

Name of the Student: _____

Max. Marks : 26 Marks

Time : 26 Minutes

Mark Schemes

Q1.

- (a) A ligand is an electron pair / lone pair donor

Allow uses lone / electron pair to form a co-ordinate bond

1

A bidentate ligand donates two electron pairs (to a transition metal ion) from different atoms / two atoms (on the same molecule / ion)

QoL

1

- (b) CoCl_4^{2-} diagram

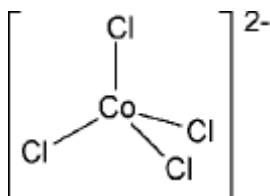
1

Tetrahedral shape

1

$109^\circ 28'$

1



Four chlorines attached to Co with net 2- charge correct

Charge can be placed anywhere, eg on separate formula

Penalise excess charges

Allow 109° to 109.5°

$[\text{Co}(\text{NH}_3)_6]^{2+}$ diagram

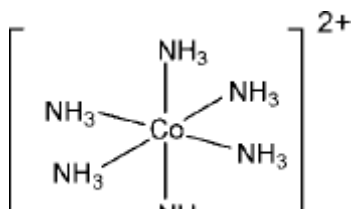
1

Octahedral shape

1

90°

1



Six ammonia / NH_3 molecules attached to Co with 2+ charge correct

Allow 180° if shown clearly on diagram

CE= 0 if wrong complex but mark on if only charge is incorrect

- (c) In different complexes the d orbitals / d electrons (of the cobalt) will have different energies / d orbital splitting will be different

1

Light / energy is absorbed causing an electron to be excited

1

Different frequency / wavelength / colour of light will be absorbed / transmitted / reflected

1

- (d) 1 mol of H_2O_2 oxidises 2 mol of Co^{2+}
Or $\text{H}_2\text{O}_2 + 2\text{Co}^{2+} \rightarrow 2\text{OH}^- + 2\text{Co}^{3+}$

1

$M_r \text{ CoSO}_4 \cdot 7\text{H}_2\text{O} = 281$

If M_r wrong, max 3 for M1, M4, M5

1

Moles $\text{Co}^{2+} = 9.87 / 281 = 0.03512$

1

Moles $\text{H}_2\text{O}_2 = 0.03512 / 2 = 0.01756$

M4 is method mark for (M3) / 2 (also scores M1)

1

Volume $\text{H}_2\text{O}_2 = (\text{moles} \times 1000) / \text{concentration}$
 $= 0.01756 \times 1000 / 5.00$

$= 3.51 \text{ cm}^3 / (3.51 \times 10^{-3} \text{ dm}^3)$

Units essential for answer

M5 is method mark for (M4) $\times 1000 / 5$

Allow 3.4 to 3.6 cm^3

If no 2:1 ratio or ratio incorrect Max 3 for M2, M3 & M5

Note: Answer of 7 cm^3 scores 3 for M2, M3, M5 (and any other wrong ratio max 3)

Answer of 16.8 cm^3 scores 3 for M1, M4, M5 (and any other wrong M_r max 3)

Answer of 33.5 cm^3 scores 1 for M5 only (so wrong M_r AND wrong ratio max 1)

1

[16]

Q2.

- (a) Co-ordinate / dative / dative covalent / dative co-ordinate

Do not allow covalent alone

1

- (b) (lone) pair of electrons on oxygen/O

If co-ordination to O^{2-} , CE=0

1

forms co-ordinate bond with Fe / donates electron pair to Fe

'Pair of electrons on O donated to Fe' scores M1 and M2

1

- (c) 180° / 180 / 90

Allow any angle between 85 and 95

Do not allow 120 or any other incorrect angle

Ignore units eg $^\circ\text{C}$

1

- (d) (i) 3 : 5 / 5 FeC_2O_4 reacts with 3 MnO_4^-

Can be equation showing correct ratio

1

- (ii) **M1** Moles of MnO_4^- per titration = $22.35 \times 0.0193/1000 = 4.31 \times 10^{-4}$
Method marks for each of the next steps (no arithmetic error allowed for M2):

Allow 4.3×10^{-4} (2 sig figs)

Allow other ratios as follows:

eg from given ratio of 7/3

1

M2 moles of FeC_2O_4 = ratio from (d)(i) used correctly $\times 4.31 \times 10^{-4}$

M2 = $7/3 \times 4.31 \times 10^{-4} = 1.006 \times 10^{-3}$

1

M3 moles of FeC_2O_4 in 250 cm^3 = M2 ans $\times 10$

M3 = $1.006 \times 10^{-3} \times 10 = 1.006 \times 10^{-2}$

1

M4 Mass of $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ = M3 ans $\times 179.8$

M4 = $1.006 \times 10^{-2} \times 179.8 = 1.81 \text{ g}$

1

M5 % of $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ = (M4 ans/1.381) $\times 100$

M5 = $1.81 \times 100/1.381 = 131 \%$ (130 to 132)

1

(OR for M4 max moles of $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ = $1.381/179.8$ ($= 7.68 \times 10^{-3}$)

for M5 % of $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ = (M3 ans/above M4ans) $\times 100$)

eg using correct ratio 5/3:

Moles of FeC_2O_4 = $5/3 \times 4.31 \times 10^{-4} = 7.19 \times 10^{-4}$

Moles of FeC_2O_4 in 250 cm^3 = $7.19 \times 10^{-4} \times 10 = 7.19 \times 10^{-3}$

Mass of $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ = $7.19 \times 10^{-3} \times 179.8 = 1.29 \text{ g}$

% of $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ = $1.29 \times 100/1.381 = 93.4$ (allow 92.4 to 94.4)

Note correct answer (92.4 to 94.4) scores 5 marks

Allow consequentially on candidate's ratio

$$\text{eg } M2 = 5/2 \times 4.31 \times 10^{-4} = 1.078 \times 10^{-3}$$

$$M3 = 1.0078 \times 10^{-3} \times 10 = 1.078 \times 10^{-2}$$

$$M4 = 1.078 \times 10^{-2} \times 179.8 = 1.94 \text{ g}$$

$$M5 = 1.94 \times 100/1.381 = 140 \% (139 \text{ to } 141)$$

Other ratios give the following final % values

1:1 gives 56.1% (55.6 to 56.6)

5:1 gives 281% (278 to 284)

5:4 gives 70.2% (69.2 to 71.2)

[10]