ACID-BASE REACTIONS

Proton (H^+) Donor — Proton Acceptor — according to defn.

$HCl_{(g)} + NaOH_{(aq)} \rightarrow ?$

$H^+_{(aq)} + Cl^-_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)}$

HOH or ~~NaCl~~

$H_2O_{(l)}$

$HCl_{(g)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$ Molecular Eq.

$H^+_{(aq)} + Cl^-_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + Na^+_{(aq)} + Cl^-_{(aq)}$ Ionic Eq

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

Net & Strong Electrolytes

Strong base: $NaOH_{(aq)}$ 1.0 M → 1 mol NaOH → 1 mol Na^+ + 1.0 mol OH^-

Weak acid: CH_3COOH 1.0 M (1 L) → 1 mol CH_3COOH (10% dissociation) → 0.1 mol H^+ + 0.1 mol CH_3COO^-

Instead of 0.1 mol H_2O, 1.0 mol of H_2O will be produced!!

OH^- is such a strong base, that it will rip off the un-dissociated CH_3COOH.

∴ The CH_3OOH will still act as like a strong acid in presence of strong base

STRONG BASE FORCES A WEAK ACID INTO COMPLETE DISSOCIATION!!

ex. What volume of 0.100 M HCl sol'n is needed to neutralize 25.0 mL of 0.350 M NaOH sol'n?

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

$$\frac{0.350 \text{ mol NaOH}}{L} \times \frac{1 \text{ mol } OH^-}{1 \text{ mol NaOH}} \times 0.025 \text{ L} \times \frac{1 \text{ mol } H^+}{1 \text{ mol } OH^-} \times \frac{1 \text{ mol HCl}}{1 \text{ mol } H^+}$$

(or skip these)

$$\text{mol } OH^- \times \frac{1.0 \text{ L}}{0.10 \text{ mol HCl}}$$

$$= 8.75 \times 10^{-2} \text{ L}$$

MONOPROTIC ACID: $HCl + NaOH \rightarrow H_2O_{(l)} + NaCl$

DIPROTIC ACID: $H_2SO_4 + 2\,NaOH \rightarrow 2\,H_2O + Na_2SO_4$

TRIPROTIC ACID: $H_3PO_4 + 3\,NaOH \rightarrow 3\,H_2O + Na_3PO_4$

↑ # of acidic hydrogens

TITRATION

- Titrant (conc. accurately known)
- sol'n (unknown conc.)
- equivalence point (can be determined with dye)

A KOH sol'n is standardized by titrating against sulfamic acid, HSO_3NH_2. If 34.20 mL of the base are needed to neutralize 0.395 g of the acid, find the molarity of KOH.

$$HSO_3NH_{2(aq)} + KOH \longrightarrow H_2O_{(l)} + KSO_3NH$$

↑ 1 acetic hydrogen

$$0.395\ \text{g}\ HSO_3NH_2 \times \frac{1\ \text{mol}}{97.0\ \text{g}} \times \frac{1\ \text{mol KOH}}{1\ \text{mol}\ HSO_3NH_2} = 4.07 \times 10^{-3}\ \text{mol KOH}$$

$$[KOH] = \frac{4.07 \times 10^{-3}\ \text{mol}}{0.0342\ \text{L}} = 0.119\ \text{M KOH}$$ (well known = standard sol'n)

Titration: catch 1st transition from colorless to pink

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ex. Titration of 6.50-g sample of a diprotic acid requires 137.5mL of a 0.750 M NaOH sol'n for complete neutralization. Determine the molar mass of the acid.

$$H_2X + 2\,NaOH \rightarrow 2\,H_2O_{(l)} + Na_2X$$

H_2X: Diprotic Acid

$$\frac{0.750\ mol\ NaOH}{L} \times 0.1375\,L \times \frac{1\ mol\ H_2X}{2\ mol\ NaOH} = 5.156 \times 10^{-2}\ mol\ H_2X$$

$$M.M = \frac{6.50\ g}{5.156 \times 10^{-2}\ mol} = 126\ g/mol$$

ex. A sol'n is prepared by dissolving 15.0 g of NaOH in 150.0 mL of 0.25 M nitric acid.

Will the final sol'n be acidic, basic or neutral?

To try at home if you want

Calculate the conc. of all of the ions present in the sol'n after the rxn has occured.

$$15.0\ g\ NaOH \times \frac{1\ mol\ NaOH}{40.0\ g} = 0.38\ mol\ NaOH$$ — In excess

Basic

$$0.150\ L \times \frac{0.25\ mol\ HNO_3}{L} = 0.038\ mol\ HNO_3$$