CONCEPT BOOSTER

Hello friends!! Yes Yes Yes!! Exam season has finally arrived and we already done with first phase of JEE Main examination. Hope you all have done well. The pattern of the questions were as par what we have discussed in concept booster earlier. This issue is again devoted to a critical thinking part in coordination chemistry and this article is all about identifying colour in coordination compounds. A single question can vary your rank and hence every single article can change your destiny from nadir to zenith. So, enjoy and combat the battle. All the very best.

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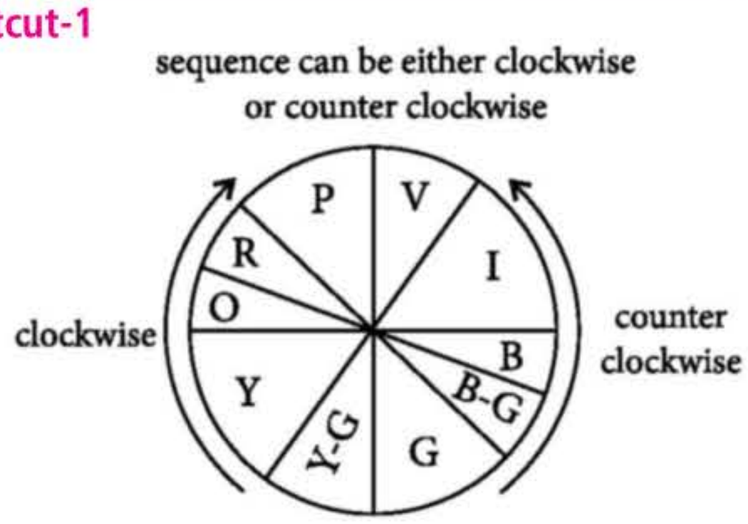
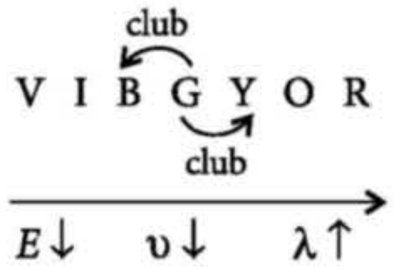
COLOUR IN COORDINATION COMPOUNDS

Shortcut-1

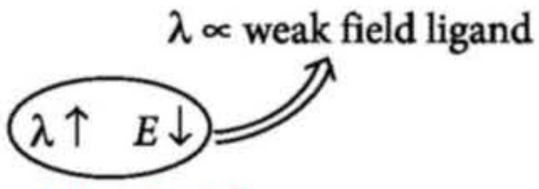


P = Purple, V - Violet, I = Indigo, B = Blue, B-G = Blue-Green, G = Green, Y-G = Yellow-Green, Y = Yellow, O = Orange, R = Red

Shortcut-2



Shortcut-3



Application of shortcut-1

$$[M(H_2O)_6]^{3+} \xrightarrow[-2H_2O]{+(AB)} [M(H_2O)_4(AB)]^{3+} \xrightarrow[-2H_2O]{+(AB)}$$

Green (X) Blue-Green (Y)

$$[M(H_2O)_2(AB)_2]^{3+} \xrightarrow[-2H_2O]{+(AB)} [M(AB)_3]^{3+}$$

Colour = ? (Z) Violet

What is the colour of *Z*?

(a) P (b) Y

(c) B (d) Y-G

Soln.: (c) As *X* is green, therefore, in the colour wheel start from Green and go to Violet. You get blue in between. ∴ Correct option is (c).

Application of shortcut-3

Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is

(a) $[Co(H_2O)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$

(b) $[Co(H_2O)_6]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$

(c) $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(H_2O)_6]^{3+}$

(d) $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$

[NEET 2017]

Soln.: (d) $\lambda \propto$ Weak field ligand

∴ $H_2O < NH_3 < en$ (strength)

∴ Wavelength : $H_2O > NH_3 > en$

There are many factors responsible for colours in coordination compounds. However, as per crystal field theory colour in coordination complexes arise due to two aspects :

1. ***d-d* transition** – Popularly known as *d-d* spectra or ligand field spectra.
2. **Charge transfer transitions** – Popularly known as charge transfer spectra.

In case of *d-d* transitions, what we first see is whether the metal is having any unpaired electron or not. This unpaired electron takes part in transition. We have also seen the e_g and t_{2g} splitting of '*d*' orbitals. However, colour due to *d-d* transition is not so simple as orgel

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diagrams, spin selection rule, Laporte selection rule etc. need to discussed to understand *d-d* transition completely. However, all these points are beyond the scope of discussion here.

On the other hand, there are certain d^0 and d^{10} species likes K_2CrO_4, $KMnO_4$, HgI_2 which are intensely coloured. But definitely the colours of these species are not due to *d-d* transition but due to charge transfer absorption. We also find some other examples like $FeCl_3$, $FeBr_3$, FeI_3 etc. which are exceptions for the concept of *d-d* transition.

Frankly speaking, charge transfer is a redox process. If we consider Fe^{3+} ion (d^5 metal ion) as an oxidising ion and X^- (like Cl^-, Br^- etc.) as reducing ion then an electron transfer takes place from X^- to the empty valence orbital of the oxidising ion. Now, the major question is, what conditions will favour charge transfer absorption? Answer can be attributed to both oxidising as well as reducing ion differently.

For metal ion :

- Having high ionisation energy.
- Empty orbitals with lower energies.

These two conditions will favour charge transfer from ligand to metal.

For ligand :

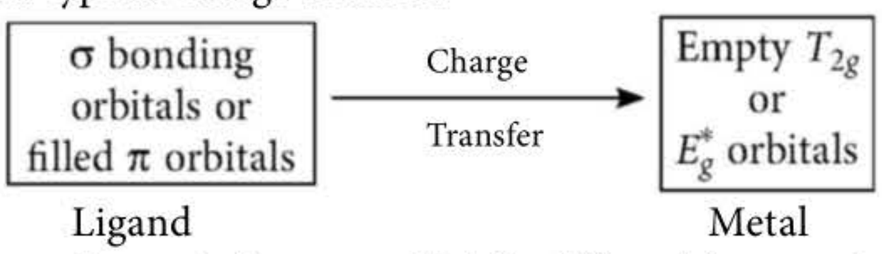
- Lower electron affinity.
- Filled orbitals of relatively higher energy.

Remember that absorption of light is more probable in case of charge transfer spectra than that of *d-d* transiton. Hence, charge transfer absorption always produces intense colour.

Following charge transfer transitions are mostly to be considered.

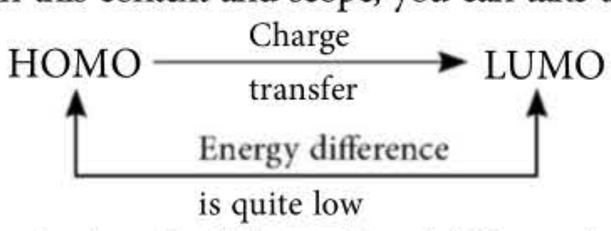
Ligand to Metal Charge Transfer (LMCT)

Mostly octahedral and tetrahedral complexes undergo this type of charge transfer.



t_{2g} and e_g notations are slightly different in meaning than T_{2g} and E_g^*.

However, in this context and scope, you can take them same.



Here, light is absorbed from the visible region or near UV region.

Examples :

1. MnO_4^- (Purple) : Simple ligand–metal charge transfer takes place.
2. I^- complexes : I^- is an easily oxidisable species due to its large size. So, in case of I^- complexes, even if the metal ions are not good oxidants, LMCT takes place. FeI_3 (intense black), P_6I_2 (yellow), HgI_2 (red).
3. Examples for the transitions where charge transfer takes place from π orbitals of ligands to metal orbitals include CdS (yellow), HgS (red), PbO (yellow), etc. In these transitions, *ns*, *np* or *nd* orbitals of metal can participate.

Metal to Ligand Charge Transfer (MLCT)

Two conditions are there :

(a) Ligands have vacant orbitals with relatively lower energy.

(b) Metals have filled orbitals with relatively higher energy.

MLCT is basically observed for octahedral complexes having CO, *py*, *bpy*, *o*-phen etc. as ligands and SCN^- too in some cases *e.g.*, $[Fe(SCN)_6]^{3-}$, $[Fe(o\text{-phen})_3]^{2+}$, $[Fe(bpy)_3]$ etc.

Metal to Metal Charge Transfer (MMCT)

It is very easy to understand as here the whole idea circulates around metal. MMCT occurs in those cases where a metal ion exists in two different oxidation states. *e.g.*, Prussian blue, $Fe_4^{III}[Fe^{II}(CN)_6]_3$ etc.

CBSE students excelling in international sports can take exams later

In a positive development for school students who excel in sports, the Central Board of Secondary Education has made it possible for them to appear for their Class X and XII Board Exams at a later date if international sports events clash with the timetable.

The board has created a special provision for such students to ensure that their exams and sporting events do not clash and that they do not have to miss out on either of them.

The concrete policy was created after the board received multiple requests from students over the past few years. In March-April 2018, the board had given concessions to nine students studying in CBSE schools from across the country as their events coincided with the exam dates.

As per a circular issued by the board on 26th December 2018, students who wish to avail the concession have to make a request to the board in writing through their schools along with the recommendation of the Sports Authority of India informing of their participation in a particular international event. The board will conduct exams for students whose requests have been accepted at a later stage, on a date mutually convenient to the student and the board. The examination, however, will be conducted before the results of the board exams are scheduled to be declared.