

Extension Work

This work is not mandatory. It is to assist you in revision of unit 1.

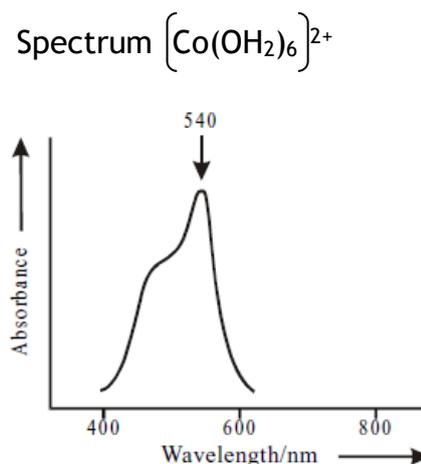
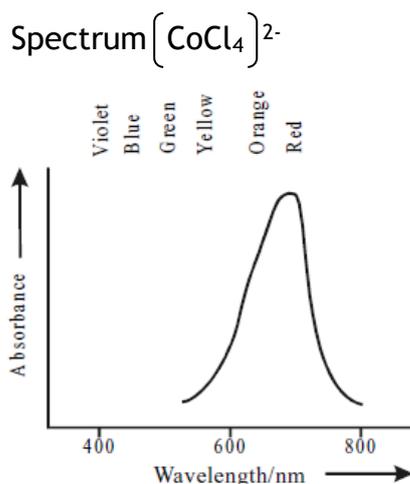


Watch the clips from Youtube.

<https://www.youtube.com/watch?v=aKzTtURgTgA>

<https://www.youtube.com/watch?v=d2CQPYo0WAA>

- In some textbooks, zinc is not regarded as a transition element.
 - Explain in terms of electronic structure why this should be so.
 - What is thought to be a reason for so many catalysts being derived from transition elements?
 - Explain how catalysts can affect the activation energy of a reaction.
- The following are the absorption spectra of two coloured solutions containing complex cobalt(II) ions.



- Give the name of both complexes.
 - Predict the colour of the solution containing $[\text{CoCl}_4]^{2-}$ ions.
 - Calculate the energy difference, in kJ mol^{-1} , corresponding to the absorbance peak at 540 nm for the solution containing $[\text{Co}(\text{OH}_2)_6]^{2+}$ ions.
- For the complex ion tetrachloridocuprate(II), give the formula of the ion, including its charge.
 - Dilution of a solution containing tetrachloridocuprate(II) ions with water results in all of the chlorido ligands being displaced by water ligands. An octahedral complex ion forms.
 - Name the octahedral complex ion.
 - Draw its structure.



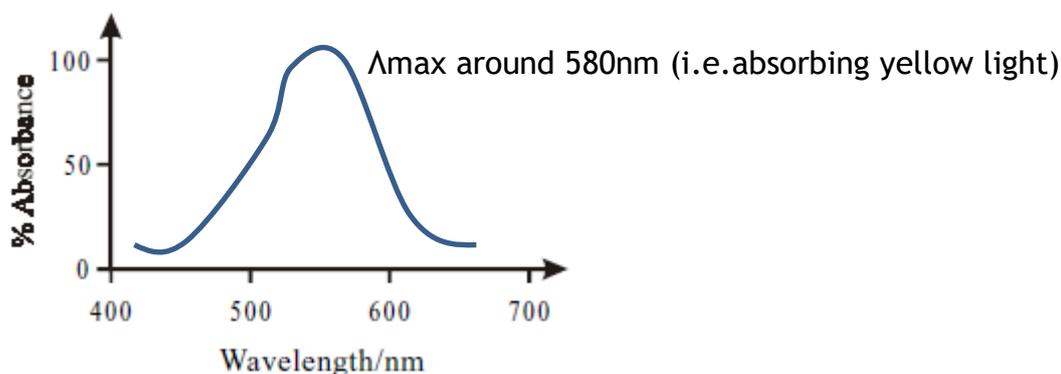
4. A green solution of nickel(II) chloride was added to a colourless solution of ammonium tetrafluoroborate, producing a pale lilac coloured complex.

- Write down the electronic configuration for the Ni^{2+} ion.
- Give a brief explanation for the green colour of the nickel(II) chloride solution.
- Suggest a reason for the change in colour when the two solutions react together.

5. The table below gives information about complex ions containing vanadium.

Ion	Colour
$[\text{V}(\text{OH}_2)_6]^{2+}$	Violet
$[\text{V}(\text{OH}_2)_6]^{3+}$	Green
$[\text{VO}]^{2+}$	blue
$[\text{VO}_2]^+$	

- Determine the oxidation number of vanadium in the ions $[\text{VO}_2]^+$ and $[\text{V}(\text{OH}_2)_6]^{2+}$.
- (i) Give the electronic configuration for vanadium in the $[\text{VO}_2]^+$ ion.
(ii) Suggest why you would predict this ion to be colourless.
- Light of wavelength varying from 400 to 700 nm is passed through a solution containing $[\text{VO}]^{2+}$ ions. Copy the axes shown below and draw the absorption spectrum that you would expect to obtain. (You may wish to use page 20 of the data booklet).



6. Three compounds can result from the reaction between copper(II) chloride and ammonia. These compounds were reacted with silver(I) nitrate solution and the number of moles of silver(I) chloride formed per mole of each compound was calculated.

Compound	Empirical formula	Moles of silver(I) chloride
1	$\text{CuCl}_2 \cdot 4\text{NH}_3$	2
2	$\text{CuCl}_2 \cdot 3\text{NH}_3$	1
3	$\text{CuCl}_2 \cdot 2\text{NH}_3$	0

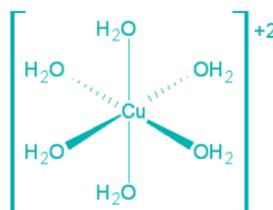
- Give the formula of the **complex** ion for each compound.
- Suggest why these three compounds have different colours from aqueous copper salts.

Answers

1. a) It has a full d sub-shell.
 b) Vacant d orbitals are readily available for bonding, i.e. show variable oxidation states.
 c) One reactant may be adsorbed (or held by covalent bonds, often with d orbitals of the catalyst) in a suitable orientation for a more successful collision.
or in such a way that bonds within the reactant are weakened (and there is a new arrangement of bonds, i.e. a reaction occurs).

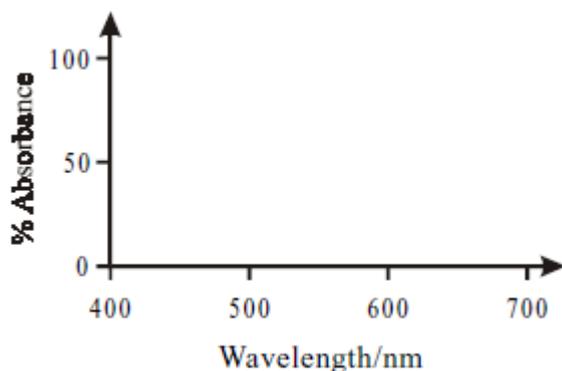
2. a) tetrachloridocobaltate (II) hexaaquacobalt (II)
 b) Blue-green
 c) 221.7 kJ mol⁻¹

3. a) $[\text{CuCl}_4]^{2-}$ b) i) hexaaquacopper(II) ii)

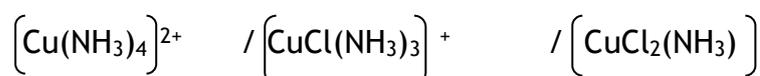


4. a) $\text{Ni}^{2+} 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$
 b) Chlorido ligands split the d orbitals and energy (a selection of frequencies) from the visible spectrum promotes electrons across the gap. The complementary colour to that which is absorbed is viewed.
 c) The size of the d-d split is altered by the presence of different ligands, so frequencies absorbed are different and the colour transmitted is altered.

5. a) +5 and +2 respectively.
 b) i) $1s^2 2s^2 2p^6 3s^2 3p^6$ ii) It has no d-electrons to be promoted.
 c)



6. a) Ligands are held to a central metal ion by dative covalent bonds, not by ionic bonds. The ionic chloride ions are free to form a precipitate with Ag^+ ions whereas the covalently bonded chlorides are not.



- b) The degree of d-d splitting is controlled by the ligand involved. NH_3 on its own will therefore be different from NH_3 with varying proportions of Cl .

