

Mark schemes

1

(a) Brown ppt/solid 1

Gas evolved/effervescence 1



Must be stated, Allow CO₂ evolved. Do not allow CO₂ alone

Correct iron product (1) allow Fe(OH)₃ and in equation

Balanced equation (1)

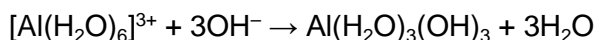
2

(b) White ppt/solid 1

Colourless Solution

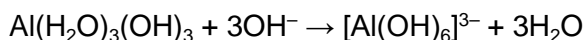
Only award M2 if M1 given or initial ppt mentioned

1



Allow $[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \rightarrow \text{Al}(\text{OH})_3 + 6\text{H}_2\text{O}$

1



Allow formation of $[\text{Al}(\text{H}_2\text{O})_{6-x}(\text{OH})_x]^{(x-3)-}$ where $x = 4, 5, 6$

Allow product without water ligands

Allow formation of correct product from $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$

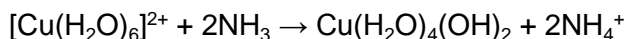
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(c) Blue ppt/solid 1

(Dissolves to give a) deep blue solution

Only award M2 if M1 given or initial ppt mentioned

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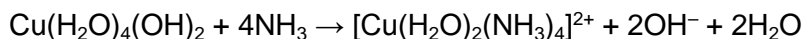


Allow $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow \text{Cu}(\text{OH})_2 + 2\text{NH}_4^+ + 4\text{H}_2\text{O}$

Allow two equations: $\text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^-$

then $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Cu}(\text{OH})_2 + 4\text{H}_2\text{O}$ etc

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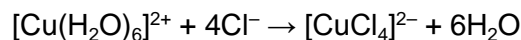


Allow $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+} + 4\text{H}_2\text{O}$

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(d) Green/yellow solution

1



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2

(a) oxidation state of N in $\text{Cu}(\text{NO}_3)_2$: +5;

1

oxidation state of N in NO_2 : +4;

1

oxidation product: oxygen;

1

(b) copper-containing species: $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$;

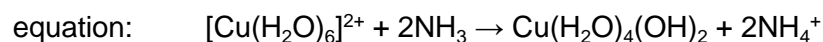
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shape: octahedral;

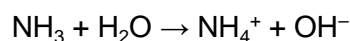
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(c) (i) precipitate B: $\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2$ or $\text{Cu}(\text{OH})_2$ or name;

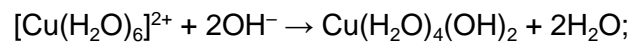
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OR



and



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(ii) NH_3 accepts a proton;

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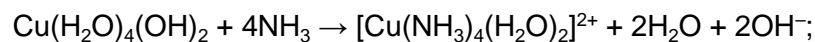
(d) (i) identity: $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$;

1

colour: deep blue;

1

equation:



1

(ii) NH_3 is an electron pair donor;

1

(e) identity: $[\text{CuCl}_4]^{2-}$;

1

colour: yellow-green;

1

shape: tetrahedral;

1

(f) (i) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$;

1

(ii) role of Cu: a reducing agent;

1

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3

(a) Iron

1

Heterogeneous; catalyst in a different phase from that of the reactants

1

Poison; a sulphur compound (allow sulphur)

1

Poison strongly adsorbed onto active sites/ blocked

1

Poison not desorbed or reactants not adsorbed or catalyst surface area reduced

1

(b) Pale green solution	1	
Green precipitate formed		1
Insoluble in excess ammonia		1
Equation:		
e.g. $[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow [\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{NH}_4^+$ Species		1
Balance		1
<i>NB Allow equations with H_2O and OH^- if reaction of H_2O with NH_3 also given</i>		
		Max 4

[9]