

Name of the Student: \_\_\_\_\_

Max. Marks : 23 Marks

Time : 23 Minutes

## Mark Schemes

Q1.

- (a) Cobalt has variable oxidation states

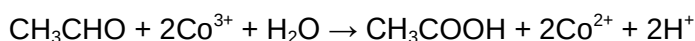
*Allow exists as Co(II) and Co(III)*

1

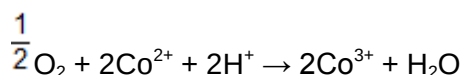
(It can act as an intermediate that) lowers the activation energy

*Allow (alternative route with) lower  $E_a$* 

1

*Allow multiples; allow molecular formulae**Allow equations with  $\text{H}_3\text{O}^+$* 

1



1

- (b) (i)
- $[\text{Co}(\text{H}_2\text{O})_6]^{2+} + 3\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2 \rightarrow [\text{Co}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_3]^{2+} + 6\text{H}_2\text{O}$

*Do not allow en in equation, allow  $\text{C}_2\text{H}_8\text{N}_2$* 

1

The number of particles increases / changes from 4 to 7

*Can score M2 and M3 even if equation incorrect or missing provided number of particles increases*

1

So the entropy change is positive / disorder increases / entropy increases

1

- (ii) Minimum for
- M1**
- is 3 bidentate ligands bonded to Co

*Ignore all charges for M1 and M3 but penalise charges on any ligand in M2*

1

Ligands need not have any atoms shown but diagram must show 6 bonds from ligands to Co, 2 from each ligand

Minimum for **M2** is one ligand identified as  $\text{H}_2\text{N}-----\text{NH}_2$ *Allow linkage as  $-\text{C}-\text{C}-$  or just a line.*

1

Minimum for **M3** is one bidentate ligand showing two arrows from separate nitrogens to cobalt

1

(c) Moles of cobalt =  $(50 \times 0.203) / 1000 = \underline{0.01015}$  mol

*Allow 0.0101 to 0.0102*

1

Moles of AgCl =  $4.22/143.4 = 0.0294$

*Allow 0.029*

*If not AgCl (eg AgCl<sub>2</sub> or AgNO<sub>3</sub>), lose this mark and can only score **M1**, **M4** and **M5***

1

Ratio = Cl<sup>-</sup> to Co = 2.9 : 1

*Do not allow 3 : 1 if this is the only answer but if 2.9:1 seen somewhere in answer credit this as **M3***

1

[Co(NH<sub>3</sub>)<sub>6</sub>]Cl<sub>3</sub> (square brackets not essential)

1

Difference due to incomplete oxidation in the preparation

*Allow incomplete reaction.*

*Allow formation [Co(NH<sub>3</sub>)<sub>5</sub>Cl]Cl<sub>2</sub> etc.*

*Some chloride ions act as ligands / replace NH<sub>3</sub> in complex.*

*Do not allow 'impure sample' or reference to practical deficiencies*

1

[15]

Q2.

- (a) Yes, because it is oxidised to ethanal /  $\text{CH}_3\text{CHO}$   
**OR** it is oxidised to a compound that contains  $\text{CH}_3\text{CO}$  group  
*Ignore 'primary alcohols are oxidised to aldehydes'.  
Need 'yes' and an explanation to be awarded the mark.*

1

- (b)  $M_r \text{CHI}_3 = 393.7$  **(M1)**  
*Allow if clearly shown in a calculation.  
Allow 394*

1

Moles  $\text{CHI}_3 = 10 / 393.7 = 2.54 \times 10^{-2}$  **(M2)**  
*Allow a consequential answer on an incorrect  $M_r$ .  
 $2.54 \times 10^{-2}$  scores **M1** and **M2**.*

1

Moles  $\text{I}_2 = 7.62 \times 10^{-2}$  **(M3)**  
*Allow  $3 \times \text{M2}$ .*

1

Mass  $\text{I}_2 = 7.62 \times 10^{-2} \times 253.8 = 19.34\text{g}$  **(M4)**  
*Allow **M3**  $\times 253.8$  or **M3**  $\times 254$*

1

Scaling  $19.34 / 0.832 = 23.2\text{g}$  **(M5)**  
*Allow **M4** / 0.832  
Lose this mark if the answer is not given to 3 significant figures.  
Answer without working scores **M5** only.  
Allow any chemically correct alternative method.  
Calculations which combine several steps in one expression can score  
the marks for all of these individual steps.*

1

- (c) Remove soluble impurities  
*Allow 'remove excess sodium hydroxide / iodine'.  
Allow 'remove excess sodium methanoate / sodium iodide'.  
Allow 'remove excess reagents'.*

1

- (d) Will not dissolve solid / solid is insoluble in water  
*Allow 'will not react with solid'.*

1

[8]