SOLUBLE COMPOUNDS	EXCEPTIONS
Almost all salts of Na^+, K^+, NH_4^+	
Salts of nitrate, NO_3^- chlorate, ClO_3^- perchlorate, ClO_4^- acetate, $CH_3CO_2^-$	
Almost all salts of Cl^-, Br^-, I^-	Halides of Ag^+, Hg_2^{2+}, Pb^{2+}
Salts containing F^-	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Salts of sulfate, SO_4^{2-}	Sulfates of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}

INSOLUBLE COMPOUNDS	EXCEPTIONS
Most salts of carbonate, CO_3^{2-} phosphate, PO_4^{3-} oxalate, $C_2O_4^{2-}$ chromate, CrO_4^{2-} sulfide, S^{2-}	Salts of NH_4^+ and the alkali metal cations
Most metal hydroxides and oxides	Alkali metal hydroxides and $Ba(OH)_2$

Fig. 3-10, p. 126

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Fig. 3-10, p. 126

Precipitation Reactions

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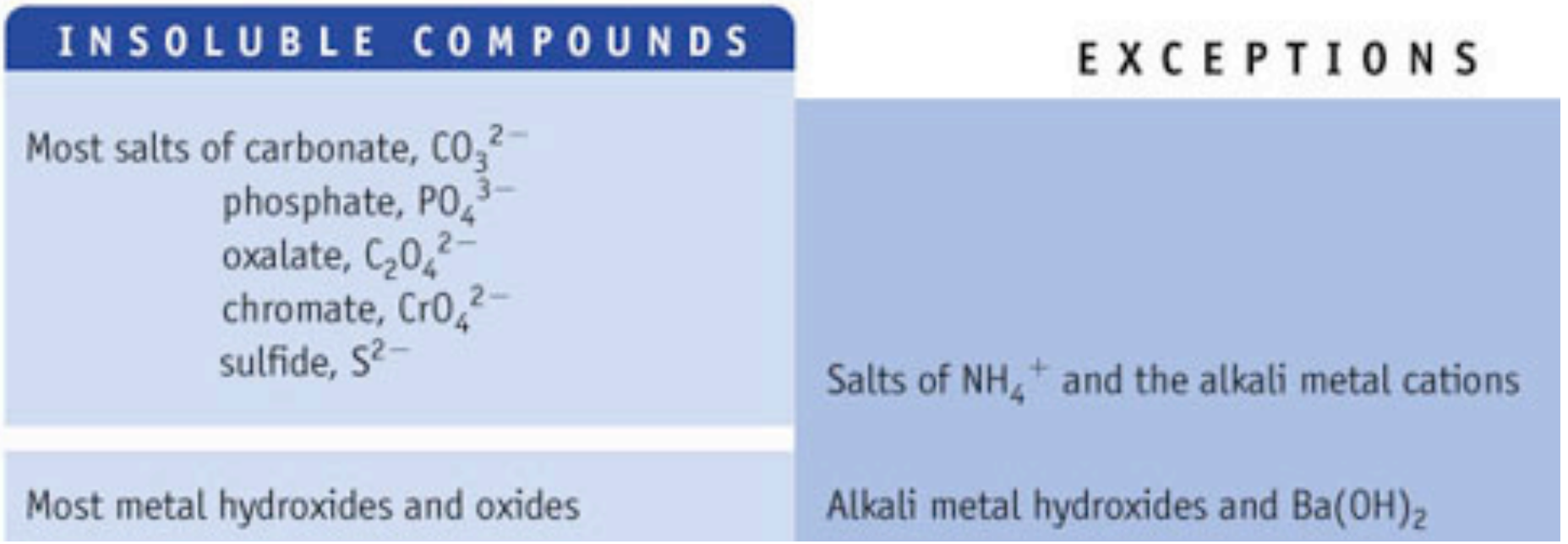

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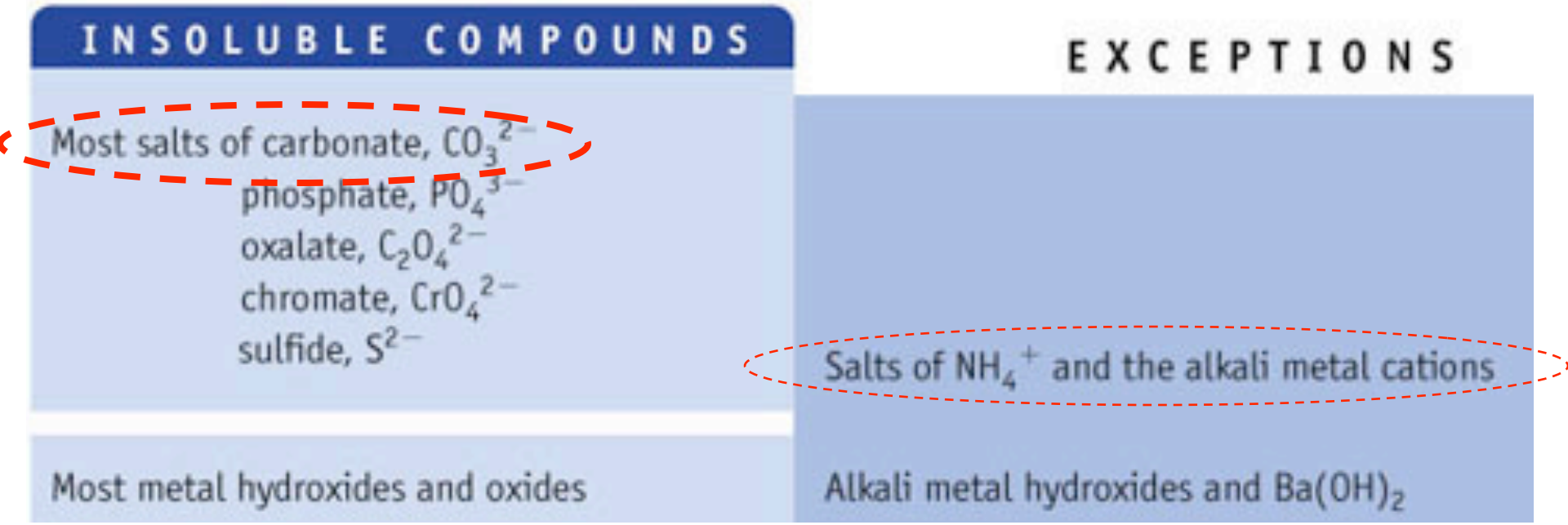

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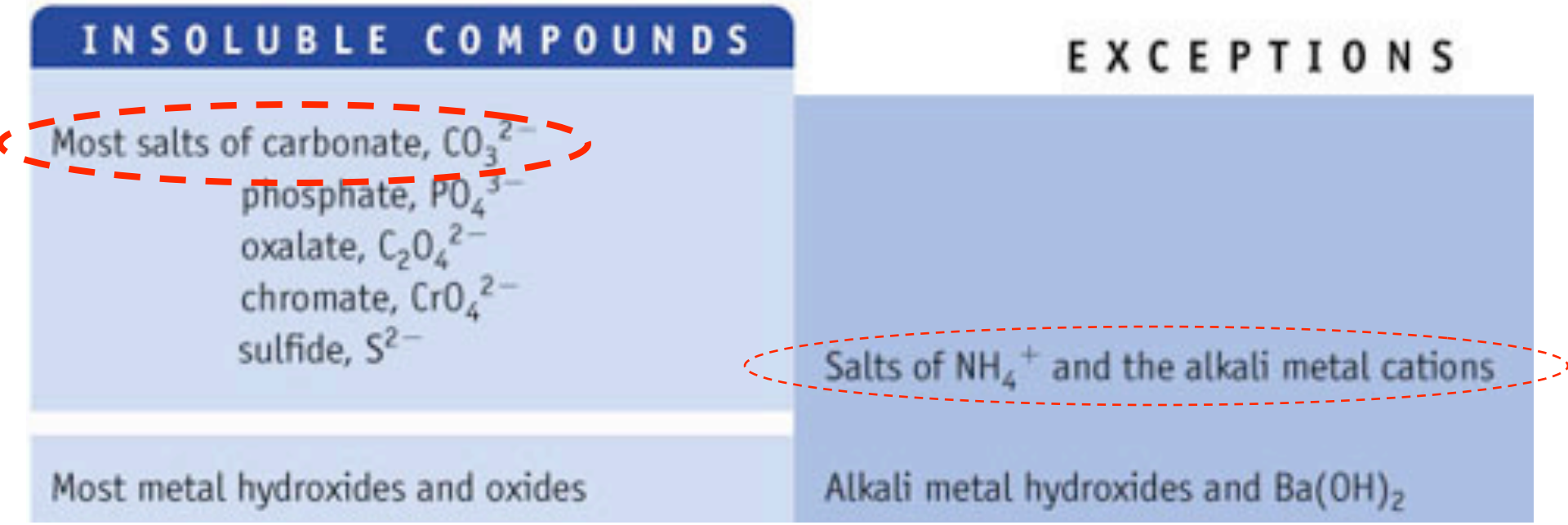

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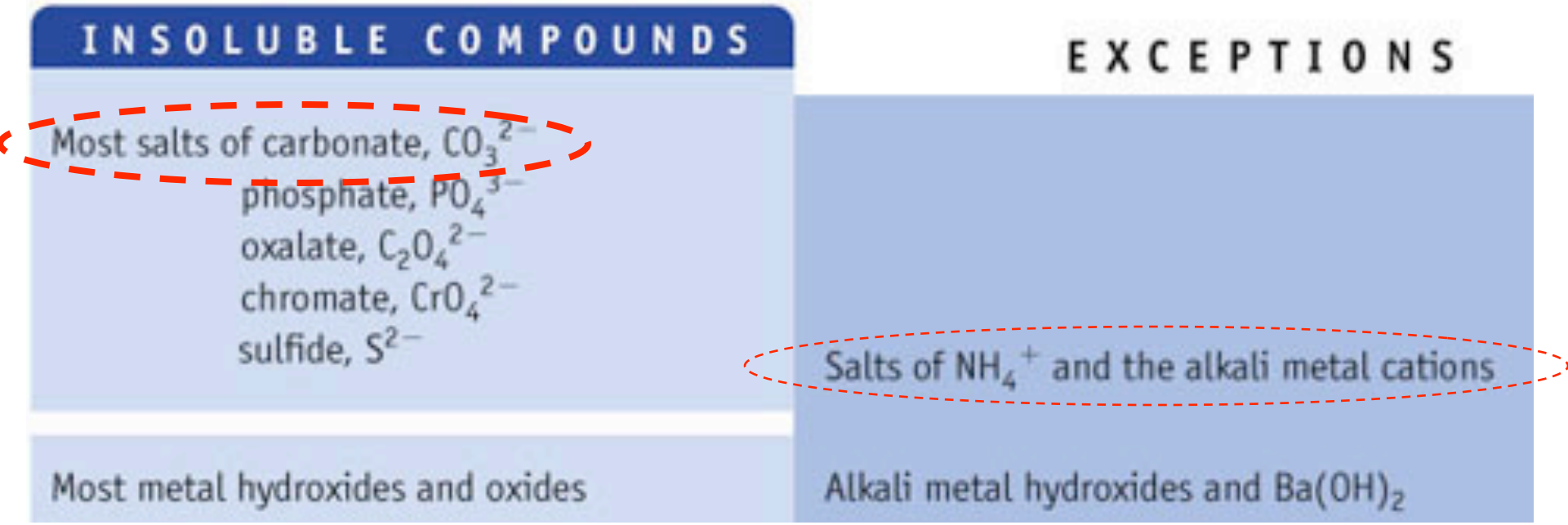

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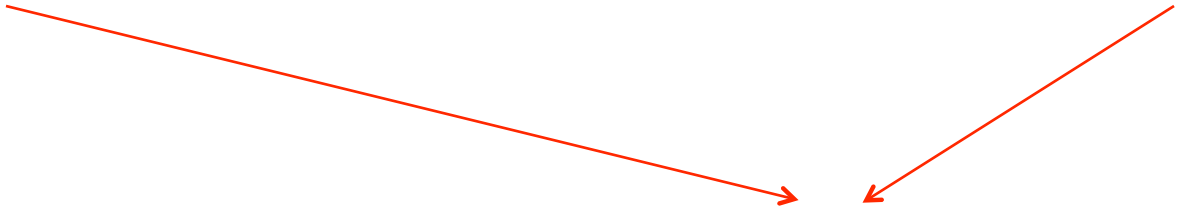

$CaCO_3(s)$

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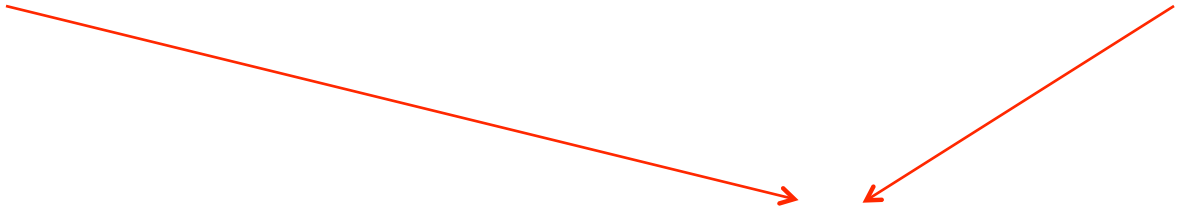

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Net Ionic Equation

$$Ca^{2+}(aq) + CO_3^{2-}(aq) \longrightarrow CaCO_3(s)$$

Equilibria

$$A \xleftrightarrow{K=1} B$$

10 moles of A are added to a beaker.

At equilibrium, how many moles of B are in the beaker?

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$$K = 1 = \frac{[B]}{[A]} \qquad [B] = [A]$$

5 moles 5 moles

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After equilibration, all of B is instantaneously removed from the beaker.

After *re-equilibration*, how many moles of B are in the beaker?

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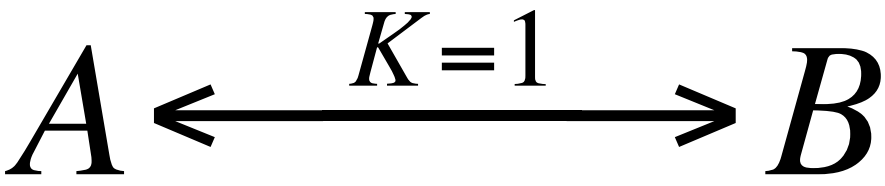

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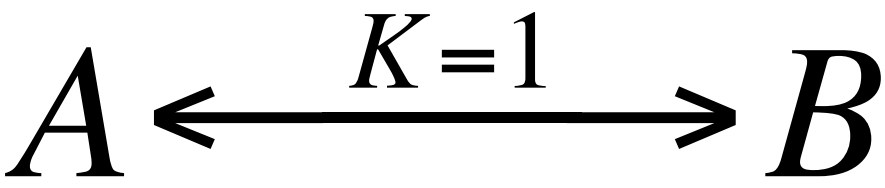

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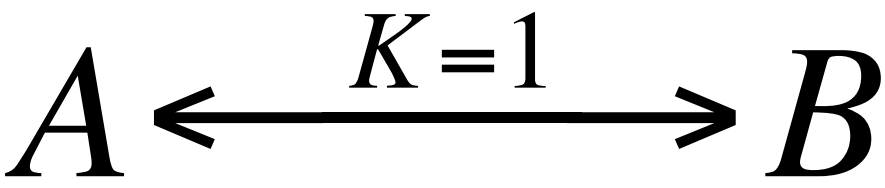

2.5 moles 2.5 moles

10 moles of A are added to a beaker.

After equilibration, all of B is instantaneously removed from the beaker.

After *re-equilibration*, how many moles of B are in the beaker?

Le Chatelier's principle

If the conditions of a system at equilibrium are changed, the system moves in such a way as to oppose the effects of that change.

$$a + b \overset{K}{\longleftrightarrow} c + d$$

TABLE 3.2 Common Acids and Bases

Strong Acids (Strong Electrolytes)		Soluble Strong Bases	
HCl (aq)	Hydrochloric acid	LiOH	Lithium hydroxide
HBr (aq)	Hydrobromic acid	NaOH	Sodium hydroxide
HI (aq)	Hydroiodic acid	KOH	Potassium hydroxide
HNO_3	Nitric acid	$Ba(OH)_2$	Barium hydroxide
$HClO_4$	Perchloric acid		
H_2SO_4	Sulfuric acid		
Weak Acids (Weak Electrolytes)*		**Weak Base (Weak Electrolyte)**	
H_3PO_4	Phosphoric acid	NH_3	Ammonia
H_2CO_3	Carbonic acid		
CH_3CO_2H	Acetic acid		
$H_2C_2O_4$	Oxalic acid		
$H_2C_4H_4O_6$	Tartaric acid		
$H_3C_6H_5O_7$	Citric acid		
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* These are representative of hundreds of weak acids.

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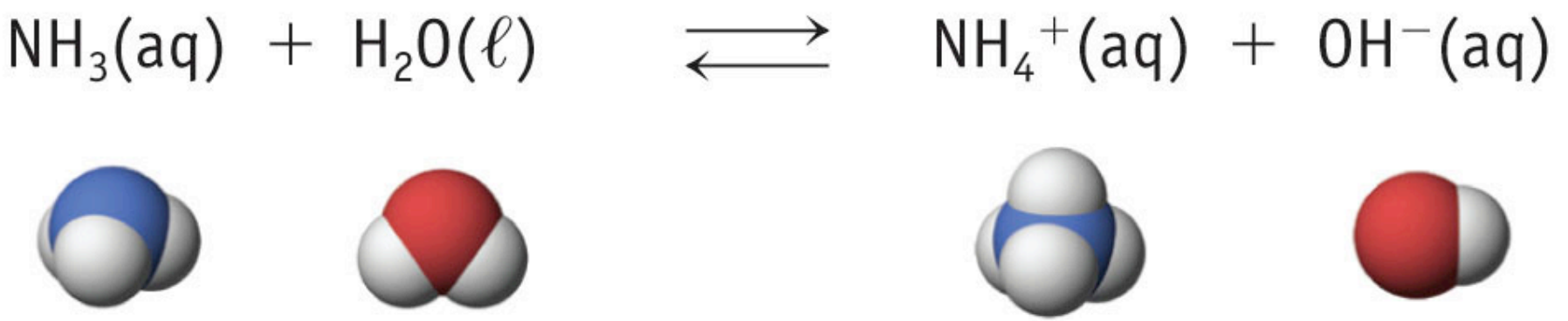

ammonia, base
weak electrolyte
< 100% ionized

water

ammonium ion

hydroxide ion

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Precipitation ***drives*** this rxn forward

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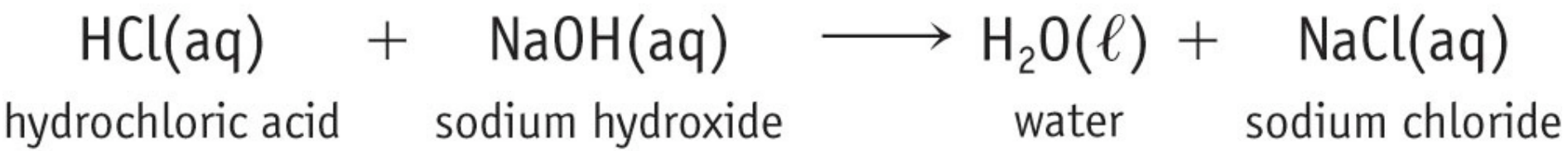
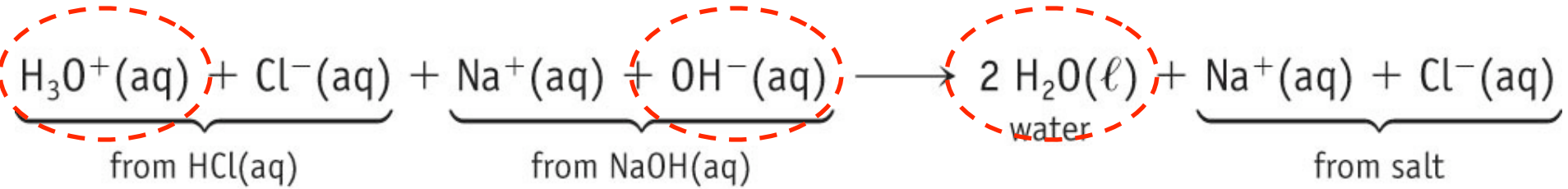
Acid-Base Chemistry

$$\underset{\text{hydrochloric acid}}{HCl(aq)} + \underset{\text{sodium hydroxide}}{NaOH(aq)} \longrightarrow \underset{\text{water}}{H_2O(\ell)} + \underset{\text{sodium chloride}}{NaCl(aq)}$$

$$\underbrace{H_3O^+(aq) + Cl^-(aq)}_{\text{from HCl(aq)}} + \underbrace{Na^+(aq) + OH^-(aq)}_{\text{from NaOH(aq)}} \longrightarrow \underset{\text{water}}{2\,H_2O(\ell)} + \underbrace{Na^+(aq) + Cl^-(aq)}_{\text{from salt}}$$

Acid-Base Chemistry





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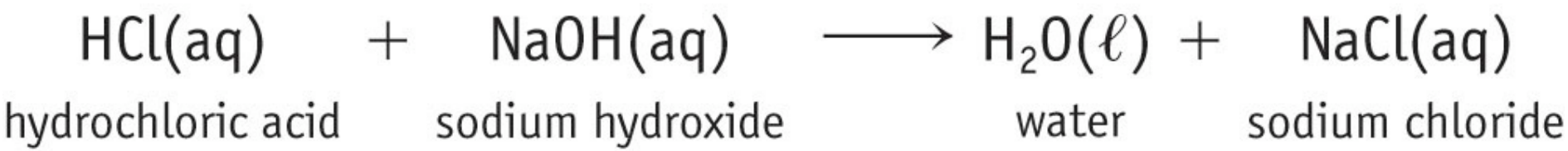

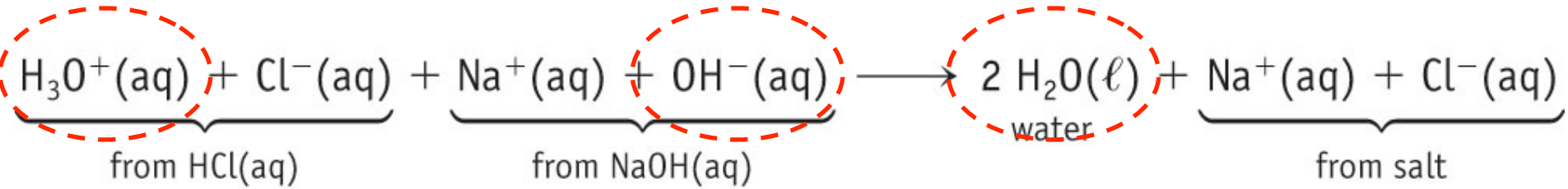

Net Ionic Equation

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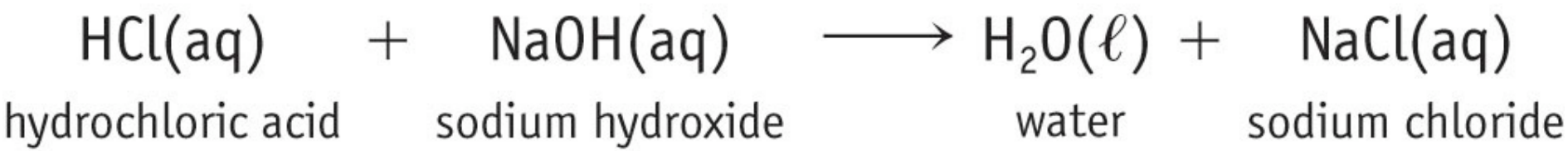

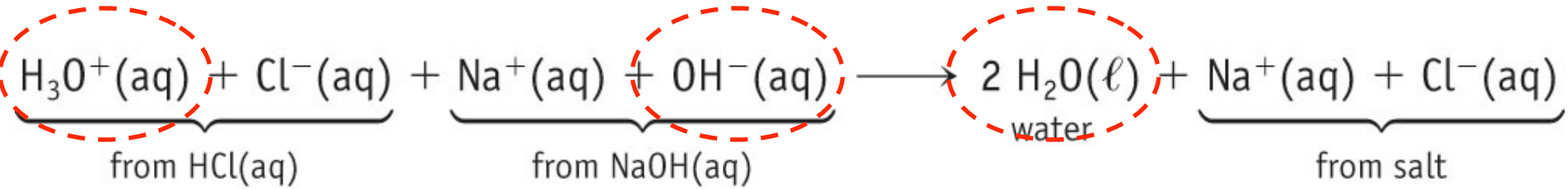

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Acid-base reactions can ***drive*** reactions forward

TABLE 3.3 Gas-Forming Reactions

Metal carbonate or bicarbonate + acid → metal salt + $CO_2(g)$ + $H_2O(\ell)$

$Na_2CO_3(aq) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + CO_2(g) + H_2O(\ell)$

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Table 3-3, p. 140

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Assumes a container open to the environment

Table 3-3, p. 140

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Gas evolution can ***drive*** reactions forward

Table 3-3, p. 140

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$NaHCO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(\ell)$
Metal sulfide + acid → metal salt + $H_2S(g)$
$Na_2S(aq) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + H_2S(g)$
Metal sulfite + acid → metal salt + $SO_2(g)$ + $H_2O(\ell)$
$Na_2SO_3(aq) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + SO_2(g) + H_2O(\ell)$
Ammonium salt + strong base → metal salt + $NH_3(g)$ + $H_2O(\ell)$
$NH_4Cl(aq) + NaOH(aq) \rightarrow NaCl(aq) + NH_3(g) + H_2O(\ell)$

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Metal sulfite + acid → metal salt + $SO_2(g)$ + $H_2O(\ell)$
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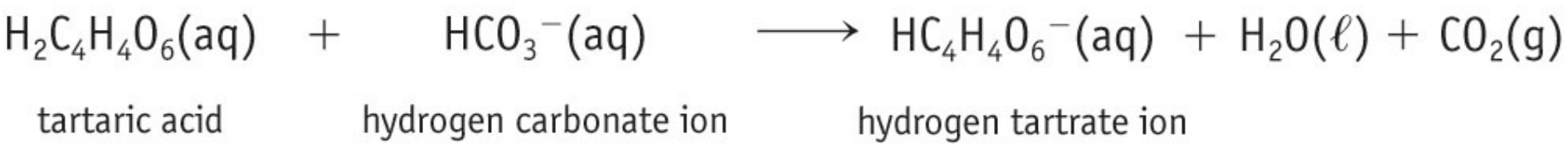
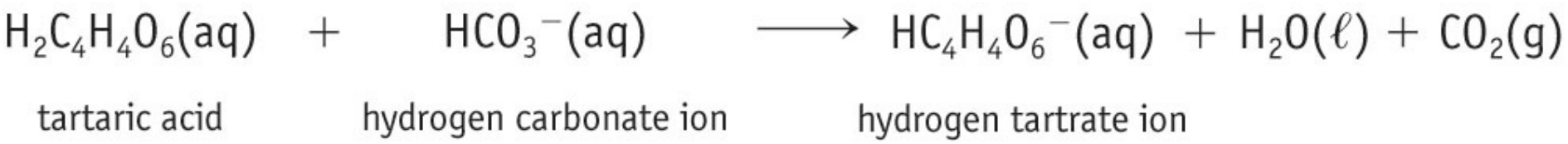
Table 3-3, p. 140





Gas evolution AND acid base reaction
drive this reaction forward