AQA A-Level Chemistry

Reactions of aqueous ions mark scheme · goes with “Reactions of aqueous ions” · whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions

Mark schemes

Reactions of aqueous ions · 5 questions

Q1 · November 2020 · Paper 1 · Q5 · [10 marks]

(a) M1 B = $Al(H_2O)_3(OH)_3$

Ignore [ ]

[1 mark]

M2 bubbles/effervescence

M2 Do not allow gas evolved

[1 mark]

M3 2 $[Al(H_2O)_6]^{3+} + 3CO_3^{2-} \rightarrow 2Al(H_2O)_3(OH)_3 + 3H_2O + 3CO_2$

M3 Ignore absence of square brackets around Al complex

M3 Allow correct balanced equations with Na_2CO_3

[1 mark]

(b) M1 C = $[Al(OH)_4]^-$ OR $[Al(H_2O)_2(OH)_4]^-$ OR $[Al(OH)_6]^{3-}$

[1 mark]

M2 Excess NaOH

M2 Allow excess OH^-

[1 mark]

M3 $[Al(H_2O)_6]^{3+} + 4OH^- \rightarrow [Al(OH)_4]^- + 6H_2O$

OR

$[Al(H_2O)_6]^{3+} + 4OH^- \rightarrow [Al(H_2O)_2(OH)_4]^- + 4H_2O$

OR

$[Al(H_2O)_6]^{3+} + 6OH^- \rightarrow [Al(OH)_6]^{3-} + 6H_2O$

M3 Allow equations to form $Al(H_2O)(OH)_5^{2-}$

M3 Allow correct balanced equations with NaOH

[1 mark]

(c) $[Al(EDTA)]^-$

Do not penalise absence of square brackets

[1 mark]

(d) M1 $[Al(H_2O)_6]^{3+} + H_2O \rightleftharpoons [Al(H_2O)_5(OH)]^{2+} + H_3O^+$ OR

$[Al(H_2O)_6]^{3+} \rightleftharpoons [Al(H_2O)_5(OH)]^{2+} + H^+$

Accept other equations

[1 mark]

M2 Al^{3+} has a small size and high charge OR has a high charge density

M2 Allow the aluminium ion has a small size and high charge OR has a high charge density

[1 mark]

M3 Weakens the OH bond (in water) releasing H^+ ions

[1 mark]

Q2 · June 2024 · Paper 3 · Q22 · [1 mark]

Answer: **D**

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

Q3 · June 2023 · Paper 1 · Q7 · [17 marks]

(a) $1s^2\ 2s^2\ 2p^6$

Allow [He] $2s^2 2p^6$

[1 mark]

(b) $Al_2(SO_4)_3 + 12H_2O \rightarrow 2\ [Al(H_2O)_6]^{3+} + 3SO_4^{2-}$

Allow $[Al(H_2O)_6]2(SO_4)_3$

[1 mark]

(c) M1 Al^{3+} has a high charge and small size

OR

Al^{3+} has a high charge density

M2 Al^{3+} weakens the O-H bond (in water ligands and donates H^+ to water or forms H_3O^+ ions with water)

M2 Al^{3+} attracts electrons from the O-H bond (in the ligand and releases H^+ or H_3O^+ ions)

OR

Al^{3+} polarises the O-H bond/water molecule

[2 marks]

(d) Colourless (solution)

Allow no d-d transitions (as there are no d electrons)

OR

Doesn't absorb visible light

[1 mark]

(e) $[Al(H_2O)_6]^{3+} + 3NH_3 \rightarrow Al(H_2O)_3(OH)_3 + 3NH_4^+$

White ppt or white solid

Do not accept effervescence

Do not accept white ppt dissolves in excess NH_3

Ignore state symbols

[2 marks]

(f) $[Al(H_2O)_6]^{3+}$

[1 mark]

(g) A circle around one or more N

A circle around one or more O^-

[2 marks]

(h) M1 n ($EDTA^{4-}$) added = 5×10^{-4} mol

alternative methods will be allowed

M2 n (Zn^{2+}) = 1.89×10^{-4} mol

M3 n ($EDTA^{4-}$) reacted with the 25 cm^3 sample of Al^{3+} = $5 \times 10^{-4} - 1.89 \times 10^{-4} = 3.11 \times 10^{-4}$ mol

M3 = M1 – M2

M4 n $EDTA^{4-}$ reacted with the 250 cm^3 sample of Al^{3+} = 3.11×10^{-4} **x 10** = 3.11×10^{-3} mol

$$M4 = \frac{M3 \times 250}{25}$$

M5 n $Al_2(SO_4)_3\ xH_2O$ = $\frac{3.11 \times 10^{-3}}{2} = 1.555 \times 10^{-3}$ mol

$$M5 = \frac{M4}{2}$$

M6 M_r $Al_2(SO_4)_3\ xH_2O$ = $\frac{1.036}{1.555 \times 10^{-3}} = 666.2$

$$M6 = \frac{1.036}{M5}$$

M7 342.3 + 18 x = 666(.2) so x = 18

$$M7 = \frac{(M6 - 342.3)}{18}$$ *and answer as integer*

[7 marks]

Q4 · June 2023 · Paper 3 · Q4 · [6 marks]

This question is marked using Levels of Response.

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 $Fe^{2+} + CO_3^{2-} \rightarrow FeCO_3$

(3c) $Ag^+ + Cl^- \rightarrow AgCl$ AND $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$

Q5 · June 2018 · Paper 1 · Q7 · [9 marks]

07.1

$AlCl_3 + 6H_2O \rightarrow [Al(H_2O)_6]^{3+} + 3Cl^-$

Allow

$AlCl_3 + 6H_2O \rightarrow Al(H_2O)_5(OH)^{2+} + H^+ + 3Cl^-$

Or equation to form $Al(H_2O)_4(OH)_2^+$

[1 mark]

07.2

$[Al(H_2O)_6]^{3+} + H_2O \rightarrow [Al(H_2O)_5(OH)]^{2+} + H_3O^+$

allow equations to form $[Al(H_2O)_4(OH)_2]^+$

[1 mark]

07.3

white ppt/solid

effervescence/bubbles/fizzing

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

M1 and M2 in either order

accept multiples

only allow spectator ions in a balanced equation

[3 marks]

07.4

White ppt/solid

$[Al(H_2O)_6]^{3+} + 3OH^- \rightarrow [Al(H_2O)_3(OH)_3] + 3H_2O$

Colourless solution forms / ppt or solid dissolves

$[Al(H_2O)_3(OH)_3] + OH^- \rightarrow [Al(H_2O)_2(OH)_4]^- + H_2O$

OR

$[Al(H_2O)_3(OH)_3] + OH^- \rightarrow [Al(OH)_4]^- + 3H_2O$

only allow spectator ions in a balanced equation

only allow 6 or 4 co-ordination

Allow $[Al(OH)_6]^{3-}$ in a balanced equation

[4 marks]

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