Review I: Transition Metals

1. Electron configuration for:
    a. Cr
    b. Cr^{2+}

2. Oxidation number for:
    a. $Cr_2O_4^{2-}$
    b. CrO_4^{2-}
    c. $CrCl_4^{2-}$

3. Classify as oxidation or reduction and balance
$Cr_2O_4^{2-} \rightarrow CrO_4^{2-} + Cr^{3+}$

4. Identify (i) central ion (ii) ligand (iii) Coordination number
    a. $Cr(NH_3)_4^{2+}$
    b. $CrCl(H_2O)_5^{2+}$
    c. $(NH_4)_3VF_6$

5. Given Coordination number, write the formula and name of the complex ion formed
    a. $Cu^{2+} + H_2O$ (CN = 4)
    b. $Fe^{3+} + CN^-$ (CN = 6)
    c. $NI^{2+} + Cl^-$ (CN = 4)
    d. $Ag^+ + NH_3$ (CN = 2)
    e. $Cu^{2+} + Cl^-$ (CN = 4)

6. Identify 4 types of bonding in $CuSO_4 \cdot 5H_2O$

7. Compare the trends in Atomic radii, IE, energy for the elements in a short period (3 marks) to those of TM. Explain in terms of electron arrangement

8. Give 4 properties/characteristics of d-block elements and of their compounds. Illustrate your answers with suitable examples.

9. Why Sc and Zn do not behave as typical d-block elements?

10. $Cu^{2+}(H_2O)_4$ is blue. When conc. HCl is added it turns yellow/green. Why? Explain.

11. Which can act as a ligand: PH_3, PH_4^+, F^-, $C_2O_4^{2-}$, H_2O

12. The stability constants of the following two complex ions are:

i) $Cu(NH_3)_4^{2+}$ $K_c = 1.58 \times 10^{13}$
ii) $CuCl_4^{2-}$ $K_c = 3.98 \times 10^{5}$

a) Write the equation to which these constants refer

b) Use the equation and stability constants to predict what would happen if NH_3 solution were added drop by drop to a solution of $CuCl_4^{2-}$ ions

13. a) What are geometric isomers?
c) Draw the structure families of CrS^- and trans dichlorodiammine cobalt(II)

14. Explain why a H_2O solution of copper(II)sulphate is used to filter out heat waves (red end of spectrum)?

ANSWERS: Review I: Transition Metals

1.
   a. [Ar] 3d5 4s1
   b. [Ar]3d4
2.
   a. +3
   b. +6
   c. +2
3. $Cr_2O_4^{2-}$ ----> $CrO_4^{2-} + Cr^{3+} + 3e^-$ oxidation reaction
4.
   a. i: Cr^{2+} ii:NH_3 iii:4
   b. i:Cr^{3+} ii: Cl, H_2O iii:+3
   c. i: V^{3+} ii: F, NH_4 iii: +3
5.
   a. $Cu(H_2O)_4^{2+}$ tetraaquacopper (II) iron
   b. $Fe(CN)_6^{3-}$ hexacyanoferrate (III) ion
   c. $NiCl_4^{2-}$ tetrachloronickel (II) ion
   d. $Ag(NH_3)_2^{+}$ diamminesilver (I) ion
   e. $CuCl_4^{2-}$ tetrachlorocopper(II) ion
6. Covalent bonds within the S and O, in sulphate ion and covalent bonds within the water molecule, Ionic bonds between Cu^{2+} and SO_4^{2-}, ion-dipole attractions between H_2O and $CuSO_4$

7. While it is common for a short period to experience large differences going across a period, the properties of TM remains fairly constant. This is because transition metals generally differ in electrons in the d-shell, increasing going across the period. However, the chemistry of the electrons is mainly involved in the s orbitals, so going across the period, the increase of electrons in the d-shell helps to shield the 4s electrons, keeping the effective nuclear charge relatively constant.

8. Forms coloured complex in solution, eg copper (II) sulphate is blue; Several oxidation states as a result of similar energy levels of 4s and 3d orbitals; catalytic properties, paramagnetic properties

9. All compounds of scandium have an empty 3d shell and all compounds of zinc have a filled 3d shell, hence they do not behave like TM.

10. The H2O ligand is replaced by HCl creating the complex ion $CuCl_4^{2-}$. This new ligand leads to repulsion of the electrons in the d shell of the central ion to a different extent, leading to different change in energy during transition, hence different coloured complex.

11. PH3, F-, CrO4(2-), H2O

12.
    a. i: $K_c=[NH3]^4[Cu^{2+}]/[Cu(NH3)^{2+}]$ ii: $K_c=[Cl-]^4[Cu^{2+}]/[CuCl4)^{2-}]$
    b. Since the equilibrium expression for the dissociation $Cu(NH3)^{2+}$ is highly product favoured (as per the equilibrium constant), adding drops of NH3 would be unlikely to lead to the formation of $Cu(NH3)^{2+}$

14. Copper (II) Sulphate has a characteristic blue coloured solution. This is a result of its absorption of red light, leading to the refection of blue wavelength light. Since it absorbs red light, it can easily filter out heat waves.