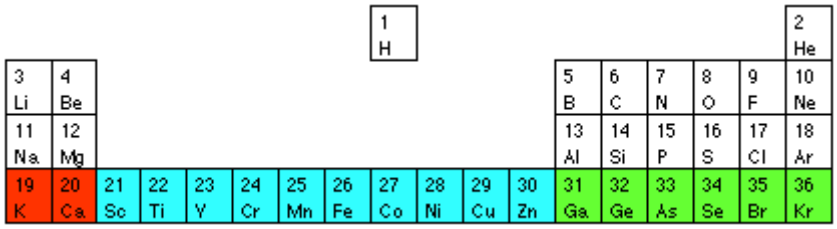
TRANSITION METALS: GENERAL FEATURES

1. a) Write the electronic structure of the following transition metal atoms using the short form in which, for example, Co would be [Ar]$3d^7 4s^2$. Use this small bit of the Periodic Table (taken from the Chemguide page) for the atomic numbers.



(i) Cu (ii) Ti (iii) Zn (iv) Cr

b) Write the electronic structures of the following ions using the same short form as above.

(i) Fe^{2+} (ii) Fe^{3+} (iii) V^{3+} (iv) Ni^{2+} (v) Cu^{2+}

2. Explain the difference between the terms *transition metal* and *d-block element*.

3. a) Transition metals show variable oxidation states. Give examples of two different oxidation states shown by manganese in its compounds. In each case, give the oxidation state, and an example of a compound or ion containing manganese in that oxidation state.

b) The first three ionisation energies for calcium and iron (in kJ mol^{-1}) are shown in this table taken from the Chemguide page.

metal	1st IE	2nd IE	3rd IE
Ca	590	1150	4940
Fe	762	1560	2960

(i) Both calcium and iron form a 2+ ion rather than a 1+ ion, despite the fact that a 2+ ion needs a lot more ionisation energy than a 1+ ion. Explain why the 2+ ion is formed rather than the 1+.

(ii) Explain why iron can form a 3+ ion whereas calcium only forms a 2+ ion.

4. Copper forms three common complex ions: $[Cu(H_2O)_6]^{2+}$, $[Cu(NH_3)_4(H_2O)_2]^{2+}$ and $[CuCl_4]^{2-}$.

   a) What is the general name given to groups such as water, ammonia or chloride ions which surround the central metal ion?

   b) How are these groups bound to the central metal ion?

   c) What colours are the $[Cu(H_2O)_6]^{2+}$ and $[Cu(NH_3)_4(H_2O)_2]^{2+}$ ions?

5. Transition metals and their compounds are frequently used as catalysts.

   a) Name the catalyst in the Haber Process for the manufacture of ammonia.

   b) Name the catalyst used in the hydrogenation of carbon-carbon double bonds.

   c) Name the catalyst in the Contact Process for the manufacture of sulphuric acid.