Class 12 Chemistry

Coordination Compounds

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Exercise 9.1

Wrtie the formulas for the following coordination compounds:

(i). Tetraamminediaquacobalt(III) chloride.

(ii). Potassium tetracyanidonichelate(II).

(iii). Tris(ethane-1,2-diamine) chromium(III) chloride.

(iv) Amminebromidochloridonitrito-N-Platinate(II).

(v). Dichlororidobis (ethane-1,2-diamine) platinum(IV) nitrate.

(vi). Iron(III) hexacyanidoferrate(II).

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Exercise 9.2

Write the IUPAC names of the following coordiantion compounds:

(i) $\left[Co\left(NH_3\right)_6\right]Cl_3$

(ii) $\left[Co\left(NH_3\right)_5Cl\right]Cl_2$

(iii) $K_3\left[Fe(CN)_6\right]$

(iv) $K_3\left[Fe\left(C_2O_4\right)_3\right]$

(v) $K_2\left[PdCl_4\right]$

(vi) $\left[Pt\left(NH_3\right)_2Cl\left(NH_2CH_3\right)\right]Cl$

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Exercise 9.3

Indicate the type of isomerism exhibited by the following complexes and draw the structures for these isomers:

(i) $K\left[Cr\left(H_2O\right)_2\left(C_2O_4\right)_2\right.$

(ii) $\left[Co(en)_3\right]Cl_3$

(iii) $\left[Co\left(NH_3\right)_5\left(NO_2\right)\right]\left(NO_3\right)_2$

(iv) $\left[Pt\left(NH_3\right)\left(H_2O\right)Cl_2\right]$

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Exercise 9.4

Give evidence that $\left[Co\left(NH_3\right)_5Cl\right]SO_4$ and $\left[Co\left(NH_3\right)_5SO_4\right]Cl$ are ionisation isomers.

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Exercise 9.5

Deduce the structures of $\left[NiCl_4\right]^{2-}$ and $\left[Ni(CN)_4\right]^{2-}$ considering the hybridisation of the metal ion. Calculate the magnetic moment (spin only) of the species.

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Exercise 9.6

$\left[NiCl_4\right]^{2-}$ is paramagnetic while $\left[Ni(CO)_4\right]$ is diamagnetic though both are tetrahedral Why?

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Exercise 9.7

$\left[Fe\left(H_2O\right)_6\right]^{3+}$ is strongly paramagnetic whereas $\left[Fe(CN)_6\right]^{3-}$ is weakly paramagnetic. Explain.

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Exercise 9.8

Explain $\left[Co\left(NH_3\right)_6\right]^{3+}$ is an inner orbital complex whereas

$\left[Ni\left(NH_3\right)_6\right]^{2+}$ is an outer orbital complex.

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Exercise 9.9

Predict the number of unpaired electrons in the square planar

$\left[Pt(CN)_4\right]^{2-}$ ion.

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Exercise 9.10

The hexaquo manganese(II) ion contains five unpaired electrons,

while the hexacyanoion contains only one unpaired electron.

Explain using the crystal field theory.

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Exercise 9.11

WERNERS THEORY OF COORDINATION COMPOUNDS

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Exercise 9.12

$FeSO_4$ solution mixed with $\left(NH_4\right)_2SO_4$ solution is 1 : 1 molar ratio gives the test of Fe^{2+} ion but $CuSO_4$ solution mixed with aqueous ammonia in 1 : 4 molar ratio does not give the test of Cu^{2+} ion.

Explain why?

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Exercise 9.13

Explain with two examples each of the following: coordination entity, ligand, coordination number, coordination polyhedron,

homoleptic and heteroleptic

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Exercise 9.14

What is meant by unidentate and ambidentate ligands? Give two examples for each.

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Exercise 9.15

Specify the oxidation numbers of the metals in the following coordination entities:

(i). $\left[Co\left(H_2O\right)(CN)(en)_2\right]^{2+}$

(ii). $\left[CoBr_2(en)_2\right]\oplus$

(iii). $\left[PtCl_4\right]^{2-}$ (iv). $K_3\left[Fe(CN)_6\right]$

(v). $\left[Cr\left(NH_3\right)_3Cl_3\right]$

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Exercise 9.16

Using *IUPAC* norms write the fomulas for the following

(i). Tetrahydroxozincate(II).

(ii). Potassium tetrachloridopalladate(II).

(iii). Diamminedlchloridoplatinum(II).

(iv). Potassium tetracyanidonickelate(II).

(v). Pentaamminenitrito-O-Cobalt(III).

(vi). Hexaamminecobalt(III) sulphate

(vii). Potassium tri(oxalato)chromate(III).

(viii). Hexaammlneplatinum(IV)

(ix). Tetrabromidocuprate(II).

(x). Pentaamminenitrito-N-cobalt(IlI).

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Exercise 9.17

Using IUPAC norms write the systematic names of the following:

(i). $\left[Co\left(NH_3\right)_6\right]Cl_3$

(ii). $\left[Pt\left(NH_3\right)_2Cl\left(NH_2CH_3\right)\right]Cl$

(iii). $\left[Ti\left(H_2O\right)_6\right]^{3+}$

(iv). $\left[Co\left(NH_3\right)_4Cl\left(NO_2\right)\right]Cl$

(v). $\left[Mn\left(H_2O\right)_6\right]^{2+}$

(vi). $\left[NiCl_4\right]^{2-}$

(vii). $\left[Ni\left(NH_3\right)_6\right]Cl_2$

(viii). $\left[Co(en)_3\right]^{3+}$

(ix). $\left[Ni(CO)_4\right]$

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Exercise 9.18

List various types of isomerism possible for coordination compounds, giving an example of each.

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Exercise 9.19

How many geometrical isomers are possible in the following corrdination entities?

(i). $\left[Cr\left(C_2O_4\right)_3\right]^{3-}$

(ii). $\left[Co\left(NH_3\right)_3Cl_3\right]$

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Exercise 9.20

Draw the structures of optical isomers of:

(i). $\left[Cr\left(C_2O_4\right)_3\right]^{3-}$

(ii). $\left[PtCl_2(en)_2\right]^{2+}$

(iii). $\left[Cr\left(NH_3\right)_2Cl_2(en)\right]^{\oplus}$

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Exercise 9.21

Draw all the isomers (geometrical and optical) of:

(i) $\left[CoCl_2(en)_2\right]^{+}$

(ii) $\left[Co\left(NH_3\right)Cl(en)_2\right]^{2+}$

(iii) $\left[Co\left(NH_3\right)_2Cl_2(en)\right]^{+}$

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Exercise 9.22

Write all the geometrical isomers of $\left[Pt\left(NH_3\right)(Br)(Cl)(py)\right]$ and how many of these will exhibit optical isomers?

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Exercise 9.23

Aqueous copper sulphate solution (blue in colour) gives:

(i). A green precipitate with aqueous potassium fluoride and

(ii). A bright green solution with aqueous potassium chloride.

Explain these experimental results.

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Exercise 9.24

What is the coordination entity formed when excess of aqueous

KCN is added to an aqueous solution of copper sulphate? Why is it that no precipitate of copper sulphide is obtained when H_2S (g) is passed through this solution?

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Exercise 9.25

Discuss the nature of bonding in the following coordination entities on the basis of valence bond theory:

(i). $\left[Fe(CN)_6\right]^{4-}$

(ii). $\left[FeF_6\right]^{3-}$

(iii). $\left[Co\left(C_2O_4\right)_3\right]^{3-}$

(iv). $\left[CoF_6\right]^{3-}$

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Exercise 9.26

Draw figure to show the splitting of d orbitals in an octahedral crystal field.

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Exercise 9.27

What is spectrochemical series? Explain the difference between a weak field ligand and a strong field ligand.

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Exercise 9.28

What is crystal field splitting energy? How does the magnitude of $\triangle_0$ decide the actual configuration of d orbitals in a coordination entity?

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Exercise 9.29

$\left[Cr\left(NH_3\right)_6\right]^{3+}$ is paramagnetic while $\left[Ni(CN)_4\right]^{2-}$ is diamagnetic. Explain why?

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Exercise 9.30

A solution of $\left[Ni\left(H_2O\right)_6\right]^{2+}$ is green but a solution of $\left[Ni(CN)_4\right]^{2-}$ is colourless Explain.

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Exercise 9.31

$\left[Fe(CN)_6\right]^{4-}$ and $\left[Fe\left(H_2O\right)_6\right]^{2+}$ are of different colours in dilute solutions why?

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Exercise 9.32

BONDING IN METAL CARBONYLS

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Exercise 9.33

Give the oxidation state, d-orbitals occupation and coordination number of the central metal ion in the following complexes:

(i). $K_3\left[Co\left(C_2O_4\right)_3\right]$

(ii). cis - $\left[Cr(en)_2Cl_2\right]Cl$

(iii). $\left(NH_4\right)_2\left[CoF_4\right]$

(iv). $\left[Mn\left(H_2O\right)\right]SO_4$

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Exercise 9.34

Wrtie down the IUPAC name for each of the following complexes and indicate the oxidation state, electronic configuration and coordination number.and magnetic moment of the complex.

(i). $K\left[Cr\left(H_2O\right)_2\left(C_2O_4\right)_2\right].3H_2O$

(ii). $\left[Co\left(NH_3\right)_5Cl\right]Cl_2$

(iii). $\left[CrCl_3(py)_3\right]$

(iv). $Cs\left[FeCl_4I\right]$

(v). $K_4\left[Mn(CN)_6\right]$

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Exercise 9.35

Explain the violet colour of the complex $\left[Ti\left(H_2O\right)_6\right]^{3+}$ on the

basis of crystal field theory.

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Exercise 9.36

What is meant by the chelate effect? Give and example.

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Exercise 9.37

Discuss briefly giving an example in each case the role of coordination compounds in: (i) biological systems (iii) analytical chemistry (ii) medicinal chemistry and (iv) extraction/metallurgy of metals

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Exercise 9.38

How many ions are produced from the complex $Co\left(NH_3\right)_6Cl_2$ in solution?

(i). 6

(ii). 4

(iii). 3

(iv). 2

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Exercise 9.39

Amongst the following ions which one has the highest magnetic moment value?

(i). $\left[Cr\left(H_2O\right)_6\right]^{3+}$

(ii). $\left[Fe\left(H_2O\right)_6\right]^{2+}$

(iii). $\left[Zn\left(H_2O\right)\right]^{2+}$

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Exercise 9.40

Among the following, the most stable complex is

(i). $\left[Fe\left(H_2O\right)_6\right]^{3+}$

(ii). $\left[Fe\left(NH_3\right)_6\right]^{3+}$

(iii). $\left[Fe\left(C_2O_4\right)_3\right]^{3-}$

(iv). $\left[FeCl_6\right]^{3-}$

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Exercise 9.41

What will be the correct order for the wavelengths of absorption in the visible region for the following:

$\left[Ni\left(NO_2\right)_6\right]^{4-}, \left[Ni\left(NH_3\right)_6\right]^{2+}, \left[Ni\left(H_2O\right)_6\right]^{2+}$?

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Solved Example 1

On the basis of the following observations made with aqueous solutions, assign secondary valences to metals in the following compounds:

Formula	Moles of AgCl precipitated per mole of the compounds with excess $AgNO_3$
(i) $PdCl_2.4NH_3$	2
(ii) $NiCl_2.6H_2O$	2
(iii) $PtCl_4.2HCl$	0
(iv) $CoCl_3.4NH_3$	1
(v) $PtCl_2.2NH_3$	0

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Solved Example 2

Write the formulas for the following coordination compounds:

(a) Tetraa mmineaqua chlorido cobalt (III) chloride

(b) Potassium tetrahydroxid ozincate (II)

(c) Potassium trioxalato aluminate (III)

(d) Dichloridobis (ethane-1,2-diamine) cobalt (III)

(e) Tetra carbonyl nickel (0)

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Solved Example 3

Write the IUPAC names of the following coordination compounds:

(a) $\left[Pt\left(NH_3\right)_2Cl\left(NO_2\right)\right]$

(b) $K_3\left[Cr\left(C_2O_4\right)_3\right]$

(c) $\left[CoCl_2(en)_2\right]Cl$

(d) $\left[Co\left(NH_3\right)\right]Cl$

(e) $Hg\left[Co(SCN)_4\right]$

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Solved Example 4

Why is geometrical isomerism not possible in tetrahedral complexes having two different types of unidentate ligands coordinated with central metal ion ? .

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Solved Example 5

Draw structures of geometrical isomers of $\left[Fe(CN)_4\left(NH_3\right)_2\right]^?$.

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Solved Example 6

Out of the following two coordination entities Which is chiral (optically active)

(a) *cis* - $\left[CrCI_2(OX)_2\right]^{3-}$

(b) *trans* - $\left[CrCI_2(OX)_2\right)]^{3-}$.

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Solved Example 7

The spin only magnetic moment value of $\left[MnBr_4\right]^{2-}$ ion is $5.9BM$

On the basis of *VBT* Predict the hybridisation and geometry of

$\left[MnBr_4\right]^{2-}$ ion ` .

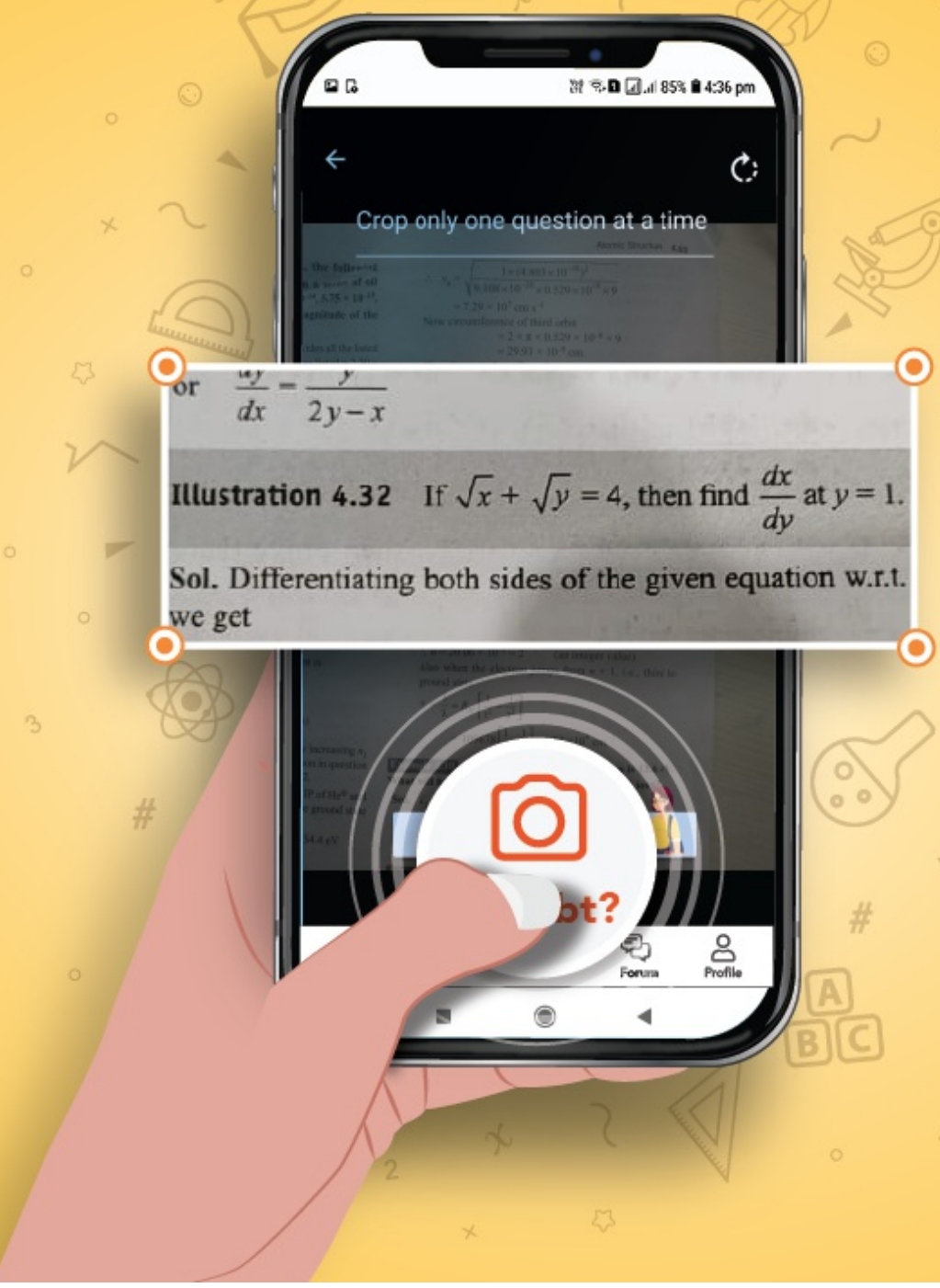
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