

Mark schemes

1	Identifies precipitate as being BaSO ₄	1
	Moles of Barium sulfate = mass/Mr (= 0.764 / 233.4) = 0.003273 moles	
	<i>Allow conseq if Mr BaSO₄ or BaCl₂ incorrect</i>	1
	Mass of Barium chloride = 208.3 × 0.003273 = 0.6818 g	1
	Percentage of Magnesium chloride = $\frac{1.056 - 0.6818}{1.056} \times 100$	
	<i>Do NOT penalise incorrect precision here</i> <i>Allow range 33.7-35.5% (rounding errors penalised elsewhere in paper)</i>	1
		[4]
2	A	[1]
3	A	[1]
4	(a) More (electron) shells / (outer) electrons further from the nucleus / larger atoms / more shielding	
	<i>If 'molecules' mentioned CE = 0</i> <i>It = Ba</i> <i>Mark independently</i> ALLOW energy levels for shells <i>Both ideas must be comparative</i>	1
	So weaker <u>attraction</u> of nucleus/protons for (outer) electrons NOT hold/pull/bonded for 'attraction' <i>Idea of nucleus or protons must be clear</i> ALLOW M2 if electrons implied from mention in M1 ALLOW converse if it is clear that answer refers to Ca	1

- (b) White solid / white ash
ALLOW 'white smoke/powder'
IGNORE 'product'
NOT ppt
IGNORE fumes
IGNORE tube/glass goes black

1

Bright light / white light
ALLOW glow/flame for light

1

$\text{Mg} + \text{H}_2\text{O} \rightarrow \text{MgO} + \text{H}_2$
IGNORE state symbols

1

- (c) BaSO_4 is insoluble but $\text{Ba}(\text{NO}_3)_2$ is soluble
OR
 BaSO_4 precipitates but $\text{Ba}(\text{NO}_3)_2$ product(s) of second reaction is soluble/remains in solution
OR
 BaSO_4 is insoluble but no reaction occurs in second case
NOT just 'no observation' in second case
Comparison of solubilities must be implied
NOT Barium is soluble/insoluble
Correct state symbols required

1

$\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$

1

[7]

5

- (a) $1s^22s^22p^63s^23p^64s^2$
 Allow correct numbers that are not superscripted

1

- (b) $\text{Ca}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) + \text{H}_2(\text{g})$
 State symbols essential

1

- (c) Oxidising agent

1

- (d) $\text{Ca}(\text{g}) \rightarrow \text{Ca}^{+}(\text{g}) + \text{e}^{-}$
 State symbols essential
 Allow 'e' without the negative sign

1

- (e) Decrease
 If answer to 'trend' is not 'decrease', then chemical error = 0 / 3

1

Ions get bigger / more (energy) shells
Allow atoms instead of ions

1

Weaker attraction of ion to lost electron

1

[7]

6

(a) **Q** is calcium or magnesium

1

bromide

1

R is aluminium

1

chloride

1

S is iron(III)

1

sulfate

1

Mark this question independently

(b) $\text{Ba}^{2+} + \text{SO}_4^{2-} \longrightarrow \text{BaSO}_4$

1

$[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \longrightarrow \text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 + 3\text{H}_2\text{O}$

1

$2[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{CO}_3^{2-} \longrightarrow 2\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3 + 3\text{H}_2\text{O} + 3\text{CO}_2$

1

$[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 4\text{Cl}^- \longrightarrow [\text{FeCl}_4]^- + 6\text{H}_2\text{O}$

1

[10]

7

(a) **M1** acidified potassium dichromate or $K_2Cr_2O_7 / H_2SO_4$

OR $K_2Cr_2O_7 / H^+$ **OR** acidified $K_2Cr_2O_7$

M2 (orange to) green solution **OR** goes green

M3 (solution) remains orange or no reaction or no (observed) change

*If no reagent or incorrect reagent in **M1**, **CE = 0** and no marks for **M1**, **M2** or **M3***

*If incomplete / inaccurate attempt at reagent e.g. "dichromate" or "dichromate(IV)" or incorrect formula or no acid, **penalise M1 only and mark on***

*For **M2** ignore dichromate described as "yellow" or "red"*

*For **M3** ignore "nothing (happens)" or "no observation"*

Alternative using $KMnO_4 / H_2SO_4$

M1 acidified potassium manganate(VII) / potassium permanganate or $KMnO_4 / H_2SO_4$

OR $KMnO_4 / H^+$ **OR** acidified $KMnO_4$

M2 colourless solution **OR** goes colourless

M3 (solution) remains purple or no reaction or no (observed) change

*For **M1***

*If incomplete / inaccurate attempt at reagent e.g. "manganate" or "manganate(IV)" or incorrect formula or no acid, **penalise M1 only and mark on***

*Credit alkaline $KMnO_4$ for possible full marks but **M2** gives brown precipitate or solution goes green*

(b) **M1** (Shake with) Br₂ **OR** bromine (water) **OR** bromine (in CCl₄ / organic solvent)

M2 (stays) orange / red / yellow / brown / the same

OR no reaction **OR** no (observed) change

M3 decolourised / goes colourless / loses its colour / orange to colourless

*If no reagent or incorrect reagent in **M1**, **CE = 0** and no marks for **M1**, **M2** or **M3***

*If incomplete / inaccurate attempt at reagent (e.g. Br), **penalise M1 only and mark on***

*No credit for combustion observations; **CE = 0***

*For **M2** in every case*

Ignore “nothing (happens)”

Ignore “no observation”

Ignore “clear”

OR as alternatives

Use KMnO₄ / H₂SO₄

M1 acidified potassium manganate(VII) / potassium permanganate **OR**
KMnO₄ / H₂SO₄

OR KMnO₄ / H⁺ **OR** acidified KMnO₄

M2 (stays) purple or no reaction or no (observed) change

M3 decolourised / goes colourless / loses its colour

Use iodine

M1 iodine or I₂ / KI or iodine solution

M2 no change

M3 decolourised / goes colourless / loses its colour

Use concentrated sulfuric acid

M1 concentrated H₂SO₄

M2 no change

M3 brown

*For **M1**, it must be a whole reagent and / or correct formula*

*For **M1** penalise incorrect attempt at correct formula, but mark **M2** and **M3***

With potassium manganate(VII)

*If incomplete / inaccurate attempt at reagent e.g. “manganate” or “manganate(IV)” or incorrect formula or no acid, **penalise M1 only and mark on***

*Credit alkaline / neutral KMnO_4 for possible full marks but **M3** gives brown precipitate or solution goes green*

Apply similar guidance for errors in the formula of iodine or concentrated sulfuric acid reagent as those used for other reagents.

(c) **M1** Any soluble chloride including hydrochloric acid (ignore concentration)

M2 white precipitate or white solid / white suspension

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

OR as an alternative

M1 Any soluble iodide including HI

M2 yellow precipitate or yellow solid / yellow suspension

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

OR as an alternative

M1 Any soluble bromide including HBr

M2 cream precipitate or cream solid / cream suspension

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

OR as an alternative

M1 NaOH or KOH or any soluble carbonate

M2 brown precipitate or brown solid / brown suspension with NaOH / KOH
(white precipitate / solid / suspension with carbonate)

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

*If no reagent or incorrect reagent or insoluble chloride in **M1**, **CE = 0**
and no marks for **M1**, **M2** or **M3***

Allow chlorine water

*If incomplete reagent (e.g. chloride ions) or inaccurate attempt at
formula of chosen chloride, or chlorine, **penalise M1 only and
mark on***

*For **M2** require the word "white" and some reference to a solid.
Ignore "cloudy solution" OR "suspension" (similarly for the
alternatives)*

*For **M3***

Ignore "nothing (happens)"

Ignore "no observation"

Ignore "clear" on its own

Ignore "dissolves"

(d) **M1** Any soluble sulfate including (dilute or aqueous) sulfuric acid

M2 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

M3 white precipitate or white solid / white suspension

*If no reagent or incorrect reagent or insoluble sulfate in **M1**, **CE = 0** and no marks for **M1**, **M2** or **M3***

Accept $MgSO_4$ and $CaSO_4$ but not barium, lead or silver sulfates

*If concentrated sulfuric acid or incomplete reagent (e.g. sulfate ions) or inaccurate attempt at formula of chosen sulfate, **penalise M1 only and mark on***

*For **M3** (or **M2** in the alternative) require the word “white” and some reference to a solid.*

Ignore “cloudy solution” OR “suspension”

*For **M2** (or **M3** in the alternative)*

Ignore “nothing (happens)”

Ignore “no observation”

Ignore “clear” on its own

Ignore “dissolves”

OR as an alternative

M1 NaOH or KOH

M2 white precipitate or white solid / white suspension

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

*If incomplete reagent (e.g. hydroxide ions) or inaccurate attempt at formula of chosen hydroxide, **penalise M1 only and mark on***

*If **M1** uses NH_3 (dilute or concentrated) **penalise M1 only and mark on***

3

[12]

8

(a) **M1** Increases / gets bigger

*If **M1** is incorrect **CE = 0** for the clip*

*If **M1** is blank, mark on and seek to **credit the correct information in the text***

M2 requires a correct **M1**

M2** requires correct **M1

More shells or sub-shells or (main) levels or sub-levels or orbitals (of electrons)

*If “molecules” penalise **M2***

Not simply “more electrons”

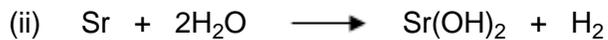
Not “more outer shells”

Ignore reference to nuclear charge and shielding

2

(b) (i) Increases / gets more reactive / reacts more vigorously / violently (down the Group)

1



Credit multiples and correct ionic equations

Ignore state symbols

1

(c) $\text{Ba}(\text{OH})_2$

This MUST be a formula so ignore the name

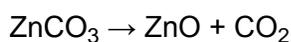
Credit $\text{Ba}^{2+} 2\text{OH}^-$

Ignore state symbols

1

[5]

9



Ignore state symbols.

If equation incorrect, allow one mark only for correct atom economy method.

1

Percentage atom economy =

Mark consequentially for incorrect formula mass(es)

1

$$\frac{81.4}{125.4} \times 100 = 64.9$$

Accept answer to at least 2 significant figures

1

[3]

10

(a) Compound 1

If M1 incorrect, CE = 0

M1

1

No visible change with H_2SO_4

M2

1

Gives white ppt with NaOH

M3

1

(b) BaCO₃

1

The carbonate ion releases CO₂

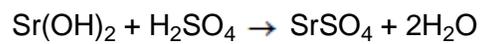
1

but the BaSO₄ formed is highly insoluble.

1

(c) Compound 4

1



Allow ionic equation; ignore state symbols

1

[8]