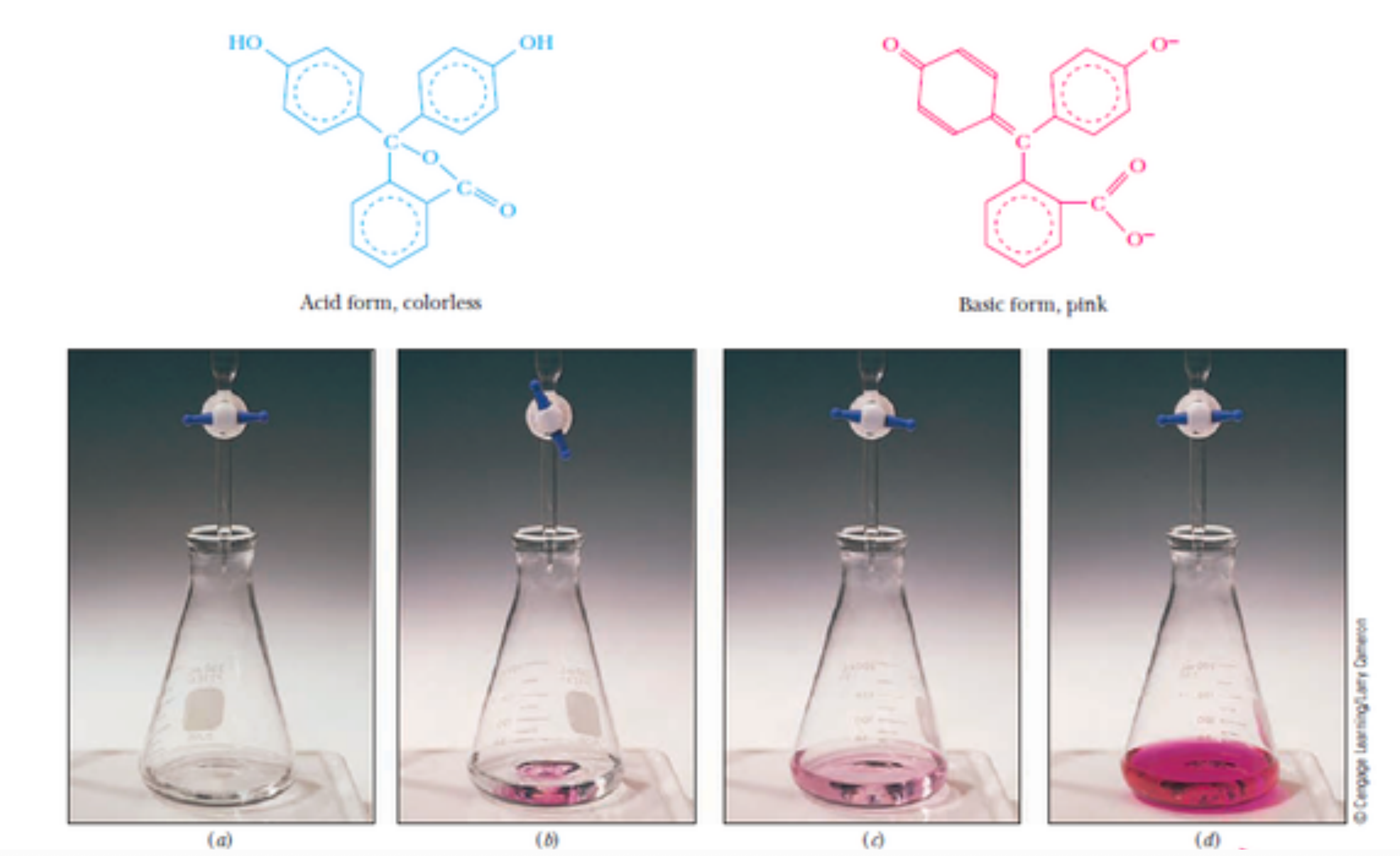
Acid/Base Titration



https://www.quora.com/Why-do-we-use-phenolphthalein-as-an-indicator-in-acid-base-titration

Titration :

The titration of a 10.00 mL sample of an HCl solution of unknown conc. requires 12.54 mL of a 0.100 M NaOH solution to reach the equivalence point. What is the conc. of the HCl solution?

Equivalence point: moles (HCl) = moles NaOH

1. # moles (NaOH)

$$12.54\ mL\ NaOH \cdot \frac{1\ L}{1000\ mL} \cdot 0.100\ \frac{mol}{L} = 1.25 \cdot 10^{-3}\ mol\ (NaOH)$$

2. moles (HCl)

$$\#\ moles\ (HCl) = 1.25 \cdot 10^{-3}\ mol\ (NaOH) \cdot \frac{1\ mol\ HCl}{1\ mol\ NaOH}$$

$$HCl\ (aq) + NaOH\ (aq) \rightarrow H_2O\ (l) + NaCl\ (aq)$$

3. Molarity

$$M\ (HCl) = \frac{1.25 \cdot 10^{-3}\ mol}{0.01} = 0.125\ M$$

The titration of 20.0 mL of H_2SO_4 solution of unknown concentration requires 22.87 mL of a 0.158 M KOH solution. What is the conc. of the H_2SO_4 solution?

$H_2SO_4(aq) + 2KOH(aq) \rightarrow 2H_2O(l) + K_2SO_4(aq)$

$$\# \text{ moles } (KOH) = 22.87\,mL \cdot \frac{1L}{1000\,mL} \cdot 0.158\,M$$
$$= 3.61 \cdot 10^{-3}\,mol$$

$$\# \text{ moles } (H_2SO_4) = 3.61 \cdot 10^{-3}\,mol\,(KOH) \cdot \frac{1\,mol\,(H_2SO_4)}{2\,mol\,(KOH)}$$
$$= 1.81 \cdot 10^{-3}\,mol$$

$$M(H_2SO_4) = \frac{1.81 \cdot 10^{-3}\,mol}{0.02\,L} = 0.0903\,M$$
$$= 90.3\,mM$$

$2HCl(aq) + Ba(OH)_2 \rightarrow 2H_2O(l) + BaCl_2(aq)$

$H_2SO_4(aq) + Ba(OH)_2 \rightarrow 2H_2O(l) + BaSO_4(s)$

Gas Evolution Reaction

Sulfides:

$$2HCl(aq) + K_2S(aq) \rightarrow \underline{H_2S(g)} + KCl(aq)$$

Carbonates

$$2HCl(aq) + K_2CO_3(aq) \rightarrow H_2CO_3(aq) + 2KCl(aq)$$

$$\rightarrow H_2O(l) + CO_2(g) + 2KCl(aq)$$

Sulfites:

$$2HCl(aq) + K_2SO_3(aq) \rightarrow H_2SO_3(aq) + 2KCl(aq)$$

$$\rightarrow H_2O(l) + SO_2(g) + 2KCl(aq)$$

Ammonium

$$NH_4Cl(aq) + KOH(aq) \rightarrow NH_3(g) + H_2O(l) + KCl(aq)$$

$$NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$$

Transfer of electrons from one reactant to another is an oxidation-reduction reaction → short: <u>redox reactions</u>

Oxidation (historically)

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$$

$$4Fe(s) + 3O_2(g) \longrightarrow 2Fe_2O_3(s)$$

Reduction (historically)

$$Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$$

Oxidation Number

Elemental Form	zero (0). Only one kind of atom present, no charge.
Atomic Ions	= the charge on the atom (monoatomic ion)
Group 1A Li, Na, K, Rb, Cs	+1 unless elemental form
Group 2A Be, Mg, Ca, Sr, Ba	+2 unless elemental form
Hydrogen (H)	+1 when bonded to a non-metal, -1 when bonded to a metal (rare)
Oxygen (O)	-1 in peroxides O_2^- -2 in all other compounds (most common)
Fluorine (F)	-1, always
Neutral Compounds	The sum of all oxidation numbers of atoms or ions in a neutral compound is zero
Ionic Compounds	The sum of all oxidation numbers of atoms in an ionic compound is the charge on the polyatomic ion.

$\overset{0}{O_2}$

$\overset{+1}{Na}\overset{-1}{Cl}$

$\overset{+1}{Na}\overset{+3}{Cl}\overset{-2}{O_2}$

$$ox\text{-}\#(Cl) = +1(Na) + \overbrace{(2\cdot(-2))}^{O_2} = +3$$

Oxidation Number

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$\overset{+3}{Fe}_2\overset{-2}{O}_3$

$\overset{+1}{H}\overset{-1}{F}$

$\overset{+1}{H}_2\overset{-1}{O}_2$

$\overset{+5}{P}\overset{-2}{O}_4^{3-}$

$\overset{+3}{N}\overset{-2}{O}_2^{-}$

$\overset{+2}{Mg}(\overset{-2}{O}\overset{+1}{H})_2$

NH_4NO_3 → $\overset{-3}{N}\overset{+1}{H}_4^{+}$, $\overset{+5}{N}\overset{-2}{O}_3^{-}$

$(NH_4)_3AsO_4$ → $\overset{-3}{N}\overset{+1}{H}_4^{+}$, $\overset{+5}{As}\overset{-2}{O}_4^{3-}$