REDOX REACTIONS

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Redox

occurs simultaneously

Comproporpination

$Ag^{2+} + Ag \rightarrow 2Ag^{+}$

(both reduced and oxidized)

Disproportionation

$2Cu^{+} \rightarrow Cu^{2+} + Cu$

(middle ground)

Electron transfer

half equation [Oxidation (loss) OIL
Reduction (gain) RIG

$Na \rightarrow Na^{+} + e^{-}$ oxidation

$O_2 + 4e^{-} \rightarrow 2O^{2-}$ reduction

$4Na \rightarrow 4Na^{+} + 4e^{-}$

$4Na + O_2 + 4e^{-} \rightarrow 4Na^{+} + 4e^{-} + 2O^{2-}$

$4Na + O_2 \rightarrow 2Na_2O$

	Oxidation	Reduction
Hydrogen transfer	Loss	Gain
Oxygen transfer	Gain	Loss
Electron transfer	Loss	Gain

→ always applicable

Oxidation

$4Al + 3O_2 \rightarrow 2Al_2O_3$ gains oxygen (-) of electron

↑ oxidized

- gain of oxygen
- loss of hydrogen
- loss of e^{-}

oxidising agent

- oxidises others but is in turn reduced
- usually has higher oxidation numbers

KI
H_2O_2 K
NH_3
C
CO
H_2
H_2S
metals
SO_2

KI (aq) test

$2I^{-}(aq) \rightarrow I_2(aq) + 2e^{-}$

- Added to oxidising agent
- brown sol is formed when I^{-} is oxidised to I_2

Reduction

$2Al_2O_3 \rightarrow 4Al + 3O_2$ loss of O_2

$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$ (+) gain of electrons

$KMnO_4$
$K_2Cr_2O_7$
H_2O_2 ↖
O_2
HNO_3
H_2SO_4
Br_2
Cl_2
I_2

- loss of oxygen
- gain in hydrogen
- loss of e^{-}

reducing agent

- reduces others but is in turn oxidised
- usually has lower oxidation numbers

$K_2Cr_2O_7$ (aq) acidified

1) Add dilute H_2SO_4 acid

$Cr_2O_7^{2-}(aq) + 14H^{+}(aq) + 6e^{-} \rightarrow 2Cr^{3+}(aq) + 7H_2O$

$KMnO_4$ (aq) acidified

$MnO_4^{-}(aq) + 5e^{-} + 8H^{+}(aq) \rightarrow Mn^{2+}(aq) + 4H_2O(l)$ (colourless)

Oxidation States

1) Oxidation state of atoms/monoatomic ion is equal to its charge

OS of H in H_2 = 0

2) Charge of a molecule / compound is equal to sum of oxidation states that make up the identity

$[Cu(H_2O)_6]^{2+}$

OS of Cu → +2

3) Some elements have a fixed oxidation state

▲ fractions are possible

Grp 1	(+1)
Grp 2	(+2)
F	(-1)
H	(+1) Except NaH (-1)
O	(-2) Except peroxides H_2O_2 (-1) / OF_2 (+2)
Cl	(-1) Except w O/F (+1)

↑ oxidation # = tend to oxidise others

↓ oxidation # reduces others

oxidation

OS ↑

reduction

OS ↓

H_2SO_4 $x + 4(-2) = -2$, $x = +6$

$Cr_2O_7^{2-}$ $2x + 7(-2) = -2$, $x = +6$

Halogen displacement

$Cl_2(g) + 2NaBr(aq) \rightarrow 2NaCl(aq) + Br_2(aq)$

0 → -1 (reduced); -1 → 0 (oxidised)

Cl is more electronegative (more likely to gain e^{-})

Balancing half equations

1) # of atoms
2) charge

ionic equation

1) conservation of mass
   - # of atoms on LHS = RHS
2) Balance of charge
   - sum of charges on LHS = RHS
3) "Add e^{-}"
4) Add H^{+}/OH^{-} depending on medium
5) Add H_2O to balance
6) Add state symbols

↳ Some half equations don't need to be balanced in charged medium

$Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^{-}$

acidic medium

1) Work out change in oxidation state

$Cr_2O_7^{2-} \rightarrow Cr^{3+}$ (+6) (+3)

2) Balance amt of element so charge matches

$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$

3) Add e^{-}

$Cr_2O_7^{2-} + 6e^{-} \rightarrow 2Cr^{3+}$ (more on RHS so add to eq)

4) Add H^{+}

$Cr_2O_7^{2-} + 6e^{-} + 14H^{+} \rightarrow 2Cr^{3+}$

5) Add H_2O

$Cr_2O_7^{2-} + 6e^{-} + 14H^{+} \rightarrow 2Cr^{3+} + H_2O$

6) State symbols

$Cr_2O_7^{2-}(aq) + 6e^{-} + 14H^{+}(aq) \rightarrow 2Cr^{3+}(aq) + H_2O(l)$

alkaline medium

$ClO^{-} \rightarrow Cl^{-}$ (+1) (-1)

match Cl charge

$ClO^{-} + 2e^{-} \rightarrow Cl^{-}$ (-1) (-2) (-1)

balance total charge

$ClO^{-} + 2e^{-} \rightarrow Cl^{-} + 2OH^{-}$ (-1) (-2) (-1) (-2)

balance equation

$ClO^{-}(aq) + 2e^{-} + H_2O(l) \rightarrow Cl^{-}(aq) + 2OH^{-}(aq)$

Combining

$MnO_4^{-} + 5e^{-} + 8H^{+} \rightarrow Mn^{2+} + 4H_2O$

$SO_3^{2-} + 2OH^{-} \rightarrow SO_4^{2-} + 2e^{-} + H_2O$

LCM: 2 x 5 = 10 → make coeff of e^{-} the same as gain in e^{-} = loss in e^{-}

$2MnO_4^{-} + 10e^{-} + 16H^{+} \rightarrow 2Mn^{2+} + 8H_2O$

$5SO_3^{2-} + 10OH^{-} \rightarrow 5SO_4^{2-} + 10e^{-} + 5H_2O$

$2MnO_4^{-} + 10e^{-} + 16H^{+} + 5SO_3^{2-} + 10OH^{-} \rightarrow 2Mn^{2+} + 13H_2O + 5SO_4^{2-} + 10e^{-}$

combine to H_2O

$2MnO_4^{-}(aq) + 6H^{+}(aq) + 5SO_4^{2-}(aq) \rightarrow 2Mn^{2+}(aq) + 3H_2O(l) + 5SO_4^{2-}(aq)$