

M1.(a) To reduce any Fe^{3+} ions to Fe^{2+} ions

Allow 'to ensure that all of the iron present is in the form of Fe^{2+} ions' or 'to ensure that no Fe^{3+} ions are present'.

1

(b) Zinc would react with $\text{MnO}_4^- / \text{Fe}^{3+}$ produced in titration

Do not allow 'would increase titre value'.

Do not allow 'zinc would react' without further qualification.

1

[2]

M2.(a) (i) Flask with side arm

1

Buchner funnel and horizontal filter paper

Allow Hirsch funnel and horizontal filter paper.

Do not allow standard Y-shaped funnel.

If there is not a clear air-tight seal (labelled or drawn) between the funnel and the flask maximum 1 mark.

1

(ii) $M_r \text{KMnO}_4 = 158(.0)$

1

Mass = $0.225 \times 158 / 3 = 11.9$ (g)

Lose M2 if no working shown.

Allow consequential mark on an incorrect M_r for KMnO_4 .

1

Precision mark: three significant figures

Allow if mass incorrect.

1

(iii) (Unpleasant) taste
Ignore smell.

1

(b) Difficult to see meniscus / line on graduated flask
Do not allow reference to over filling.

1

[7]



*For all species correct / moles and species correct but
charge incorrect*

1

*For balanced equation including all charges (also scores first
mark)*

1

(b) Manganate(VII) ions are coloured (purple)

1

All other reactants and products are **not** coloured (or too faintly coloured to detect)

Allow (all) other species are colourless

Allow Mn^{2+} are colourless / becomes colourless / pale pink

1

(c) The catalyst for the reaction is a reaction product

1

Reaction starts off slowly / gradient shallow

1

Then gets faster/rate increases / gradient increases

Allow concentration of MnO_4^- decreases faster / falls rapidly

1

(d) Mn^{2+} ions
Allow Mn^{3+} ions 1

(e) $\text{MnO}_4^- + 8\text{H}^+ + 4\text{Mn}^{2+} \rightarrow 5\text{Mn}^{3+} + 4\text{H}_2\text{O}$
Allow multiples 1

$2\text{Mn}^{3+} + \text{C}_2\text{O}_4^{2-} \rightarrow 2\text{Mn}^{2+} + 2\text{CO}_2$ 1

[10]

M4.(a) Stop the formation of MnO_2 / Ensures all MnO_4^- reacts to form Mn^{2+} / becomes colourless 1

(b) Weak acid / Does not supply sufficient H^+ 1

(c) It is self-indicating / Purple to colourless end-point or vice versa
If colours mentioned they must be correct. 1

[3]

M5.(a) Manganate would oxidise / react with Cl^- 1

Because E^\ominus for MnO_4^- is more positive than that for Cl^2 / $1.51 - 1.36 = +0.15$ (V)

Must refer to data from the table for M2.

1

(b) Moles of H^+ = $25 \times 0.0200 \times 8 / 1000 = 4.00 \times 10^{-3}$

1

Moles of $H_2SO_4 = 2.00 \times 10^{-3}$ ($4.00 \times 10^{-3} / 2$)

Allow consequential marking on incorrect moles of H^+

1

Volume $H_2SO_4 = 4.00$ (cm^3) ($2.00 \times 10^{-3} \times 1000 / 0.500$)

Allow consequential marking on incorrect moles of H_2SO_4

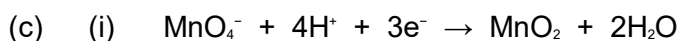
Accept 4 cm^3 .

8 cm^3 scores 2 marks.

Do not penalise precision.

Correct answer without working scores M3 only.

1



Allow multiples, including fractions.

Ignore state symbols.

1

(ii) Can't see end point due to brown colour

1

Larger titre (than expected)

Allow the idea that with two reactions can't make use of titre in calculations.

Do not allow 'an inaccurate result' without qualification.

1

(d) Solution (very) dilute / lots of water

1

[9]

M6.(a) For reactions 1 to 3 must show complex ions as reactants and products
Take care to look for possible identification on flow chart

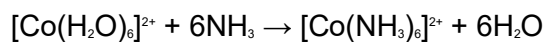
Reaction 1

ammonia solution

1

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

1



Correct equation scores all 3 marks

1

Reaction 2

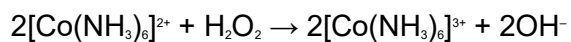
Allow oxygen, Do not allow air

H_2O_2

1

X is $[\text{Co}(\text{NH}_3)_6]^{3+}$

1



Allow $2[\text{Co}(\text{NH}_3)_6]^{2+} + \frac{1}{2}\text{O}_2 + \text{H}_2\text{O} \rightarrow 2[\text{Co}(\text{NH}_3)_6]^{3+} + 2\text{OH}^-$

Correct equations score all 3 marks

1

Reaction 3

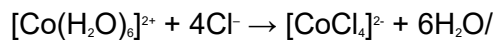
HCl

Do not allow Cl⁻ but mark on

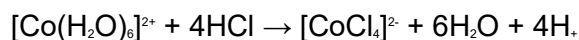
1

Y is $[\text{CoCl}_4]^{2-}$

1



Correct equation scores previous mark



This equation scores all three marks

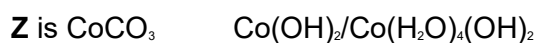
1

Reaction 4

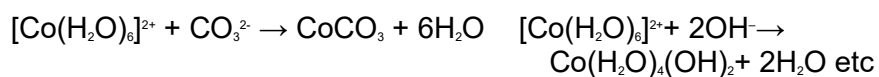


Do not allow CaCO₃ as a reagent but mark on

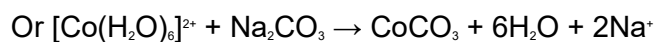
1



1

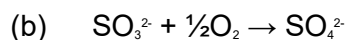


Allow waters to stay co-ordinated to Co. This mark also previous mark



Allow Co²⁺ + CO₃²⁻ → CoCO₃

1



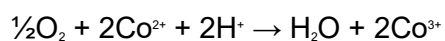
Allow multiples

1

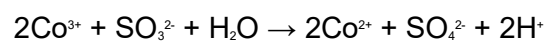
The activation energy is lower (for the catalysed route)

Or Co³⁺ attracts SO₃²⁻/Co²⁺ attracts SO₃²⁻/oppositely charged ions attract

1



1



Allow these equations in either order

1

[16]