

- M1.(a)** (i) Correctly plots all points (\pm one square) and draws straight line of best fit
Lose this mark if the candidate's line is doubled or kinked.
Lose this mark if the line does not pass within one square of the origin, extending the line if necessary.

1

Plotted points cover over half of grid

1

- (ii) 0.046 ± 0.002 (mol dm⁻³)

1

0.088 to 0.096 (mol dm⁻³)

Allow M1 \times 2

Allow two marks for correct answer.

Answer must be to at least two significant figures.

1

- (iii) Total volume = $(100 \times 0.1) / 0.04 = 250$ (cm³)

Allow any correct alternative method of working.

1

Therefore add 150 cm³

Correct answer without working scores M2 only.

1

- (b) Iron needed for haemoglobin / for red blood cells / to carry oxygen around the body

Accept well-water may contain eg Ca²⁺ ions / dissolved minerals that are good for bones / teeth etc.

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 Mn²⁺ 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 MnO₄⁻ decreases faster / falls rapidly

1

(d) Mn²⁺ ions

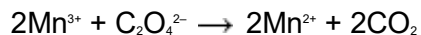
Allow Mn³⁺ ions

1



Allow multiples

1



1

[10]

M3.(a) (i) absorbs (certain frequencies of) (white) light / photons
not absorbs white / u.v. light

1

d electrons excited / promoted
or d electrons move between levels / orbitals
d electrons can be implied elsewhere in answer

1

the colour observed is the light not absorbed / light
reflected / light transmitted
allow blue light transmitted
penalise emission of light in M3

1

(ii) ΔE is the energy gained by the (excited) electrons (of Cu^{2+})
allow:

- *energy difference between orbitals / sub-shells*
- *energy of photon / light absorbed*
- *change in energy of the electrons energy lost by excited electrons*
- *energy of photon / light emitted*

1

h (Planck's) constant

1

ν frequency of light (absorbed by $\text{Cu}^{2+}(\text{aq})$)
do not allow wavelength
If energy lost / photon lost / light emitted in M1 do not penalised light emitted

1

(iii) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{Cl}^- \rightarrow [\text{CuCl}_4]^{2-} + 6\text{H}_2\text{O}$
note that $[\text{CuCl}_4]^{2-}$ is incorrect
penalise charges shown separately on the ligand and overall
penalise HCl

1

tetrahedral

1

Cl⁻ / Cl / chlorine too big (to fit more than 4 round Cu)

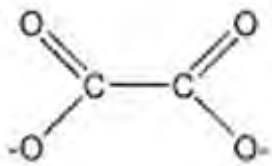
allow

water smaller than Cl

explanation that change in shape is due to change in co-ordination number

1

(b)



allow:

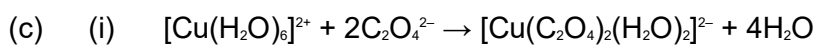
- *ion drawn with any bond angles*
- *ion in square brackets with overall / 2- charge shown outside the brackets*
- *ion with delocalised O=C–O bonds in carboxylate group(s)*

1

lone pair(s) on O⁻ / O

allow position of lone pair(s) shown on O in the diagram even if the diagram is incorrect.

1



product correct

1

equation balanced

1

6

note can only score M3 and M4 if M1 awarded or if complex in equation has 2 waters and 2 ethanedioates

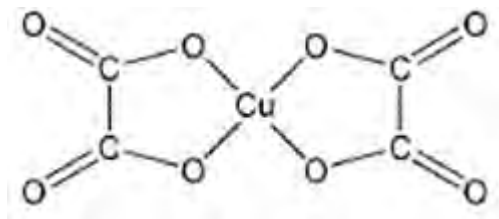
1

octahedral

If this condition is satisfied the complex can have the wrong charge(s) to allow access to M3 and M4 but not M1

1

(ii)



ignore charges

diagram must show both ethanedioates with correct bonding

ignore water

1

90°

allow 180°

mark bond angle independently but penalise if angle incorrectly labelled / indicated on diagram

1

[17]

M4.(a) Plots all of the points correctly \pm one square

1

Straight line through the points is best fit

Candidate does not have to extrapolate line to the origin.

Line must pass through the origin \pm 1 square.

Lose this mark if the candidate's line is doubled or kinked.

Allow line that doesn't pass through the origin if one or more points are misplotted.

1

(b) $7.6 \pm 0.1 \times 10^{-2}$ (mol dm⁻³)

Do not penalise precision, but at least 2 significant figures.

1

[3]