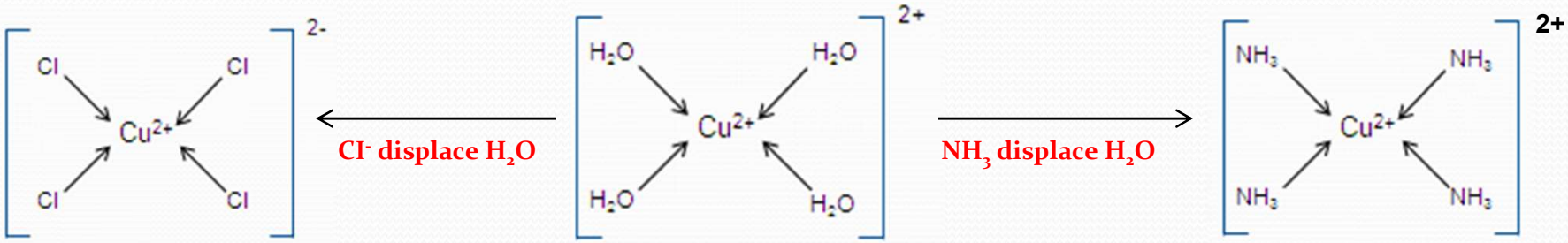
Predict the formula from the following names:

- tetracyanocuprate(I) ion
- $[Cu(CN)_4]^{3-}$
- triamminethiocyanoplatinum(III) ion
- $[PtSCN(NH_3)_3]^{2+}$
- diamminetetraaquacopper(II) ion
- $[Cu(NH_3)_2(H_2O)_4]^{2+}$
- **potassium hexacyanoferrate(III)**
- $K_3[Fe(CN)_6]$

Ligand displacement

Stronger ligand displace weaker ligand

Tetrachloro copper (II) ion | **Tetraaqua copper (II) ion** | **Tetraamine copper (II) ion**



$[Cu(H_2O)_4]^{2+} + 4CI \rightarrow [Cu(CI)_4]^{2-}$

$[Cu(H_2O)_4]^{2+} + 4NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$

Ligand displacement

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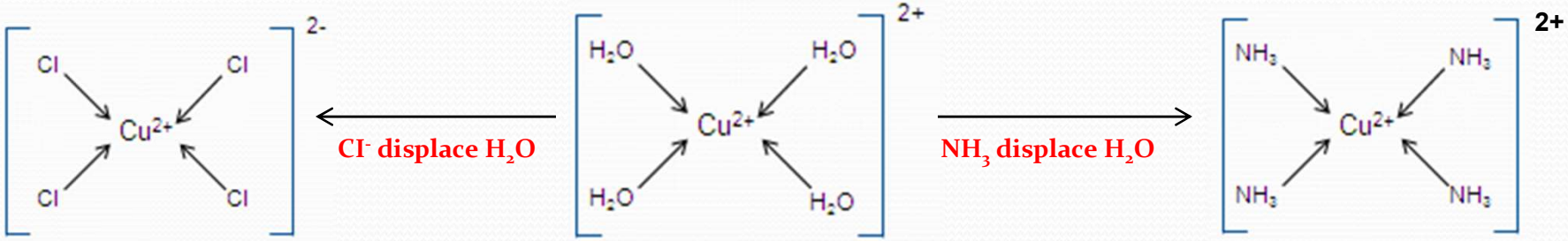


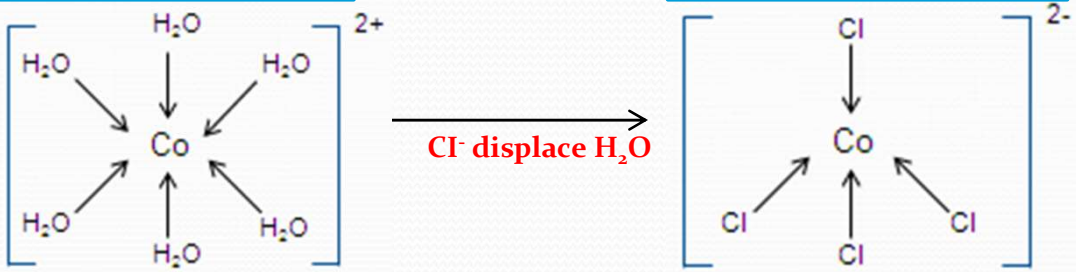
Cl^- displace H_2O

NH_3 displace H_2O

$[Cu(H_2O)_4]^{2+} + 4Cl \rightarrow [Cu(Cl)_4]^{2-}$

$[Cu(H_2O)_4]^{2+} + 4NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$

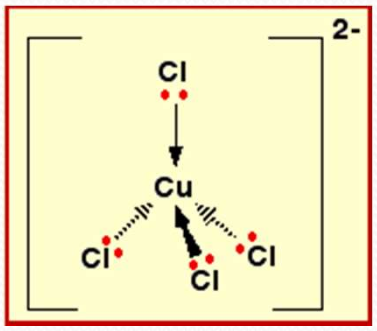
Hexaaqua cobalt (II) ion | **Tetrachloro cobalt(II) ion**



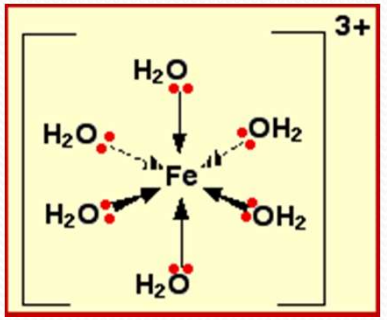
Cl^- displace H_2O

$[Co(H_2O)_6]^{2+} + 4Cl \rightarrow [Cu(Cl)_4]^{2-}$

Tetrachloro copper (II) ion

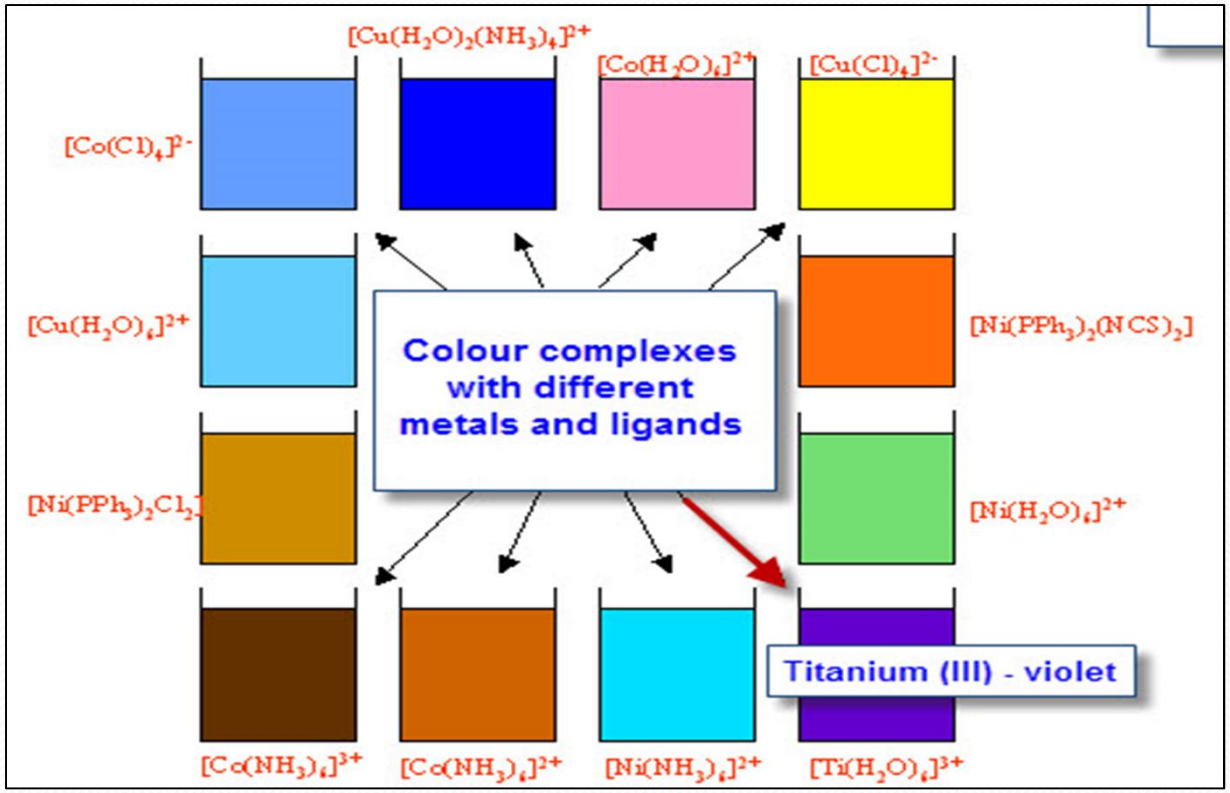


Hexaaqua iron (III) ion



Transition Metals (d block elements) – Coloured Complexes

• *Why transition metals ion complexes have different colour?*



Taken from: http://www.chm.bris.ac.uk/webprojects2003/rogers/998/chemlab.htm

Transition Metals (d block elements) – Coloured Complexes

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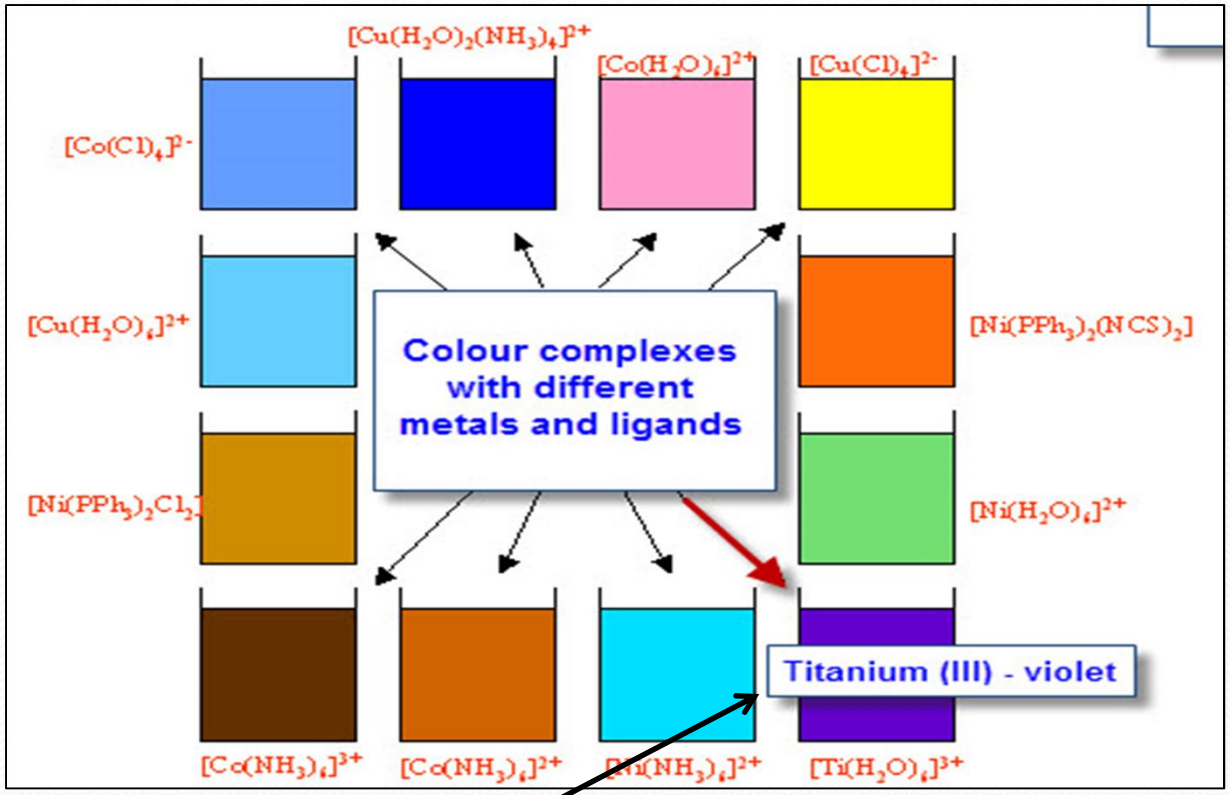

Why Titanium (III) ion is violet ?

Taken from: http://www.chm.bris.ac.uk/webprojects2003/rogers/998/chemlab.htm

Colour formation due to splitting of 3d orbitals of metal ion by ligands

Absence of ligands

- 3d orbitals same energy level
- five 3d orbitals are equal in energy

Five 3d orbitals

Colour formation due to splitting of 3d orbitals of metal ion by ligands

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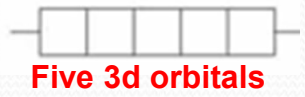
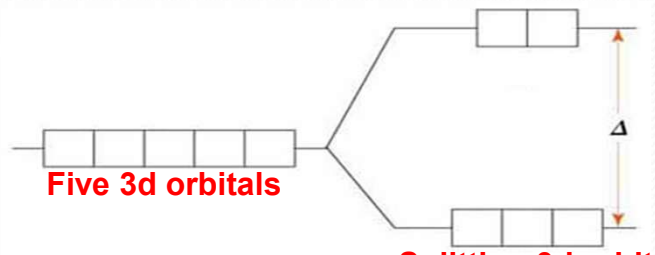
Presence of ligands
- 3d orbitals split
- five 3d orbitals unequal in energy



Five 3d orbitals



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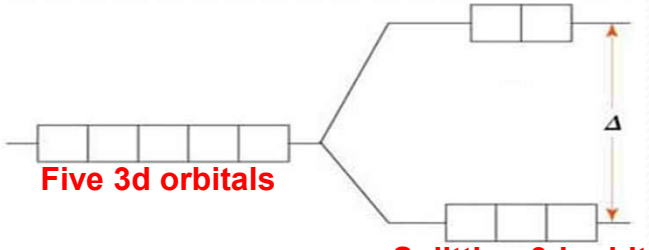
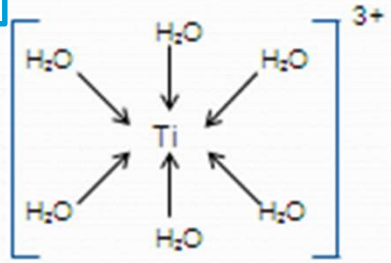


Five 3d orbitals

Splitting 3d orbitals

Why Titanium (III) ion solution is violet ?

violet



No ligands
- No splitting of 3d orbitals
- 3d orbitals equal energy

http://www.chemistryland.com/CHM151W/07-Atomic%20Structure/ElectronConfig/ElectronConfiguration.html

Transition Metals (d block elements) – Coloured Complexes

Colour formation due to splitting of 3d orbitals of metal ion by ligands

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- 3d orbitals split
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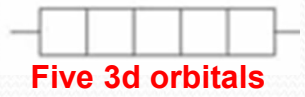

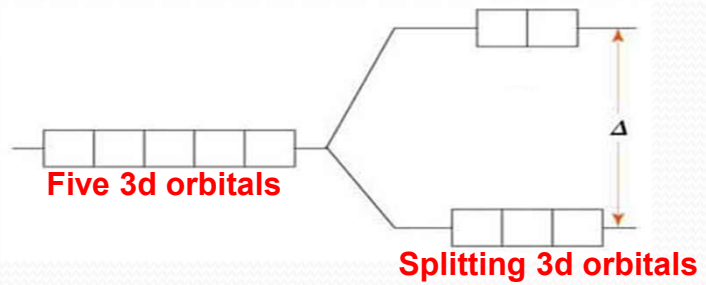

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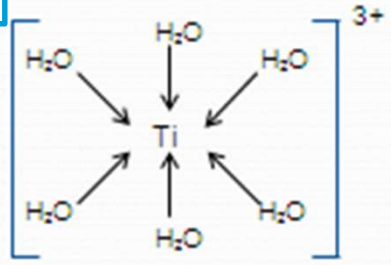
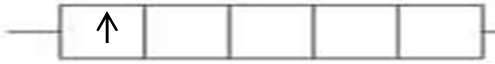
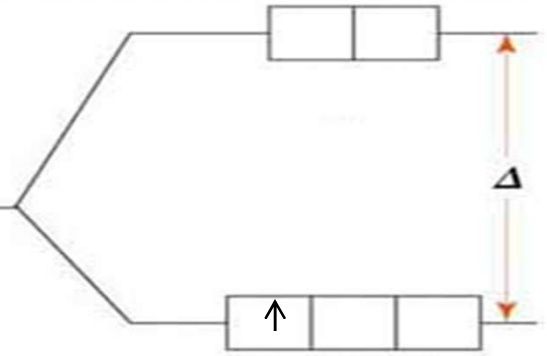


No ligands
- No splitting of 3d orbitals
- 3d orbitals equal energy



With ligands
- Splitting of 3d orbitals
- 3d orbitals unequal energy

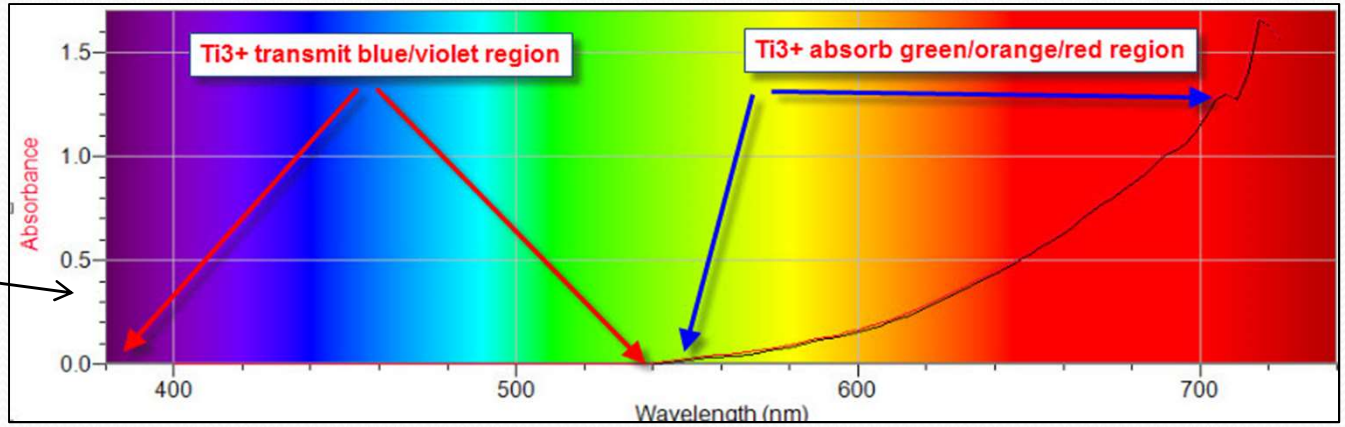


Splitting 3d orbitals
- 3d orbitals split into different energy level
- Electronic transition possible
- Photon of light absorbed to excite electrons

http://www.chemistryland.com/CHM151W/07-Atomic%20Structure/ElectronConfig/ElectronConfiguration.html

Transition Metals (d block elements) – Coloured Complexes

Why Titanium (III) ion solution is violet ?



Ti^{3+} transmit blue/violet region BUT absorb green/yellow/red

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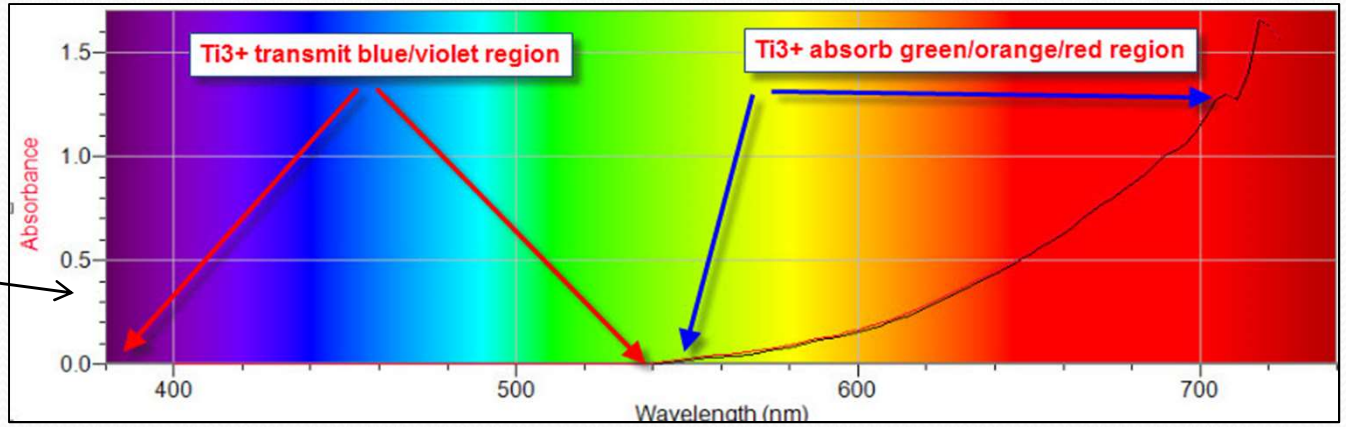

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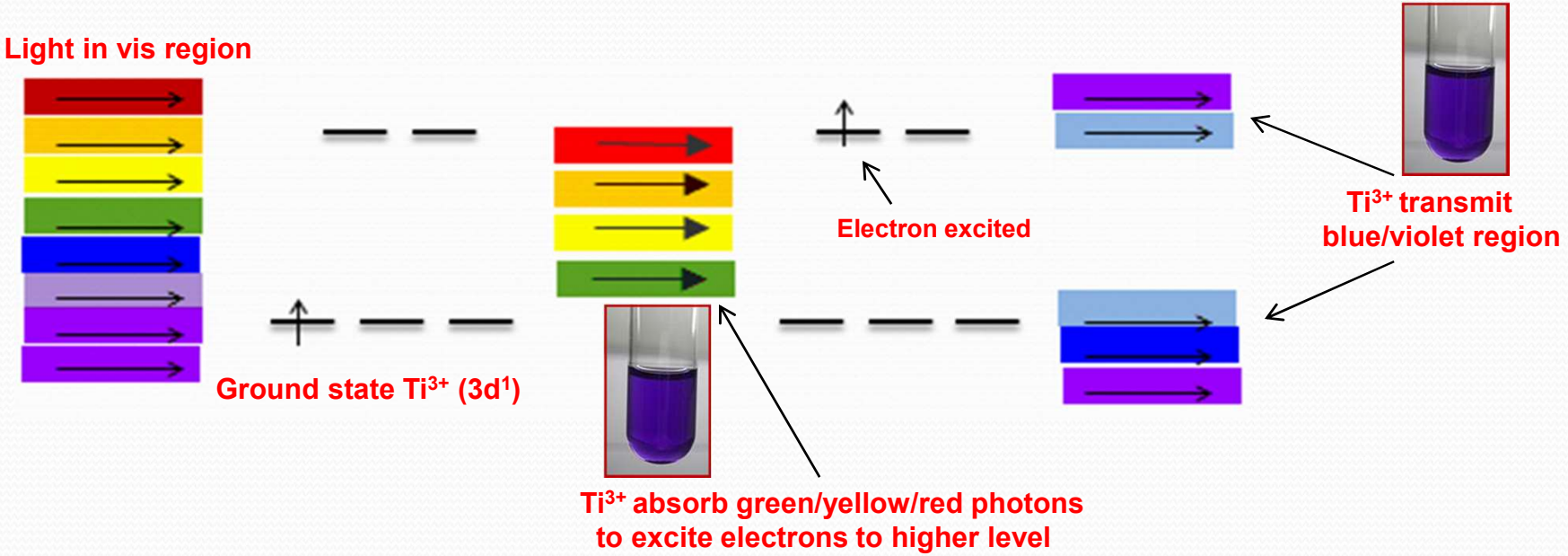
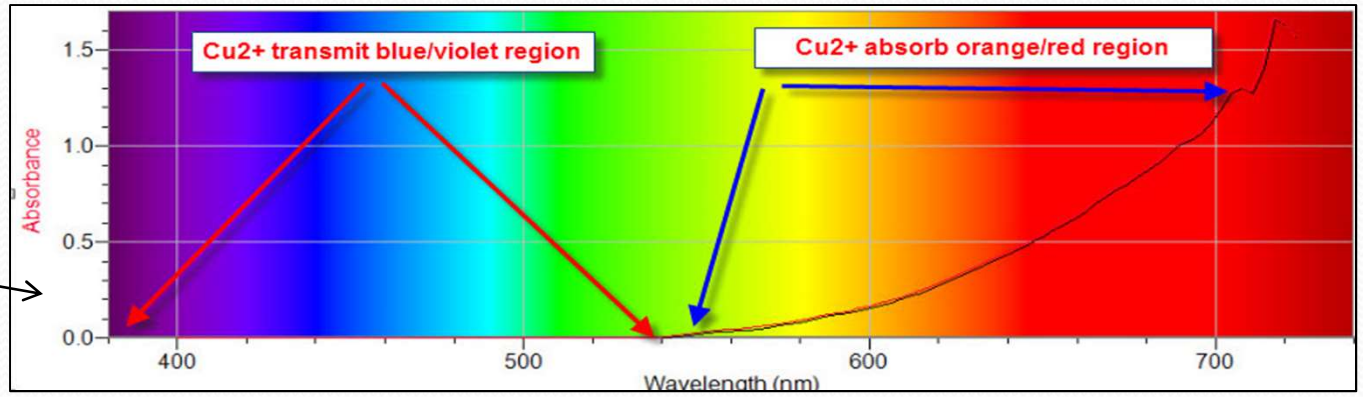


Transition Metals (d block elements) – Coloured Complexes

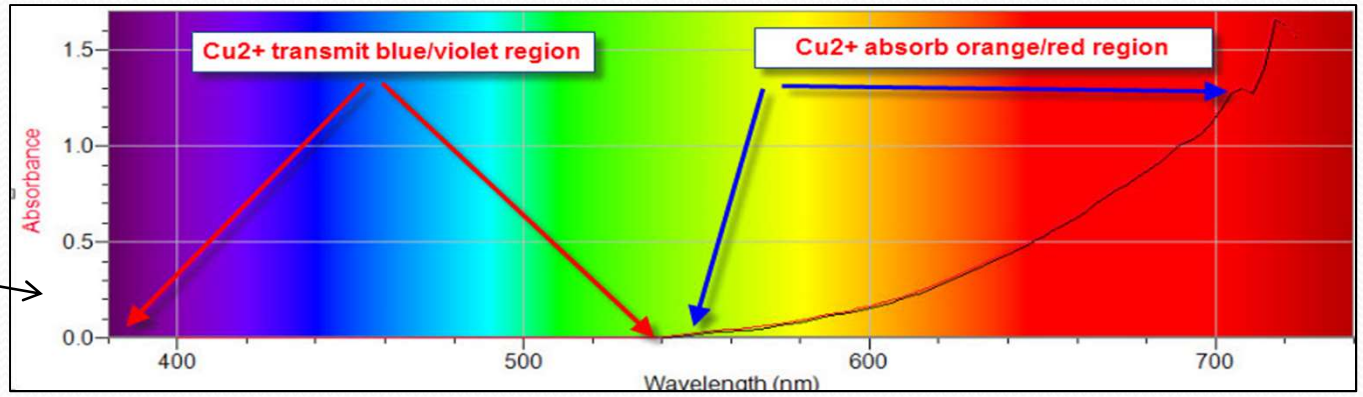
Why Copper (II) ion solution is blue ?



Cu^{2+} transmit blue/violet BUT absorb /orange/red region

Transition Metals (d block elements) – Coloured Complexes

Why Copper (II) ion solution is blue ?



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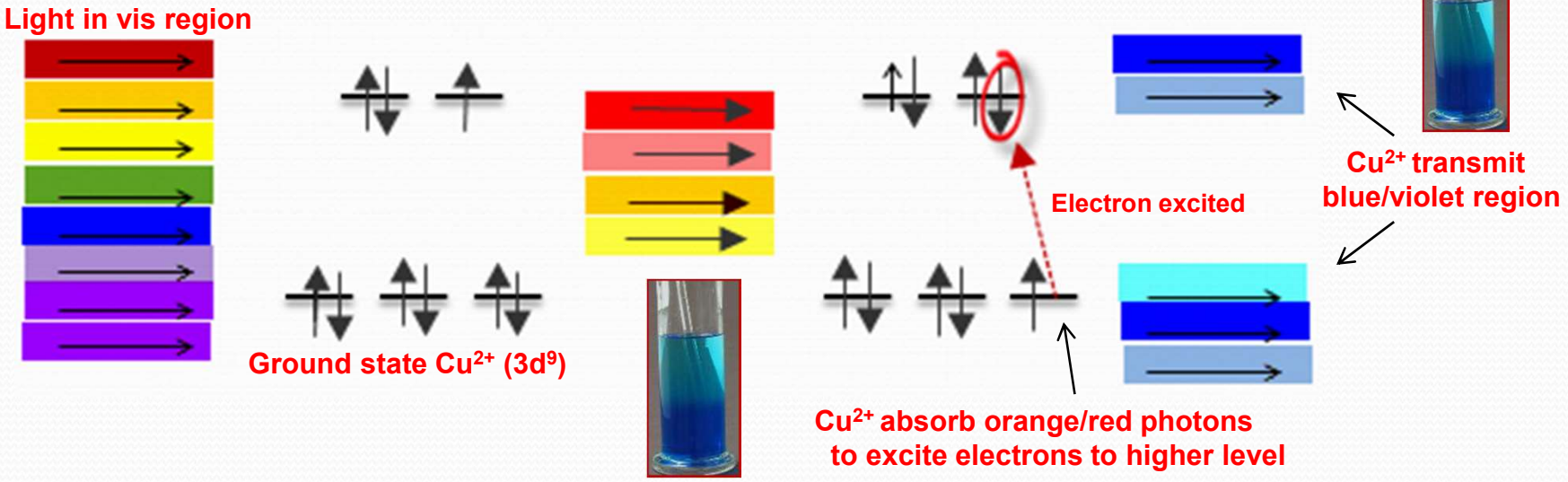


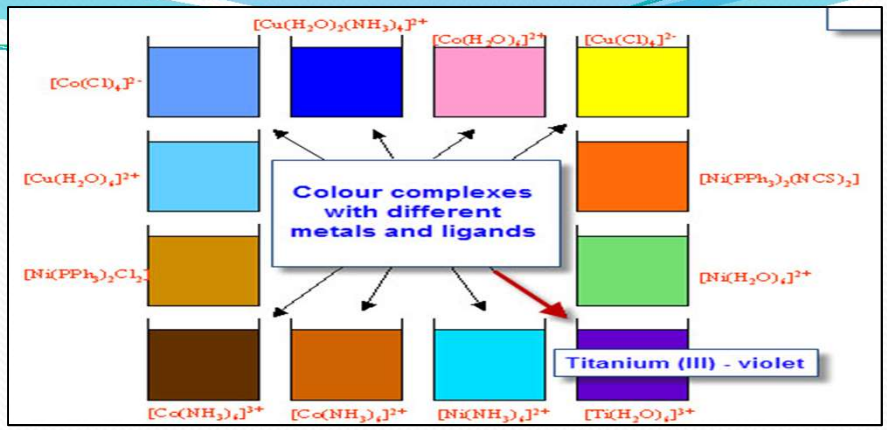
Cu^{2+} appears blue

- **Complementary colour (Red/Orange) are absorbed to excite electron**
- **Blue colour is transmitted**

Transition Metals (d block elements) – Coloured Complexes

Transition metal have different colours due to
- *splitting of 3d orbitals by ligands*
- *partially filled 3d orbitals for electron transition*

Why some are colourless ?
Cu^{2+} anhydrous – colourless
Cu^{1+} hydrous – colourless
Zn^{2+} hydrous – colourless
Sc^{3+} hydrous – colourless



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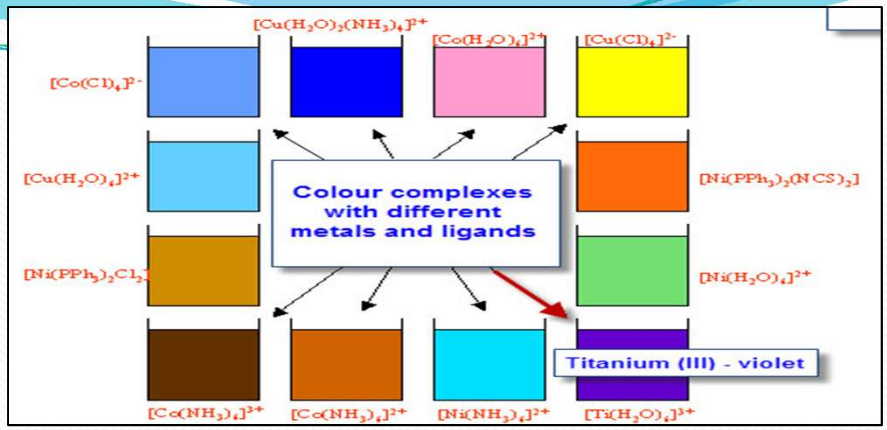
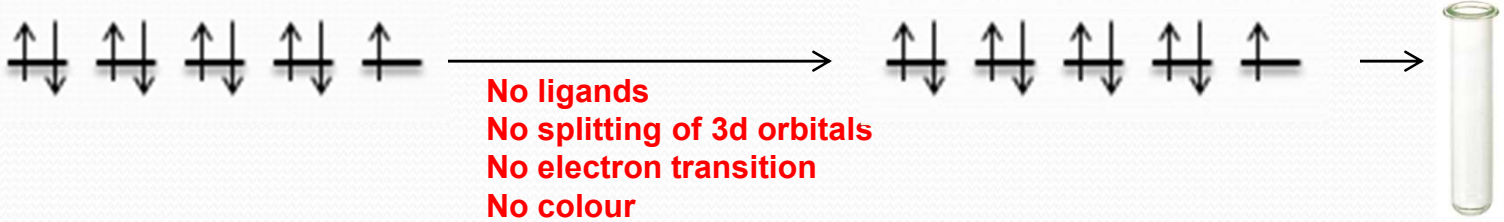


$CuSO_4$ (anhydrous) without ligands - Colourless

NO Colour



No ligands
No splitting of 3d orbitals
No electron transition
No colour

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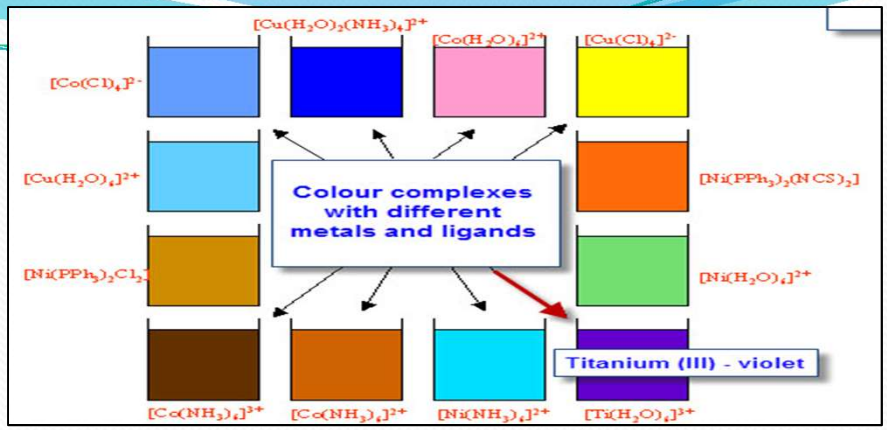

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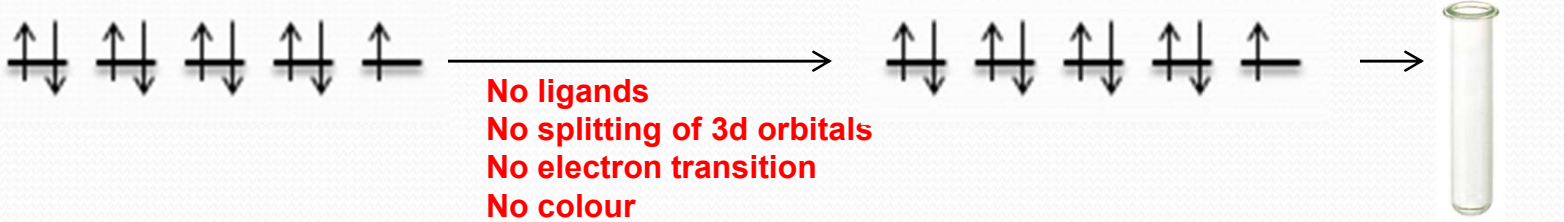
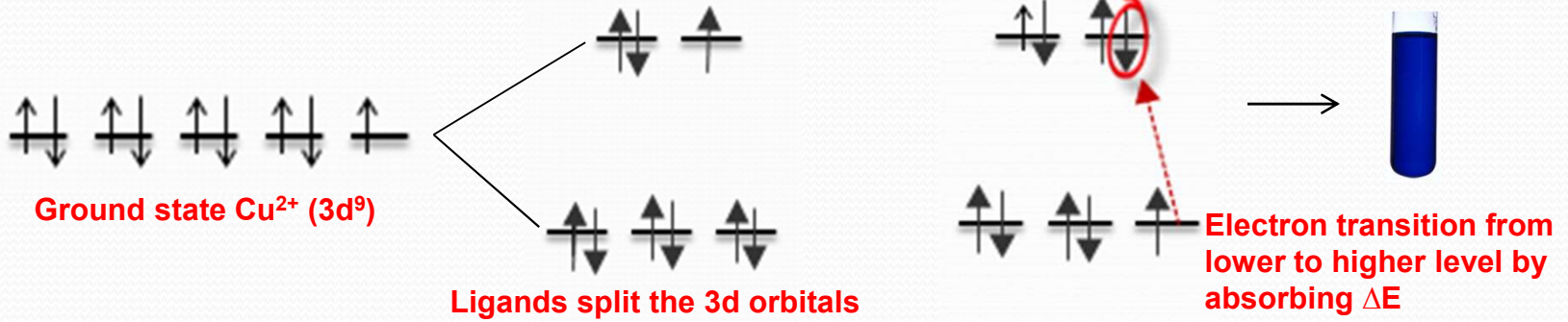


$CuSO_4$ (hydrous) with H_2O ligands – Blue Colour

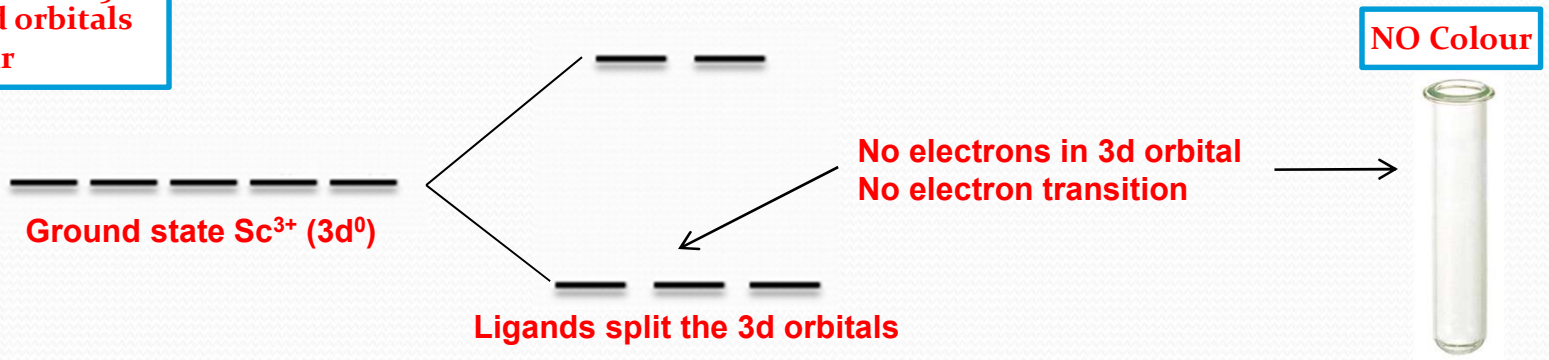


$[Cu(H_2O)_6]^{2+}SO_4$ – splitting 3d orbitals by ligand – Blue colour

Transition Metals (d block elements) – Coloured Complexes

$[Sc(H_2O)_6]^{3+}Cl_3$
- Empty 3d orbitals
- No colour

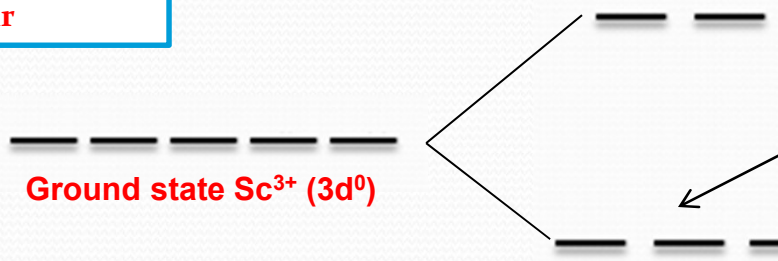
Sc^{3+} ion with ligands - Colourless



Transition Metals (d block elements) – Coloured Complexes

$[Sc(H_2O)_6]^{3+}Cl_3$
- Empty 3d orbitals
- No colour

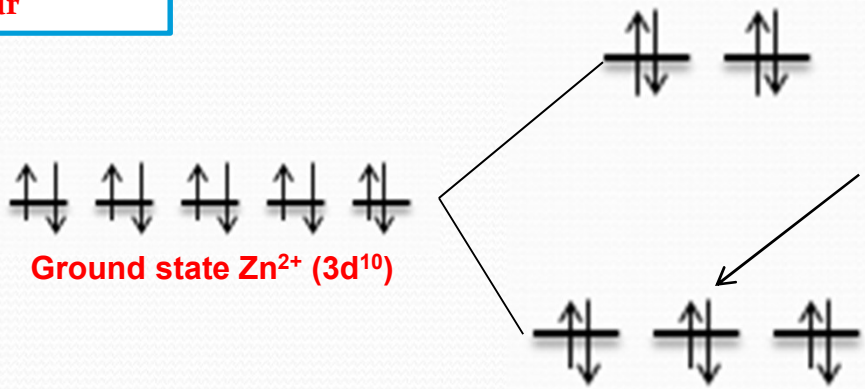
Sc^{3+} ion with ligands - Colourless



NO Colour

$[Zn(H_2O)_6]^{2+}SO_4$
- Filled 3d orbitals
- No colour

Zn^{2+} ion with ligands - Colourless

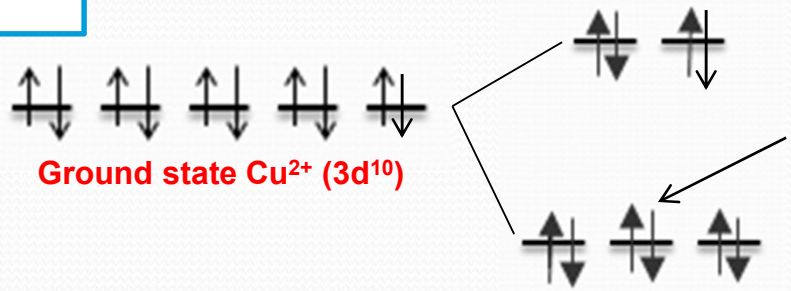


NO Colour

Transition Metals (d block elements) – Coloured Complexes

$[Cu(H_2O)_6]^{1+}Cl$
- Filled 3d orbitals
- No colour

Cu^{1+} ion with H_2O ligands - Colourless



Ground state Cu^{2+} ($3d^{10}$)

Fully filled in 3d orbital
No electron transition

Ligands split the 3d orbitals

NO Colour