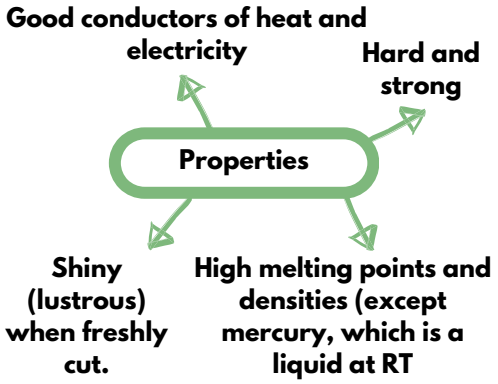
C1.3 Properties of Transition Metals

Transition Metals vs Group 1 Elements

Property	Transition Metals	Group 1 Metals
Position in the Periodic Table	Between Groups 2 & 3	Group 1 (Far Left)
Density	High (e.g., Iron: 7.87 g/cm^3, Copper: 8.92 g/cm^3)	Low (e.g., Sodium: 0.97 g/cm^3)
Melting Point	High (e.g., Chromium: 1890°C, Iron: 1538°C)	Low (e.g., Potassium: 63°C)
Strength & Hardness	Strong & Hard	Soft (can be cut with a knife)
Reactivity with Water	Slow or no reaction	Reacts violently, producing hydrogen gas
Reactivity with Oxygen	Slow (e.g., Iron rusts over weeks)	Rapid reaction, forming metal oxides instantly
Reactivity with Halogens	Some react to form halide compounds (e.g., $FeCl_3$)	React violently, forming white salts (e.g., NaCl)
Ion Formation	Variable oxidation states (e.g., Fe^{2+}, Fe^{3+})	Always form +1 ions (e.g., Na^+)
Colour of Compounds	Form coloured compounds	Usually form white compounds

Typical Properties of Transition Metals



Metal	Melting Point (°C)	Density (g/cm^3)
Chromium (Cr)	1890°C	7.19
Manganese (Mn)	1240°C	7.20
Iron (Fe)	1538°C	7.87
Cobalt (Co)	1492°C	8.90
Nickel (Ni)	1453°C	8.90
Copper (Cu)	1083°C	8.92

Transition metals serve as catalysts due to their ability to change oxidation states and offer alternative reaction pathways.
Examples:

- Iron: Used in the Haber Process for ammonia production.
- Vanadium(V) Oxide (V_2O_5): Used in the Contact Process for sulfuric acid production
- Nickel: Used in the hydrogenation of alkenes to produce margarine.

Variable Oxidation States

Transition metals can form ions with different charges.
Example:
Iron(II) (Fe^{2+}) → Green compounds.
Iron(III) (Fe^{3+}) → Brown compounds.
Other examples:

- Manganese (Mn^{2+}, Mn^{3+})
- Copper (Cu^+, Cu^{2+})

Compound	Colour
Iron(II) hydroxide ($Fe(OH)_2$)	Pale Green
Iron(III) hydroxide ($Fe(OH)_3$)	Orange-Brown
Iron(III) oxide (Fe_2O_3)	Red-Brown
Copper(II) sulfate ($CuSO_4$)	Blue
Nickel(II) chloride ($NiCl_2$)	Green
Chromium(III) oxide (Cr_2O_3)	Green
Manganese dioxide (MnO_2)	Black
Manganese(II) sulfate ($MnSO_4$)	Pale pink

Reactions with Oxygen

Slow reaction at room temperature.

- Example: Iron rusts over time (requires water and oxygen).
- Some transition metals react with oxygen when heated.
  - Example: Copper + Oxygen → Copper Oxide$2Cu\ (s) + O_2\ (g) \rightarrow 2CuO\ (s)$

Reactions with Water

- Most transition metals do not react with cold water.
- Group 1 metals react violently, but transition metals are much less reactive.
- Iron reacts slowly over time, forming hydrated iron(III) oxide (rust).

Manganese compounds: used in dry-cell batteries and glass decolourisation.

Chromium compounds: used in green glass and anticorrosion coatings

Titanium is used in joint replacements and surgical implants because it is light, strong, and biocompatible (bonds with bone).

Unlike Group 1 metals, transition metals react slowly or not at all with oxygen, water, or halogens.

Reactions with Halogens

- Some transition metals react with halogens to form halide compounds.
- Example: Iron + Chlorine → Iron(III) Chloride$Fe\ (s) + Cl_2\ (g) \rightarrow FeCl_3\ (s)$

Uses in Industry

Stainless Steel (Iron + Chromium + Nickel): Used for cutlery and construction due to corrosion resistance.
Copper: Utilized in electrical wiring and plumbing for its excellent conductivity and corrosion resistance.
Coloured Compounds: Employed in dyes, paints, stained glass, and ceramics.