quad X = .0016$ moles HCl

$$[OH^-] = \frac{.0025 \text{ moles NaOH} - .0016 \text{ moles HCl}}{.040\,L + .050\,L}$$

$[OH^-] = .01$

$$[H_3O^+] = \frac{K_w}{[OH^-]} = \frac{1\times10^{-14}}{.01} = 1\times10^{-12}$$

$$pH = -\log 1\times10^{-12} = \boxed{12.00}$$

D) 62.5 mL HCl added

- # moles Base = .0025 moles NaOH
- # moles acid

$M = \frac{mol}{L}$ $\quad .04\,M = \frac{X \text{ moles}}{.0625\,L}$ $\quad X = .0025$ moles HCl

Notice that # moles Acid = # moles Base
- must be equivalence pt

$\boxed{pH = 7.00}$

E) 80 mL HCl added

- # moles Base = .0025 moles NaOH
- # moles acid

$M = \frac{mol}{L}$ $.04M = \frac{x \text{ moles}}{.080L}$ $x = .0032$ moles HCl

Note that we now have more moles of acid ∴ we are now solving for $[H_3O^+]$

$$[H_3O^+] = \frac{.0032 \text{ moles HCl} - .0025 \text{ moles NaOH}}{.080L + .050L}$$

$[H_3O^+] = .00538$

pH = -log .00538 = **2.27**

F) 90 mL HCl added

- # moles Base = .0025 moles NaOH
- # moles acid

$M = \frac{mol}{L}$ $.04M = \frac{x \text{ mol}}{.090L}$ $x = .0036$ moles HCl

$$[H_3O^+] = \frac{.0036 \text{ moles HCl} - .0025 \text{ moles NaOH}}{.090L + .050L}$$

$[H_3O^+] = .00786$

pH = -log .00786 = **2.10**