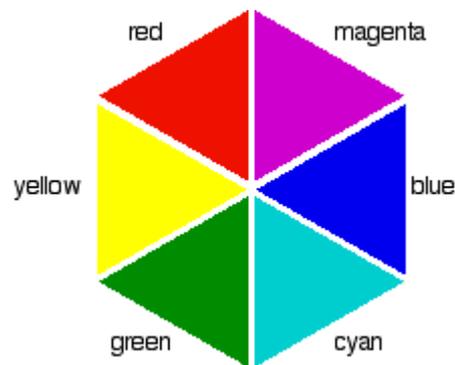


Chemguide – questions

COMPLEX IONS – ORIGIN OF COLOUR

1. The diagram shows a simple colour wheel.



a) Copper(II) sulphate solution looks pale blue because when light shines through it, some frequencies of white light are absorbed. What colour does copper(II) sulphate solution absorb?

b) When you add an excess of ammonia solution to copper(II) sulphate solution, the colour changes to a very deep blue as the tetraammineaqua copper(II) ion is formed. What colour is the solution now absorbing from white light?

2. The electronic structure of a copper atom is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$.

a) Using “electrons-in-boxes” notation, show the arrangement of the 3d electrons in a Cu^{2+} ion.

b) On an energy diagram, show what happens to the energies of the 3d electrons when the atom is approached by water molecules to make the $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ ion.

c) Explain how this allows the ion to absorb certain energies of light.

d) Explain how that differs if you replace some of the water molecules by ammonia molecules to make the $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ ion. You should be as precise as possible as to why the colour absorbed changes in the way you have stated in question 1.

e) Write the electronic structures of the Mg^{2+} , Sc^{3+} and Zn^{2+} ions, and use them to explain why these ions are colourless.

3. The colours of the complexes of a particular transition metal depend on the ligand you are using (as above with copper(II) complexes), the coordination of the complex, and the oxidation state of the metal.

a) Give and describe an example involving change of oxidation state in chromium chemistry.

b) Give and describe an example involving change of both coordination and ligand in cobalt chemistry.