5 • Reactions in Aqueous Solution

Acid-Base & Gas Forming Equations

Solutions of Strong Acids & Strong Bases

1. Solutions of hydrochloric acid and barium hydroxide are mixed.

2 HCl + Ba(OH)₂
$$\rightarrow$$
 BaCl₂ + 2 H₂O
2 H⁺ + ~~2 Cl~~ + ~~Ba²⁺~~ + 2 OH⁻ \rightarrow ~~Ba²⁺~~ + ~~2 Cl +~~ 2 H₂O
H⁺ + OH⁻ \rightarrow H₂O

2. Solutions of sulfuric acid and potassium hydroxide are mixed.

$$H_2SO_4 + 2 \text{ KOH} \rightarrow 2 \text{ H}_2O + \text{K}_2SO_4$$

2 H⁺ + $\frac{SO_4^{2-}}{2}$ + $\frac{2 \text{ K}^+}{2}$ + 2 OH⁻ \rightarrow 2 H₂O + $\frac{2 \text{ K}^+}{2}$ + $\frac{SO_4^{2-}}{2}$ H⁺ + OH⁻ \rightarrow H₂O

Solutions containing Weak Acids and/or Weak Bases

3. Solutions of calcium hydroxide and carbonic acid are mixed.

$$Ca(OH)_2 + H_2CO_3 \rightarrow CaCO_3(s) + 2 H_2O$$

 $Ca^{2+} + 2 OH^- + H_2CO_3 \rightarrow CaCO_3(s) + 2 H_2O$

4. Solutions of hydrobromic acid and ammonium hydroxide are mixed.

$$HBr + NH_4OH \rightarrow NH_4Br + H_2O$$

 $H^+ + Br^- + NH_4^+ + OH^- \rightarrow NH_4^+ + Br^- + H_2O$

Solutions reacting with Solids

5. Solid potassium hydroxide is added to a solution of sulfuric acid.

2 KOH(s) + H₂SO₄
$$\rightarrow$$
 K₂SO₄ + 2 H₂O
2 KOH(s) + 2 H⁺ + ~~SO₄²⁻~~ \rightarrow 2 K⁺ + ~~SO₄²⁻~~ + 2 H₂O
KOH(s) + H⁺ \rightarrow K⁺ + H₂O

6. A solution of hydrochloric acid is added to solid copper(II) hydroxide.

2 HCl + Cu(OH)₂(s)
$$\rightarrow$$
 CuCl₂ + 2 H₂O
2 H⁺ + 2-Cl⁻ + Cu(OH)₂(s) \rightarrow Cu²⁺ + 2-Cl⁻ + 2 H₂O

Gas Forming Reactions

7. A solution of ammonium sulfate is added to solid lead hydroxide.

$$(NH_4)_2SO_4 + Pb(OH)_2(s) \rightarrow 2 NH_3(g) + 2 H_2O + PbSO_4(s)$$

2 $NH_4^+ + SO_4^{2-} + Pb(OH)_2(s) \rightarrow 2 NH_3(g) + 2 H_2O + PbSO_4(s)$

8. Solid iron(III) sulfide is added to a dilute solution of sulfuric acid.

$$Fe_2S_3(s) + 3 H_2SO_4 \rightarrow 3 H_2S(g) + Fe_2(SO_4)_3$$

 $Fe_2S_3(s) + 6 H^+ + 3 SO_4^2 \rightarrow 3 H_2S(g) + 2 Fe^{3+} + 3 SO_4^{2-}$