Mark schemes

Q1.

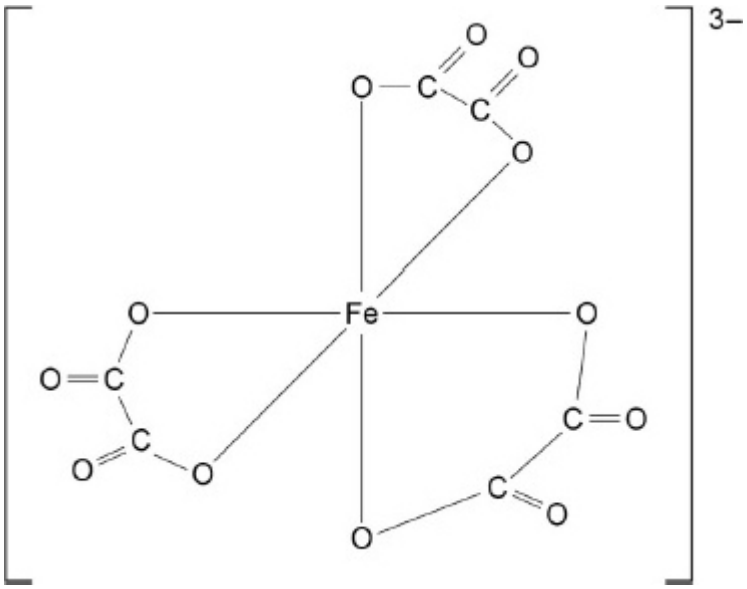
D

$Al(H_2O)_3(OH)_3$ and CO_2

[1]

Q2.

(a)



M1: 1 Mark for structure

Allow skeletal

M2: 1 mark for charge of 3^-

Ignore charges inside bracket

2

(b) **M1** When bidentate/multidentate ligands replace monodentate ligands (to form a more stable complex)

M2 Because there is an increase in entropy/positive entropy change/disorder or more particles formed (so ΔG is negative and ΔH is approximately 0)

M2 Allow S increases or ΔS is positive.

Do not accept ΔS increases or S is positive

2

(c) This question is marked using levels of response. Refer to the *Mark Scheme Instructions for Examiners for guidance* on how to mark this question.

Level 3
5-6 marks
All stages are covered and the description of each stage is generally correct and virtually complete.

Answer is communicated coherently and shows a logical progression from stage 1 to stage 2 and stage 3.

Level 2
3-4 marks
All stages are covered but the description of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows progression from stage 1 to stage 2 and/or stage 3.

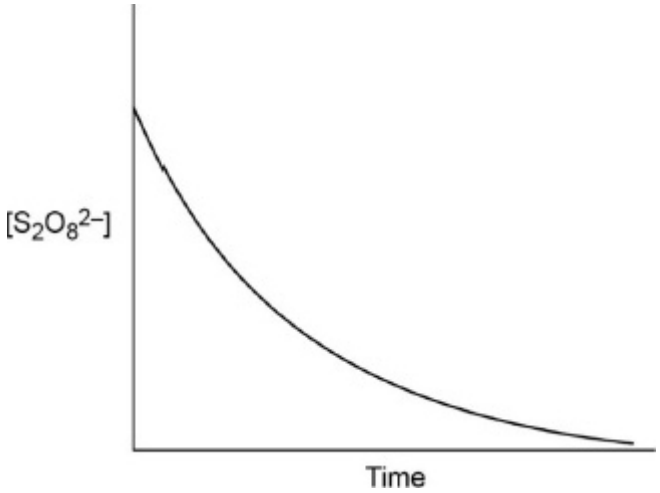
Level 1
1-2 marks
Two stages are covered but the description of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes isolated statements and these are presented in a logical order.

Level 0
0 marks
Insufficient correct chemistry to gain a mark.

Indicative Chemistry Content

stage 1



1a labelled axes
and *concentration (of $S_2O_8^{2-}$ ions) decreasing with time (ignore units)*
1b downwards curve of reducing steepness

stage 2 explanation

2a (reaction slow) because $S_2O_8^{2-}$ and I^- repel/high Ea

OR

(reaction slow) because two negative ions repel/high Ea

2b Fe^{2+} attracts the $S_2O_8^{2-}$ so lower E_a

OR

Fe^{2+} and $S_2O_8^{2-}$ oppositely charged so lower Ea

2c Iron/Fe has a variable oxidation state

OR

Fe^{2+} oxidised to Fe^{3+}

OR

$Fe^{2+} \rightarrow Fe^{3+} + e^-$

stage 3 equations

3a $2 Fe^{2+} + S_2O_8^{2-} \rightarrow 2 SO_4^{2-} + 2 Fe^{3+}$

3b $2 Fe^{3+} + 2 I^- \rightarrow 2 Fe^{2+} + I_2$

3c $S_2O_8^{2-} + 2 I^- \rightarrow 2 SO_4^{2-} + I_2$

Allow equations with hexaaqua ions

6

(d) $[Fe(H_2O)_4(OH)_2]$

1

(e) Green precipitate

$[Fe(H_2O)_6]^{2+} + Na_2CO_3 \rightarrow FeCO_3 + 6\ H_2O + 2Na^+$

OR

$[Fe(H_2O)_6]^{2+} + CO_3^{2-} \rightarrow FeCO_3 + 6\ H_2O$

Ignore state symbols

2

(f) $2[Fe(H_2O)_6]^{3+} + 3\ Na_2CO_3 \rightarrow 2\ [Fe(H_2O)_3(OH)_3] + 3\ CO_2 + 3\ H_2O + 6Na^+$

OR

$2\ [Fe(H2O)6]^{3+} + 3\ CO3^{2-} \rightarrow 2\ [Fe(H2O)3(OH)3] + 3\ CO2 + 3\ H2O$

Ignore state symbols

1

[14]

Q3.

This question is marked using Levels of Response. Refer to the Mark Scheme Instructions for Examiners for guidance.	
Level 3 **5-6 marks**	All stages are covered and the explanation of each stage is correct and virtually complete (ie two from stages 2 and 3 and three from stage 1). Answer communicates the whole explanation, including equations, coherently and shows a logical progression through all three stages.
Level 2 **3-4 marks**	All stages are covered (NB 'covered' means min two from stage 1) but the explanation of each stage may be incomplete or may contain inaccuracies. **OR** two stages covered and the explanations are generally correct and virtually complete (i.e. two from stages 2 and/or 3 and/or three from stage 1). Answer is coherent and shows some progression through all three stages. Some steps in each stage may be incomplete.
Level 1 **1-2 marks**	Two stages are covered (NB 'covered' means min two from stage 1) but the explanation of each stage may be incomplete or may contain inaccuracies. **OR** only one stage is covered but the explanation is generally correct and virtually complete (i.e. two from stages 2 and/or 3 and/or three from stage 1). Answer shows some progression between two stages.
Level 0 **0 mark**	Insufficient correct chemistry to gain a mark.

Indicative Chemistry content

Stage 1 IDs (Allow ppts if shown as products in equations or on the table)

(Allow names - with oxidation states for Fe compounds)

(1a) **BOTH** red-brown ppts from **L** = $Fe(H_2O)_3(OH)_3$ / $Fe(OH)_3$

(1b) green ppt from **M** = $Fe(H_2O)_4(OH)_2$/$Fe(OH)_2$ for NH_3

AND M = $FeCO_3$ with Na_2CO_3

(1c) white ppt with **L** = AgCl **AND** white ppt with **M** = $BaSO_4$

(1d) **L** = $FeCl_3$ **AND M** = $FeSO_4$

Stage 2 Reactions with sodium carbonate

(ALLOW if any 3+ compared with any 2+)

(2a) carbon dioxide is gas produced from **L** (could come from equation)

(2b) Fe^{3+} / $Fe(H_2O)_6^{3+}$ (in **L**) is more acidic than Fe^{2+} / $Fe(H_2O)_6^{2+}$ (in **M**) **ora**

(2c) Fe^{3+} is smaller / has higher charge / greater charge density of Fe^{3+} / is more polarising (makes ion a better proton donor)

Stage 3 Equations

(ECF from incorrect 3+ ion in L and/or 2+ ion in M)

(3a) $Fe(H_2O)_6^{3+} + 3NH_3 \rightarrow Fe(H_2O)_3(OH)_3 + 3NH_4$ + **AND**

$2Fe(H_2O)_6^{3+} + 3CO_3^{2-} \rightarrow 2Fe(H_2O)_3(OH)_3 + 3CO_2 + 3H_2O$

(3b) $Fe(H_2O)_6^{2+} + 2NH_3 \rightarrow Fe(H_2O)_4(OH)_2 + 2NH_4$ + **AND**

$Fe(H_2O)_6^{2+} + CO_3^{2-} \rightarrow FeCO_3 + 6H_2O$ **OR** $Fe^{2+} + CO3^{2-} \rightarrow FeCO3$

(3c) $Ag^+ + Cl^- \rightarrow AgCl$ **AND** $Ba^{2+} + SO4^{2-} \rightarrow BaSO4$

[6]