Balancing chemical reactions

Slide#6 solution)

Basic rule: conservation of matter (atoms)

$aCa(HCO_3)_2 + bNaOH = cCa(OH)_2 + dNaHCO_3$

$Ca: a = c$ (1)

$Na: b = d$ (2)

$H: 2a + b = 2c + d$ (3)

$C: 2a = d$ (4)

$O: 6a + b = 2c + 3d$ (5)

Four unknowns → three equations needed (obtain the ratio of each)

e.g., use (1), (2) & (4): $2a = 2c = b = d$ (satisfies (3) & (5) as well)

→ $\mathbf{Ca(HCO_3)_2 + 2NaOH = Ca(OH)_2 + 2NaHCO_3}$

Balancing redox reactions

Slide#13 solution)

Basic rule: conservation of matter ***(atoms + electrons)***

$aSO_2 + bO_2 + cH_2O \rightarrow dH_2SO_4$

$S: a = d$ (1)

$O: 2a + 2b + c = 4d$ (2)

$H: 2c = 2d$ (3)

$e^-: (O_2\,[0] + 4e^- \rightarrow 2O^{2-}) \times b;$ $(S^{4+} \rightarrow S^{6+} + 2e^-) \times a$

$4b = 2a$ (4)

e.g., use (1), (2) & (4): a = 2b = c = d (satisfies (2) as well)

$\rightarrow$ $\mathbf{2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4}$

Chemical equilibrium: solubility

Slide#19 solution)

i) Assume ionic strength is negligible (activity = molarity)

$[Ca^{2+}] = [CO_3^{2-}]$

$K_s = 10^{-8.48} = [Ca^{2+}][CO_3^{2-}] = [Ca^{2+}]^2$

$[Ca^{2+}] = 5.75 \times 10^{-5}$ M

ii) Without the assumption

Let's assume NaCl is a sole contributor of ionic strength

$$I = \frac{1}{2}[(0.01\ M)\cdot(1^2) + (0.01\ M)\cdot(1^2)] = 0.01\ M$$

$$log\gamma_{Ca} = log\gamma_{CO_3} = -0.5\cdot 2^2\left(\frac{\sqrt{0.01\ M}}{1+\sqrt{0.01\ M}} - 0.2\cdot 0.01\ M\right) = -0.175$$

$$\gamma_{Ca} = \gamma_{CO_3} = 10^{-0.175} = 0.664$$

$$\gamma_{Ca}[Ca^{2+}] = 5.75\times 10^{-5}\ M$$

$[Ca^{2+}] = 8.66 \times 10^{-5}$ M *(valid if within 5% error is accepted)*