Topic 13: Periodicity

13.1 Periodic Trends Na → Ar (the third period)

13.1.1 Explain the physical properties of the chlorides and oxides of the elements in the third period (Na → Ar) in terms of their bonding and structure.
Refer to the following oxides and chlorides :

- Oxides : Na_2O, MgO, Al_2O_3, SiO_2, P_4O_6 and P_4O_{10}, SO_2 and SO_3, Cl_2O and Cl_2O_2.
- Chlorides : $NaCl$, $MgCl_2$, Al_2Cl_6, $SiCl_4$, PCl_3 and PCl_5 and Cl_2 (sulfur chloride is not required).

Limit the explanation to the physical states of the compounds under standard conditions and electrical conductivity in the molten state only.

13.1.2 Describe the chemical trends for the chlorides and oxides referred to in 13.1.1. Include relevant equations.
Limit this to acid-base properties of the oxides and the reactions of the chlorides and oxides with water.

13.2 d-block Elements (first row)

13.2.1 List the characteristic properties of transition elements.
Restrict this to variable oxidation states, complex ion formation, coloured compounds and catalytic properties.

13.2.2 Identify which elements are considered to be typical of the d-block elements.
Sc and Zn are not typical.

13.2.3 Describe the existence of variable oxidation states in d-block elements.
The 4s and 3d sub-levels are close in energy. Students should know that all d-block elements can show an oxidation state of +2. In addition, they should be familiar with the oxidation states of the following : Cr (+3,+6), Mn(+4, +7), Fe (+3) and Cu (+1).

13.2.4 Define the term *ligand*.

13.2.5 Describe how complexes of d-block elements are formed.
Suitable examples are : $[Fe(H_2O)_6]^{3+}$, $[Fe(CN)_6]^{3-}$, $[Cu(NH_3)_4]^{2+}$, $[Ag(NH_3)_2]^{+}$.
Only monodentate ligands are required.

13.2.6 Explain why some complexes of d-block elements are coloured.
Students need only know that in complexes the d orbitals are split into two sets at different energy levels and the electronic transitions that take place between them are responsible for their colours.

13.2.7 Outline the catalytic behaviour of d-block elements and their compounds.
Limit this to :

- MnO_2 in the decomposition of hydrogen peroxide
- V_2O_5 in the Contact process
- Fe in the Haber process
- Ni in the conversion of alkenes to alkanes.

The mechanisms of action are not required.