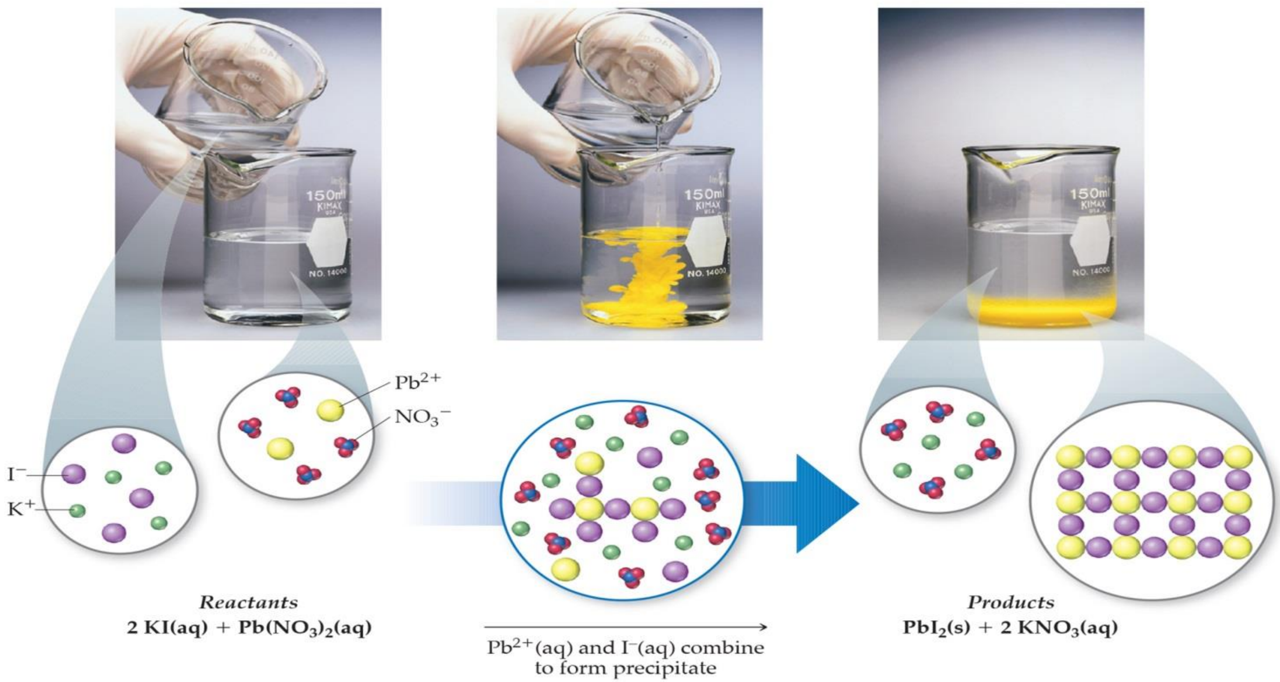
Precipitation Reactions

- Reactions that result in the formation of an insoluble product

$$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(\mathbf{s}) + 2KNO_3(aq)$$

- A precipitate is an insoluble solid formed by a reaction in solution e.g. $PbI_2(s)$



▲ FIGURE 4.4 A precipitation reaction.

Exercise 2

Using the solubility rules, predict whether the following salts are soluble, slightly soluble or insoluble.

a) $BaCl_2$

b) $MgCO_3$

c) PbS

d) Hg_2Cl_2

e) $Cu_3(PO_4)_2$

Acid-Base Reactions

ACIDS

Arrhenius: Substances that contain an ionisable H and able to ionise in aqueous solution to form H^+ or H_3O^+ ions. Acids are often called proton donors.

Strong acids - ionise completely in solution
- usually strong electrolytes

Weak acids – partially ionized

$\rightleftharpoons$ indicates reversible reaction

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3CO_2^-(aq) + H_3O^+(aq)$$

Acid-Base Reactions

BASES

Arrhenius: Compounds that contain an OH group and are able to ionise or dissociate in aqueous solution to form OH^-

Strong bases - ionise completely in solution
- strong electrolytes

$$NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$$

Weak bases – partially ionized - reversible reaction
- weak electrolytes

$$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4OH(aq) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

Oxidation & Reduction Half - Reactions

Separate the overall REDOX reaction oxidation and reduction half reaction:

$$\overset{0}{Zn}(s) + \overset{+2}{Cu^{2+}}(aq) \rightarrow \overset{+2}{Zn^{2+}}(aq) + \overset{0}{Cu}(s)$$

Half Reactions – REDOX reactions are linked by gain/loss of e^-

Oxidation Reaction:

$$Zn(s) \rightarrow Zn^{2+}(aq) + \cancel{2\,e^-}$$

Reduction Reaction:

$$Cu^{2+}(aq) + \cancel{2\,e^-} \rightarrow Cu(s)$$

Overall Reaction:

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

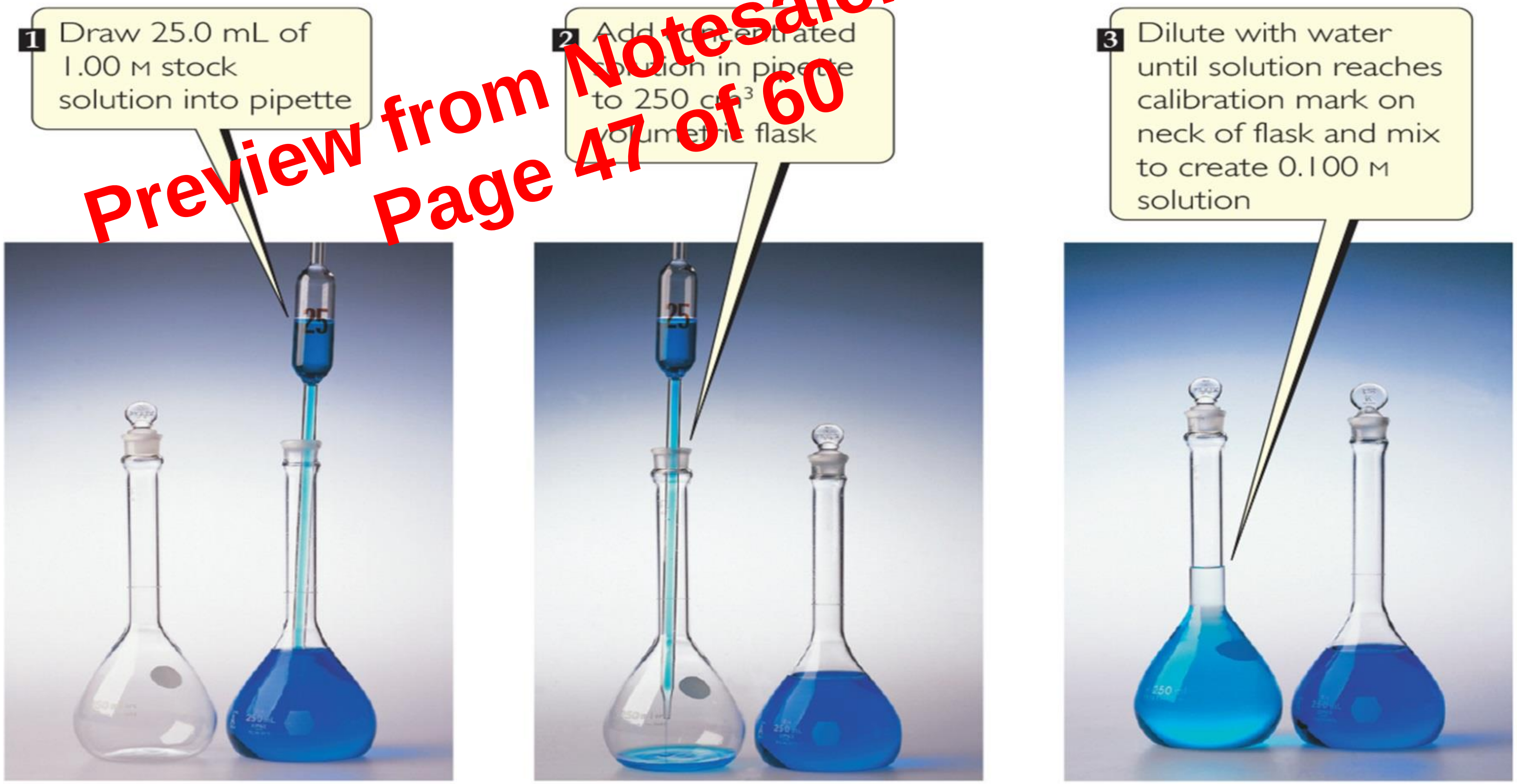
Balancing REDOX Reactions

HALF REACTION METHOD – BASIC MEDIUM Method 1

Follow the steps below:

1. Balance reaction exactly as you would for **ACIDIC MEDIUM**, i.e. steps 1-4
2. In your overall balanced acidic medium reaction, add the same number of OH^- to each side to 'neutralise' the same number of H^+ in the equation and create H_2O in its place.
3. The resulting water can be cancelled as needed.

Solution Dilution



▲ **FIGURE 4.18** **Procedure for preparing 250 dm^3 of 0.100 M $CuSO_4$ by dilution of 1.00 M $CuSO_4$.** (1) Draw 25.0 cm^3 of the 1.00 M solution into a pipette. (2) Add this to a 250 cm^3 volumetric flask. (3) Add water to dilute the solution to a total volume of 250 cm^3.

Percent Concentration

- Can be expressed in several ways. Three common methods are:

1. mass percent (%m/m) = $\frac{\text{mass solute(g)}}{\text{mass solution(g)}}$ x 100%

2. volume percent (%v/v) = $\frac{\text{volume solute}}{\text{volume solution}}$ x 100%

3. mass/volume percent (%m/v)= $\frac{\text{mass solute, g}}{\text{volume solution, mL}}$ x 100

Example

The sample of marble weighing 0,72 g was dissolved in 25,0 cm^3 of 1,00 mol dm^{-3} HCl and the resulting solution was then diluted to 100 cm^3. When 25,0 cm^3 of this diluted solution was back titrated with 15,75 cm^3 of 0,200 mol dm^{-3} NaOH were required for neutralisation.

Calculate the percentage $CaCO_3$ in the marble i.e. the percentage purity of the marble.

Solution cont.

Moles of HCl reacted with $CaCO_3$ =0.00625 – 0.00315

= 0,0031 mol HCl

Mass of $CaCO_3$ = n x MM

$$= 0{,}0031 \text{ mol HCl} \times \frac{1 \text{ mol } CaCO_3}{2 \text{ mol HCl}} \times 100 \text{ g mol}^{-1}\ CaCO_3$$

= 0,155 g $CaCO_3$ (in 25,0 cm^3 soln)

Therefore in 100 cm^3 soln:

$$0{,}155 \text{ g } CaCO_3 \times \frac{100 \text{ cm}^3 \text{ soln}}{25 \text{ cm}^3 \text{ soln}} = 0{,}62 \text{ g } CaCO_3$$

% Purity = $\frac{0{,}62 \text{ g}}{0{,}72 \text{ g}}$ x 100 % = 86 %