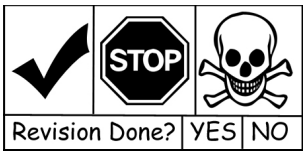
Unit 18 Transition Metals Part Two (Paper 1 & 3)

18.1 Catalysts

Transition metals and their compounds can act as heterogeneous and homogeneous catalysts.
A heterogeneous catalyst is in a different phase from the reactants and the reaction occurs at active sites on the surface.
The use of a support medium to maximise the surface area of a heterogeneous catalyst and minimise the cost.
V_2O_5 acts as a heterogeneous catalyst in the Contact process.
Fe is used as a heterogeneous catalyst in the Haber process.
Heterogeneous catalysts can become poisoned by impurities that block the active sites and consequently have reduced efficiency; this has a cost implication.
A homogeneous catalyst is in the same phase as the reactants.
When catalysts and reactants are in the same phase, the reaction proceeds through an intermediate species.

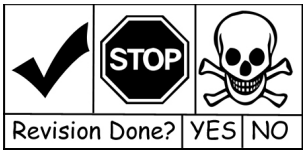
You should be able to:

• explain the importance of variable oxidation states in catalysis
• explain, with the aid of equations, how V_2O_5 acts as a catalyst in the Contact process
• explain, with the aid of equations, how Fe^{2+} ions catalyse the reaction between I^- and $S_2O_8^{2-}$
• explain, with the aid of equations, how Mn^{2+} ions autocatalyse the reaction between $C_2O_4^{2-}$ and MnO_4^-



18.2 Formation of coloured ions

Transition metal ions can be identified by their colour.
Colour arises when some of the wavelengths of visible light are absorbed and the remaining wavelengths of light are transmitted or reflected.
d electrons move from the ground state to an excited state when light is absorbed.
The energy difference between the ground state and the excited state of the d electrons is given by: $\Delta \mathbf{E = hv = hc/\lambda}$
Changes in oxidation state, co-ordination number and ligand alter ΔE and this leads to a change in colour.
The absorption of visible light is used in spectroscopy.
A simple colorimeter can be used to determine the concentration of coloured ions in solution.



18.3 Reactions of ions in aqueous solution

In aqueous solution, the following metal-aqua ions are formed:
$[M(H_2O)_6]^{2+}$, limited to M = Fe and Cu
$[M(H_2O)_6]^{3+}$, limited to M = Al and Fe
The acidity of $[M(H_2O)_6]^{3+}$ is greater than that of $[M(H_2O)_6]^{2+}$
Some metal hydroxides show amphoteric character by dissolving in both acids and bases (eg hydroxides of Al^{3+}).

You should be able to:

• explain, in terms of the charge/size ratio of the metal ion, why the acidity of $[M(H_2O)_6]^{3+}$ is greater than that of $[M(H_2O)_6]^{2+}$
• describe and explain the simple test-tube reactions of:
$M^{2+}(aq)$ ions, limited to M = Fe and Cu, and of $M^{3+}(aq)$ ions, limited to M = Al and Fe, with the bases OH^- , NH_3 and CO_3^{2-}