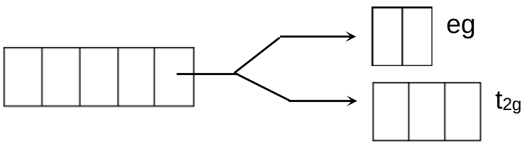
Colour of hydrated transition metal ions and their compounds :

- A substance is coloured, if it absorbs a part of white light and transmit the remaining light.
- The colour of a substance is the complementary colour of that part of visible light which is absorbed by the substance.
- Colour is due to the presence of partly filled d-orbtials, with unpaired electrons.
- The metal ion possessing completely filled d-orbitals or completely vacant d-orbtials is colourless. Ex TiO_2, CuCl.
- d-orbitals are degenerate in isolated gaseous metal ions.
- d-orbitals of the metal ion in compounds or hydrated ions or complexes posses slightly different energies.
- Under the influence of the anion of the compound or the water molecule in hydrated state these d-orbitals of the metal ions split into 2 sets. It is known as d-orbital splitting.
- One set consists of two orbitals - $d_{x^2-y^2}, d_{z^2}$ of higher energy and the other set consists three orbitals - d_{xy}, d_{yz}, d_{zx} of lower energy.



- Electron in the lower energy d-orbital is promoted to higher energy d-orbital with in the same energy level.
- Thus, the colour of transition metal ions involve d–d transitions.
- This excitation is possible in visible region (1 = 400 – 750 nm) as the energy difference between the two sets is less.
- $[Ti(H_2O)_6]^{3+}$ absorbs green and yellow lights and transmits pink colour.
- The same metal ion may exhibit different colours in different oxidation states.
- Fe^{++} - green ; Fe^{+++} - yellow
- Cr^{2+} - blue Cr^{3+} - green Cr^{6+} - yellow
- Mn^{2+} - pink Mn^{3+} - blue Mn^{6+} - green
- Sc^{3+}, Ti^{4+}, Mn^{7+}- are colourless as all the d-orbitals in these ions are vacant
- Cr^{6+} and Mn^{7+} posses vacant d orbitals but their oxyanions like $Cr_2O_7^{2-}$, CrO_4^{2-} and MnO_4^- are coloured due to charge transfer phenomenon.
- Zn^{++} and Cu^+ are colour less as all the d orbitals are completely filled.

Alloys:

- Homogenous mixture of a metal with other metal or metalloid or non metal having metallic properties is known as an alloy.
- Transition metals form alloys easily because they have similar atomic radii and similar crystal structures.
- Alloys are prepared to modify certain properties like malleability, ductility, toughness, resistance to corrosion to suit the needs in the industry.
- Alloys are classified as
  Ferrous alloys (contain iron) Ex. Cast Iron. Stainless steel,
  Non Ferrous alloys (no iron) ex. Brass, German silver.
- Alloys are prepared, by mixing the metals or components in proper composition in molten state and solidifying.
- By simultaneous electrolytic deposition of metals under the same conditions to get alloys.

Alloy	Composition	Uses
Invar	64% Fe, 35% Ni. Mn and C in trace amounts.	To make pendulum rods, due to low temperature coefficient
Nichrome	60% Ni, 25% Fe 15% Cr.	To manufacture heating elements of stoves and Furnaces
Non – Ferrous alloys		
Type metal	60–80 % Pb, 13–30% Sb, 3–10% Sn.	Used for sharply defined castings
Wood's metal	50% Bi, 25% Pb, 12.5% Sn, 12.5% Cd,	In automatic alarams. Sprinklers systems
Devarda's Alloy	50% Cu, 45% Al, 5% Zn	To reduce nitrites and nitrates to NH_3
Solder metal	50% Sn, 47.5% Pb, 2.5 % Sb	Electrical appliances
Duralumin	95% Al, 4% Cu, 0.5% Mn, 0.5 %Mg.	Aircraft
Magnalium	85-99% Al, 1–15% Mg	Balance beams, aircraft parts, motor spares
Aluminium Bronze	88–90% Cu, 10–12% Al	Ornaments, Photoframes, coins
German silver	50–60% Cu, 10–30 % Ni, 20–30% Zn	Spoons, forks, Utencils
Bell metal	80% Cu, 20% Sn	Bells
Bronze	75 – 90% Cu, 10 –25% Sn	Utensils, Coins and statues

Gun metal	88% Cu, 10% Sn, 2% Zn	Bearings, guns
Brass	60–80% Cu, 20–40 % Zn	Machine parts
STEELS :		
Name of the steel	**% of the element present**	**Uses**
Nickel steel	2.5 – 5 % Ni, Fe, C	Cable wires, guns
Manganese steel	10– 14% Mn, Fe, C	Ball mills, Helmets
Chromium steel	5 – 15% Cr, Fe, C	Kitchen ware, Razorblades
Tungsten steel	6–8% W; 14–20% Fe, C	Magnets, Electric motors

Alloys are used in nuclear engineering, dental fillings, to manufacture magnetic materials.