# Balancing Redox Equations

Goal: To make sure the number of *electrons lost* by the reducing agent equals the number of *electrons gained* by the oxidizing agent!

Two methods can be used:

1. Oxidation number method
2. Half-reaction method

## Balancing Redox Equations Using Oxidation Numbers

1. Assign oxidation numbers to all the atoms
2. Identify which atoms undergo a change in oxidation number
3. Determine the ratio in which these atoms must react so that the total increase in oxidation numbers equals the decrease
4. Balance the redox participants in the equation
5. Balance the other atoms by the inspection method

A) ① $\overset{0}{Cu_{(s)}} + \overset{+1}{Ag^{+}_{(aq)}} \rightarrow \overset{+2}{Cu^{+2}_{(aq)}} + \overset{0}{Ag_{(s)}}$

② Cu: 0 to +2 loses $2e^-$
Ag: +1 to 0 gains $1e^-$ (x2)

③ must have 2 Ag to balance e⁻'s so

④ $Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Cu^{+2}_{(aq)} + 2Ag_{(s)}$

⑤ not needed here

B) ① $\overset{+7\ -2}{MnO_4^-{}_{(aq)}} + \overset{+2}{Fe^{+2}_{(aq)}} + \overset{+1}{H^{+1}_{(aq)}} \rightarrow \overset{+2}{Mn^{+2}_{(aq)}} + \overset{+3}{Fe^{+3}_{(aq)}} + \overset{+1\ -2}{H_2O_{(l)}}$

+7 −8 = −1

② Mn: +7 to +2 gains $5e^-$
Fe: +2 to +3 loses $1e^-$

H, O: no charge

③ Fe must multiply by 5

④ $MnO_4^- + 5Fe^{+2} + H^{+1} \rightarrow Mn^{+2} + 5Fe^{+3} + H_2O$

⑤ $MnO_{4(aq)}^- + 5Fe^{+2}_{(aq)} + 8H^{+1}_{(aq)} \rightarrow Mn^{+2}_{(aq)} + 5Fe^{+3}_{(aq)} + 4H_2O_{(l)}$

$SO_4^{-2}$: +6 −8 = −2

C) $\overset{0}{Al_{(s)}} + \overset{+1\ +6\ -2}{H_2SO_4{}_{(aq)}} \rightarrow \overset{+3}{Al_2(SO_4)_{3(aq)}} + \overset{0}{H_{2(g)}}$

(+2 (+6) −8 for $H_2SO_4$; (+6) −6 for $Al_2(SO_4)_3$)

Al: 0 to +3 loses $3e^-$
H: +1 to 0 gains $1e^-$ (×3)

$$2Al_{(s)} + 3H_2SO_{4(aq)} \rightarrow Al_2(SO_4)_{3(aq)} + 3H_{2(g)}$$

* balance the rest too!

D) $\overset{+2\ -2}{PbS_{(s)}} + \overset{0}{O_{2(g)}} \rightarrow \overset{+2\ -2}{PbO_{(s)}} + \overset{+4\ -2}{SO_{2(g)}}$

(+4 −4 for $SO_2$)

S: −2 to +4 loses 6
O: 0 to −2 gains 2 (×3)

$$2PbS_{(s)} + 3O_{2(g)} \rightarrow 2PbO_{(s)} + 2SO_{2(g)}$$

only this one!

watch the balancing
×3 really means 6 O total
* make sure to balance the rest (Pb, S)