M1.(a) (i) $EDTA^{4-} + [Cu(H_2O)_6]^{2+} \rightarrow [Cu(EDTA)]^{2-} + 6H_2O$

1

(ii) (Mol EDTA = (6.45/1000) ×0.015 =)9.68×10^{-5} mol Cu(II)

1

Conc. Cu(II) = ((9.68×10^{-5}) / 0.025 =) 0.00387 mol dm^{-3}

Correct answer without working gains M2 only.

1

(b) Samples may not be consistent throughout the river
OR
Concentration may vary over time

Ignore comments on technique.

1

(c) $[Ag(NH_3)_2]^+$

Accept name eg diamminesilver(I) ion.

1

aldehyde

Allow CHO.

1

[6]

M2. (a) Partially filled/incomplete d sub-shell/orbital/shell

Ignore reference to f orbitals
*Do **not** allow d block*
*Do **not** allow half-filled d orbitals*

1

(b) Has ligand(s)

Allow molecules/ions with lone pairs

1

linked by co-ordinate bonds

Allow dative/donation of lone pair

1

(c) (Blue) light is absorbed (from incident white light)

1

Due to electrons moving to higher levels/electrons excited

Allow d → d transitions

1

Red light (that) remains (is transmitted)/light that remains (transmitted light) is the colour observed

Allow red light reflected

1

(d) (i) Circle round any O^-

List principle

1

Circle round either N

1

(ii) $EDTA^{4-} + [Co(H_2O)_6]^{2+} \rightarrow [CoEDTA]^{2-} + 6H_2O$

Allow missing square brackets
Ignore state symbols

1

(iii) Increase in entropy/Δ*S* positive

Or increase in disorder

1

Because 2 mol (of particles/molecules/species/entities) form 7 mol

Allow 'increase in number' as stated in words or as shown by any numbers deduced correctly from an incorrect equation

Do not allow increase in ions/atoms

1

(e) (i) Co-ordinate/dative/dative covalent bond

Allow pair of electrons donated by nitrogen/ligand

Do not allow pair of electrons donated from Iron/Fe

1

Covalent bond

Shared electron pair

1

(ii) Transport of oxygen/O_2

Allow any statement that implies oxygen carried (around the body)

Do not allow transport of carbon dioxide (CO_2). This also contradicts the mark (list principle)

1

(iii) Because it bonds to the iron/haemoglobin

Allow blocks site
/CO has greater affinity for haemoglobin
/carboxyhaemoglobin more stable than oxyhaemoglobin

1

Displaces <u>oxygen</u>

Or prevents transport of <u>oxygen</u>
QoL

1

[16]

M3. Linear complex e.g. $[Ag(NH_3)_2]^+$ **(1)**

Tetrahedral complex e.g. $[CoCl_4]^{2-}$ **(1)**

Octahedral complex e.g. $[Fe(H_2NCH_2CH_2NH_2)_3]^{3+}$

*Species **(1)***
*Charge **(1)***

[4]

M4. (a) $[Co(H_2O)_6]^{2+}$

1

octahedral

Only allow if species has 6 ligands
but allow if M1 not given because charge missing

1

(b) $CoCO_3$

Mark independently

1

Purple solid (allow pink)

Allow pink precipitate

1

(c) $[Co(H_2O)_6]^{2+} + 6NH_3 \rightarrow [Co(NH_3)_6]^{2+} + 6H_2O$

Allow $[Co(NH_3)_5H_2O]^{3+}$

Formula of product

1

Balanced equation

1

(d) $[Co(NH_3)_6]^{3+}$

Allow $[Co(NH_3)_5H_2O]^{3+}$

1

Oxidising agent

1

(e) $[Co(H_2NCH_2CH_2NH_2)_3]^{2+}$

Allow use of en $[Coen_3]^{2+}$

1

Entropy change for reaction is positive

Mark independently

1

Because 4 mol reactants form 7 mol products
(or increase in number of particles)

Or bidentate replaces unidentate

1

(f) $[CoCl_4]^{2-}$

1

Cl^- ligand too big to fit more than 4 round Co^{2+}

Allow Cl^- is bigger
Allow chlorine and Cl but NOT chlorine molecules.

1

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