Solution Stoichiometry

Starting with 100.0 mL of 1.21 M H_2SO_4, calculate the volume (mL) of 2.05 M KOH required to react with it completely.

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

Step 1- Balance the equation

Step 2- Calculate moles

$1.21\,M \cdot 0.1\,L = 0.121\,mol\ H_2SO_4$

Step 3- Calculate moles of KOH

$$0.121\,mol\ K_2SO_4 \cdot \frac{2\ KOH}{1\ K_2SO_4} = 0.242\,mol\ KOH$$

Step 4- Volume of KOH required

$$0.242\,mol \cdot \frac{1}{2.05\,M} = 0.118\,L = 118\,mL$$

Solution Stoichiometry

A 5.0 mL volume of 0.2 M $Al_2(SO_4)_3$ was combined with 10.0 mL of 0.2 M $Pb(NO_3)_2$.

$Al_2(SO_4)_3\ (aq) + 3\ Pb(NO_3)_2\ (aq) \rightarrow 3\ PbSO_4\ (s) + 2\ Al(NO_3)_3\ (aq)$

Calculate the mass (g) of $PbSO_4$ (s) (303.3 g/mol) that can be produced.

Step 1- Balance equation

Step 2- Calculate moles

$0.2\ M \cdot 0.005\ mL = 0.001\ mol\ Al_2(SO_4)_3$

$0.2\ M \cdot 0.01\ mL = 0.002\ mol\ Pb(NO_3)_2$

Step 3- Find the limiting reactant

$$0.002\ mol\ Pb(NO_3)_2 \cdot \frac{1\ Al_2(SO_4)_3}{3\ Pb(NO_3)_2} = 0.0007\ mol\ Al_2(SO_4)_3$$

Step 4- Mass of $PbSO_4$ produced

$$0.002\ mol\ Pb(NO_3)_2 \cdot \frac{3\ PbSO_4}{3\ Pb(NO_3)_2} \frac{303.3\ g}{1\ mol} = 0.61\ g\ PbSO_4$$

Aqueous Solutions of Ionic and Molecular Compounds

Ionic compounds

$NaCl(s) \xrightarrow{H_2O(l)} NaCl(aq)$

$NaCl(aq) \rightarrow Na^+(aq) + Cl^-(aq)$

Water-soluble ionic compound dissociates (ionizes) in an aqueous solution

$Al_2(SO_4)_3 \rightarrow 2Al^{3+}_{(aq)} + 3SO_4^{2-}(aq)$

Conduct electricity

Molecular compounds

$C_{12}H_{22}O_{11}(s) \xrightarrow{H_2O(l)} C_{12}H_{22}O_{11}(aq)$

Water-soluble molecular compounds do not dissociate in an aqueous solution

Exception: acids

$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

$HNO_3(aq) \rightarrow H^+(aq) + NO_3^-(aq)$

$H_2SO_4(aq) \rightarrow H^+(aq) + HSO_4^-(aq)$

$HClO_4(aq) \rightarrow H^+(aq) + ClO_4^-(aq)$

Aqueous Solutions

Electrolytes	Example
Strong electrolytes- Conduct electricity Solutes that are completely ionized in water	Soluble ionic compounds $NaCl(aq)$, $Al_2(SO_4)_3(aq)$, $HCl(aq)$, $HNO_3(aq)$, $H_2SO_4(aq)$, $HClO_4(aq)$
Weak Electrolytes- Weak conductivity Solutes that ionize to a very limited extent	$HC_2H_3O_2(aq)$ 1% extent ionization Molecular compounds (some)
Nonelectrolytes- Do not ionize when dissolved in water	$C_{12}H_{22}O_{11}(aq)$, $C_2H_5OH(aq)$, $CH_3OH(aq)$, H_2O Molecular compounds