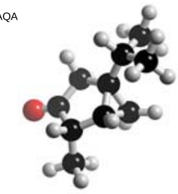
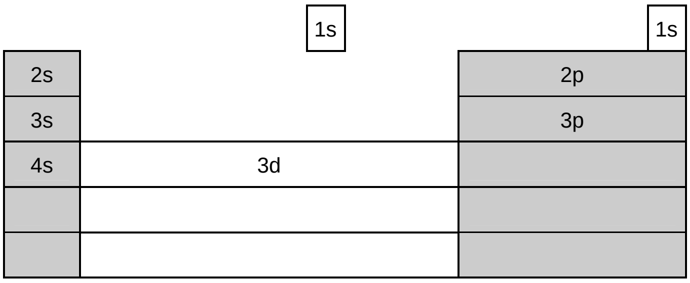
A2.CHEM5.45.001

TRANSITION METALS - INTRODUCTION



Name ………………………………………………………………………… Form …………………

1) GENERAL PROPERTIES OF TRANSITION METALS



4s fills before 3d.
4s also empties before 3d.

Give the electron structure of the following atoms / ions (start from [Ar]).

Fe	……………………………………………	Cu	……………………………………………
Fe^{3+}	……………………………………………	Cu^{+}	……………………………………………
Sc	……………………………………………	Cu^{2+}	……………………………………………
Sc^{3+}	……………………………………………	Zn	……………………………………………
V	……………………………………………	Zn^{2+}	……………………………………………
V^{2+}	……………………………………………	Cr	……………………………………………

Definition of transition metal =

metal	atom	Common ions		Transition metal?
Sc	Sc [Ar] ………………	Sc^{3+} [Ar] ………………		
Cu	Cu [Ar] ………………	Cu^{+} [Ar] ………………	Cu^{2+} [Ar] ………………	
Zn	Zn [Ar] ………………	Zn^{2+} [Ar] ………………		

The incomplete d sub-shell is responsible for a number of general properties of transition elements:

1)

2)

3)

4)

2) COMPLEX FORMATION

Some definitions

Ligand =

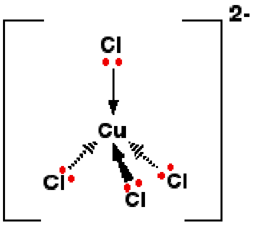
Complex =

Co-ordination number =

Lewis base =

Lewis acid =

Formation of complexes

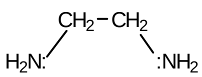
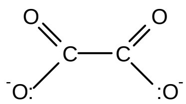
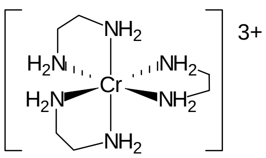
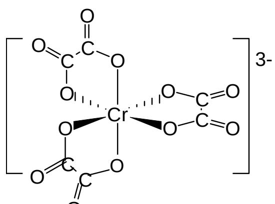


Type of ligands

Unidentate ligands – ligands which form one co-ordinate bond to a metal ion

e.g.

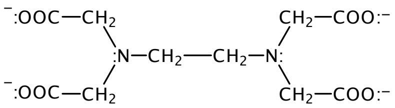
Bidentate ligands – ligands which form two co-ordinate bonds to a metal ion

Ligand	**1,2-diaminoethane (en)** 	**ethanedioate ion ($C_2O_4^{2-}$)** 
Example complex	 $[Cr(en)_3]^{3+}$	 $[Cr(C_2O_4))]^{3-}$

Multidentate ligands – ligands which form more than two co-ordinate bonds to a metal ion

<table>
<tr>
<td>Ligand</td>
<td>

$EDTA^{4-}$



forms 6 bonds

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porphyrin

forms 4 bonds

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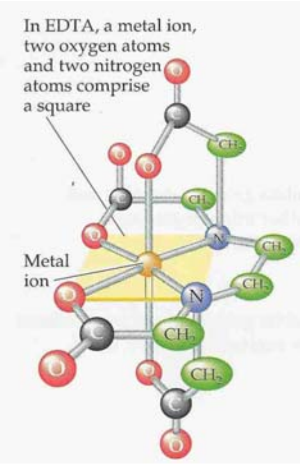
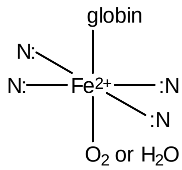
<tr>
<td>Example complex</td>
<td>



$[Cu(EDTA)]^{2-}$

</td>
<td>



haemoglobin

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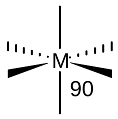
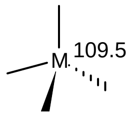
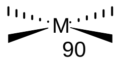
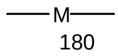
3) SHAPES OF COMPLEXES

	octahedral	**tetrahedral**	**square planar**	**linear**
co-ordination number				
shape				
occurrence				
example				

Formula	$[Ag(CN)_2]^-$	$[Cr(NH_3)_6]^{3+}$	$[Ni(en)_3]^{3+}$
Sketch			
Shape			
Bond angles			
Metal oxidation state			
Co-ordination number			

Formula	$[Co(en)_2Cl_2]^+$	$[Pt(NH_3)_2Cl_2]$	$[Fe(C_2O_4)_3]^{3-}$
Sketch			
Shape			
Bond angles			
Metal oxidation state			
Co-ordination number			

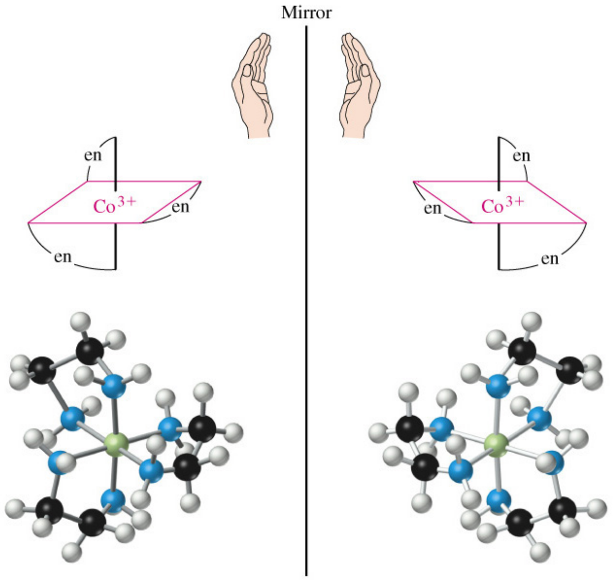
<u>Isomerism in complexes</u>

Geometric

$[PtCl_2(NH_3)_2]$

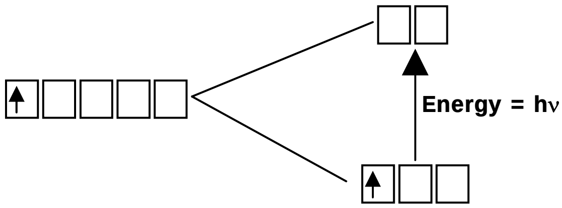
Optical

$[Co(en)_3]^{3+}$



4) FORMATION OF COLOURED IONS

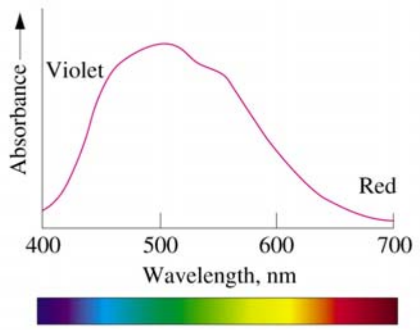
Why complexes are coloured



Factors that affect the colour

Ultraviolet/visible spectroscopy

- The frequencies at which a complex absorbs uv/visible light can be measured with a uv/visible spectrometer.
- Uv/visible light is passed through the complex, and the frequencies of uv/vis light passing through detected – those that do not pass through are absorbed.
- The more concentrated the solution the more light that is absorbed, so uv/vis can be used to measure the concentration of the solution.



(a)

Colorimetry

- The more concentrated the solution, the more it absorbs.
- This can be used to find the concentration of solutions – this is done in colorimeters.
- For some ions, a ligand is added to intensify the colour.
- The strength of absorption of solutions of known concentration is measured and a graph produced.
- The concentration of a solution of unknown concentration can be found by measuring the absorption and using the graph.