

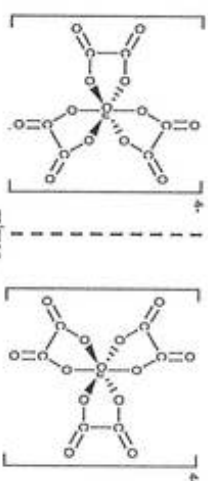
SHAPES AND COLOURS of COMPLEX IONS

ISOMERISM

u13 Team 4

OPTICAL

Optical isomerism can occur in octahedral complexes with bidentate or multidentate ligands.



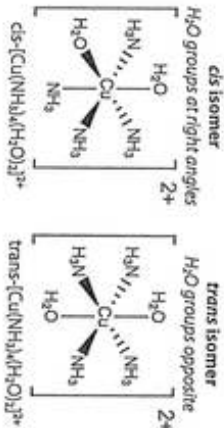
These two molecules are non-superimposable mirror images and so are optical isomers.

EXAM TIP

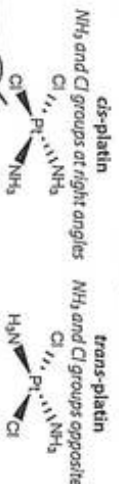
Complex by name, complex by nature! If you find drawing optical isomers tricky, draw on the wedge and dash bonds first, then add the ligands, then the mirror line, and then draw the other isomer.

CIS-TRANS

Complex ions with octahedral geometry can display cis-trans isomerism if there are two of one group and four of another.

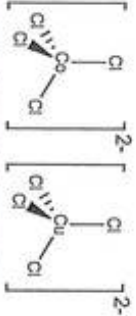


Square planar complexes can also show cis-trans isomerism if two ligands are identical. Platinum is a very common example:



TETRAHEDRAL

Complex ions with large ligands, e.g. Cl^- , generally have tetrahedral geometry.



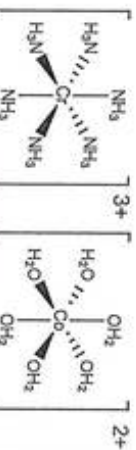
SQUARE PLANAR

Large ions can also lead to square planar complexes.



OCTAHEDRAL

Complex ions with small ligands, e.g. H_2O and NH_3 , generally have octahedral geometry.



LINEAR

Some transition metal complexes are linear, for example, Tollens' reagent $[\text{Ag}(\text{NH}_3)_2]^+$.



EXAM TIP

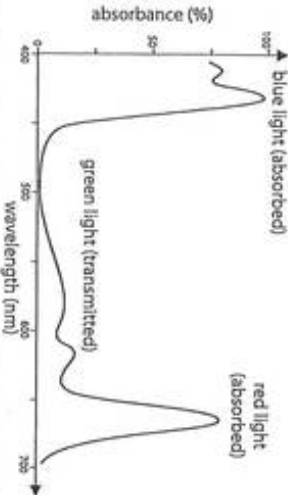
It's well worth making these shapes in 3D, and you don't need expensive modelling kit – plasticine and cocktail sticks will do the job!

WHAT CAUSES COLOUR?

COLOUR

When white light is shone on a coloured solution, the light transmitted will not contain the wavelengths of light which have been absorbed. The colour of the solution is a result of the remaining wavelengths.

For example, chlorophyll in plant leaves absorbs red and blue light, which results in the colour green.



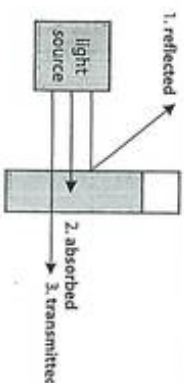
EXAM TIP

You don't need to memorise this as an example, but you should understand that the colour is a result of the light which is not absorbed.

ABSORPTION, TRANSMISSION AND REFLECTION

When light is shone on a solution of a transition metal complex, the light can be:

- reflected – the light bounces back
- absorbed – the light provides energy for an electron to move from a ground state to an excited state
- transmitted – the light passes through the sample



USE IN SPECTROSCOPY

Some types of spectroscopy – colorimetry, for example – measure the intensity of the light transmitted. This can be used to identify:

- the type of compound from the wavelengths absorbed
- the concentration of the compound from the intensity of the absorption

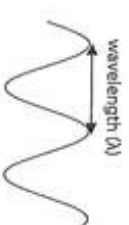
EM SPECTRUM

Light is also known as electromagnetic (EM) radiation. Higher frequencies of light have a higher energy and a shorter wavelength.

Key equation

$$\Delta E = h\nu = \frac{hc}{\lambda}$$

When an electron goes up an energy level, it absorbs light of a specific frequency (ν) which corresponds to a specific wavelength (λ).



COLOURS

The colour of compounds of a transition metal are affected by:

1. OXIDATION STATE

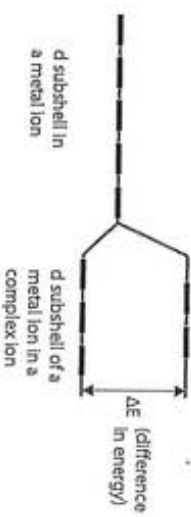
Hexaqua ions $[\text{M}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{M}(\text{H}_2\text{O})_6]^{3+}$ of iron, chromium and cobalt have distinctive colours:

	2+	3+
Iron	Green	Brown
Chromium	Blue	Violet
Cobalt	Brown	Yellow

ΔE – ENERGY OF LIGHT

ENERGY OF LIGHT

When light shines on a solution of a complex ion, the complex ion can absorb some light. This causes the electrons in the d subshell to move from a low ground state to a higher excited one.



The frequency of light absorbed depends on the value of ΔE . A larger energy difference will need light with a shorter wavelength.

2. LIGAND TYPE / COORDINATION NUMBER

Many ligand substitution reactions are accompanied by a colour change.

