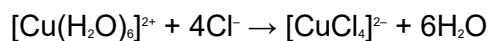


<b>M1.</b>	(a) Brown <u>ppt/solid</u>	1
	Gas evolved/effervescence	1
	$2[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{CO}_3^{2-} \rightarrow 2\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 + 3\text{CO}_2 + 3\text{H}_2\text{O}$ <p><i>Must be stated, Allow CO<sub>2</sub> evolved. Do not allow CO<sub>2</sub> alone</i>  <i>Correct iron product (1) allow Fe(OH)<sub>3</sub> and in equation</i>  <i>Balanced equation (1)</i></p>	2
	(b) White <u>ppt/solid</u>	1
	Colourless <u>Solution</u> <i>Only award M2 if M1 given or initial ppt mentioned</i>	1
	$[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \rightarrow \text{Al}(\text{H}_2\text{O})_3(\text{OH})_3 + 3\text{H}_2\text{O}$ <p><i>Allow <math>[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \rightarrow \text{Al}(\text{OH})_3 + 6\text{H}_2\text{O}</math></i></p>	1
	$\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3 + 3\text{OH}^- \rightarrow [\text{Al}(\text{OH})_6]^{3-} + 3\text{H}_2\text{O}$ <p><i>Allow formation of <math>[\text{Al}(\text{H}_2\text{O})_{6-x}(\text{OH})_x]^{(x-3)-}</math> where <math>x = 4, 5, 6</math></i>  <i>Allow product without water ligands</i>  <i>Allow formation of correct product from <math>[\text{Al}(\text{H}_2\text{O})_6]^{3+}</math></i></p>	1
	(c) Blue <u>ppt/solid</u>	1
	(Dissolves to give a) deep blue <u>solution</u> <i>Only award M2 if M1 given or initial ppt mentioned</i>	1
	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow \text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2 + 2\text{NH}_4^+$ <p><i>Allow <math>[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow \text{Cu}(\text{OH})_2 + 2\text{NH}_4^+ + 4\text{H}_2\text{O}</math></i>  <i>Allow two equations: <math>\text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^-</math></i>  <i>then <math>[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Cu}(\text{OH})_2 + 4\text{H}_2\text{O}</math> etc</i></p>	1
	$\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2 + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+} + 2\text{OH}^- + 2\text{H}_2\text{O}$ <p><i>Allow <math>[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+} + 4\text{H}_2\text{O}</math></i></p>	1

(d) Green/yellow solution

1



1

[14]

**M2.C**

[1]

**M3.** (a) (i) Ammonia

*If reagent is missing or incorrect cannot score M3*

1

Starts as a pink (solution)

1

Changes to a yellow/straw (solution)

*Allow pale brown*

*Do not allow reference to a precipitate*

1

(ii) (dark) brown

*Do not allow pale/straw/yellow-brown (i.e. these and other shades except for dark brown)*

1

(b) (i) Ruby/red-blue/purple/violet/green

*Do not allow red or blue*

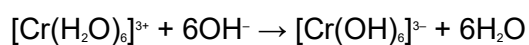
*If ppt mentioned contradiction/CE =0*

1

Green

*If ppt mentioned contradiction/CE =0*

1

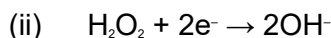


1

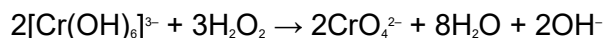
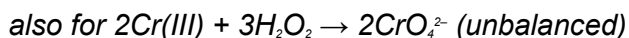
Formula of product

*Can score this mark in (b) (ii)*

1



1

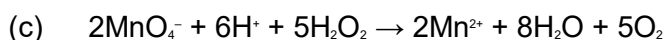
*Allow 1 mark out of 2 for a balanced half-equation such as*

2

Yellow

*Do not allow orange*

1

*if no equation and uses given ratio can score M2, M3, M4 & M5*

1

Moles  $\text{MnO}_4^- = (24.35/1000) \times 0.0187 = \underline{4.55 \times 10^{-4}}$

*Note value must be quoted to at least 3 sig. figs.**M2 is for  $4.55 \times 10^{-4}$* 

1

Moles  $\text{H}_2\text{O}_2 = (4.55 \times 10^{-4}) \times \underline{5/2} = 1.138 \times 10^{-3}$

*M3 is for  $\times 5/2$  (or  $7/3$ )**Mark consequential on molar ratio from candidate's equation*

1

Moles  $\text{H}_2\text{O}_2$  in  $5 \text{ cm}^3$  original*M4 is for  $\times 10$* 

1

$= (1.138 \times 10^{-3}) \times \underline{10} = 0.01138$

Original  $[\text{H}_2\text{O}_2] = 0.01138 \times \underline{(1000/5)} = 2.28 \text{ mol dm}^{-3}$

(allow 2.25-2.30)

*M5 is for consequentially correct answer from (answer to mark 4)  $\times (1000/5)$* *Note an answer of between 2.25 and 2.30 is worth 4 marks)*

If candidate uses given ratio 3/7 max 4 marks:

**M1:** Moles of  $\text{MnO}_4^- = 4.55 \times 10^{-4}$

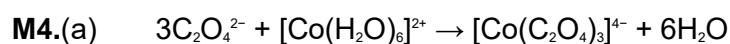
**M2:** Moles  $\text{H}_2\text{O}_2 = (4.55 \times 10^{-4}) \times \frac{7}{3} = 1.0617 \times 10^{-3}$

**M3:** Moles  $\text{H}_2\text{O}_2$  in 5  $\text{cm}^3$  original  
 $= (1.0617 \times 10^{-3}) \times 10 = 0.01062$

**M4:** Original  $[\text{H}_2\text{O}_2] = 0.01062 \times (1000/5) = 2.12 \text{ mol dm}^{-3}$   
(allow 2.10 to 2.15)

1

[17]



Accept multiples.

Equation must have cobalt(II) hexaaqua ion.

1

- (b) Ethanedioate ion reduces iron(III) ion **or**  
iron(III) ion oxidises ethanedioate ion

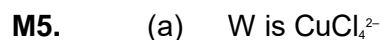
Allow answer using equations.

1

$E^\ominus(\text{CO}_2 / \text{C}_2\text{O}_4^{2-})$  more negative than  $E^\ominus(\text{Fe}^{3+} / \text{Fe}^{2+})$  **or**  
 $E^\ominus(\text{Fe}^{3+} / \text{Fe}^{2+}) > E^\ominus(\text{CO}_2 / \text{C}_2\text{O}_4^{2-})$   
**or** e.m.f. positive **or** cell voltage = +1.26

1

[3]



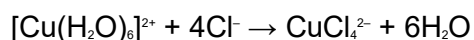
1

Yellow-green/yellow/green

Not necessary to indicate solution

Do not allow precipitate/solid

1



Allow  $+ 4\text{HCl} \rightarrow 4\text{H}^+$

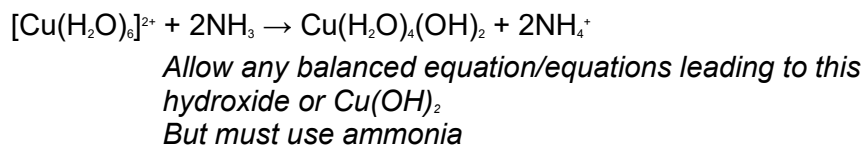
1

- (b) X is  $\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2$   
*Allow  $\text{Cu}(\text{OH})_2$ /copper hydroxide*

1

Blue precipitate/solid  
*Ignore shades*

1



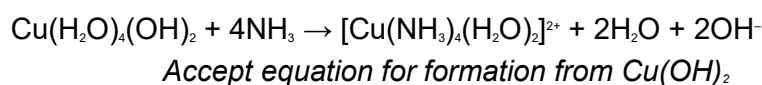
1

- (c) Y is  $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$

1

Deep/dark/royal blue solution  
*QoL*

1



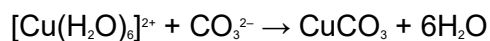
1

- (d) Z is  $\text{CuCO}_3$   
*Allow copper carbonate*

1

Green solid/precipitate  
*Allow blue-green precipitate*

1



1

- (e) (i)  $\text{Cu}^{2+}(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Cu}(\text{s}) + \text{Fe}^{2+}(\text{aq})$   
*Allow hydrated ions  
State symbols not essential but penalise if wrong*

1

Blue  
*Do not allow description of solids*

1

Green

*Allow yellow/(red-)brown/orange*

1

- (ii) Any two correct points about copper extraction from two of these three categories:

Any relevant mention of lower energy consumption

*Do not allow reference to electricity alone or to temperature alone.*

Any relevant mention of benefits of less mining (of copper ore)

*Allow avoids depletion of (copper ore) resources*

Less release of CO<sub>2</sub> (or CO) into the atmosphere

*Not just greenhouse gases. Must mention CO<sub>2</sub> or CO*

Max 2

[17]