

**M1.(a) M1 (could be scored by a correct mathematical expression)**

*Correct answer to the calculation gains all of M1, M2 and M3*

$$\text{M1 } \underline{\Delta H = \sum \Delta H_f(\text{products}) - \sum \Delta H_f(\text{reactants})}$$

*Credit 1 mark for - 101 (kJ mol<sup>-1</sup>)*

**OR** a correct cycle of balanced equations

$$\text{M2} = - 1669 - 3(- 590)$$

$$= - 1669 + 1770$$

(This also scores M1)

$$\text{M3} = + 101 \text{ (kJ mol}^{-1}\text{)}$$

**Award 1 mark ONLY for - 101**

*For other incorrect or incomplete answers, proceed as follows*

- *check for an arithmetic error (AE), which is either a transposition error or an incorrect multiplication; this would score 2 marks (M1 and M2)*
- *If no AE, check for a correct method; this requires either a correct cycle with 3Sr and 2Al OR a clear statement of M1 which could be in words and scores **only M1***

**M4 - Using powders**

Any **one** from

- To increase collision frequency / collisions in a given time / rate of collisions
- To increase the surface contact / contact between the solids / contact between (exposed) particles  
*Ignore dividing final answer by 3*  
*Penalise M4 for reference to molecules.*

5

**M5 Major reason for expense of extraction**

Any **one** from

- Aluminium is extracted by electrolysis OR aluminium extraction uses (large amounts of) electricity
- Reaction / process / It / the mixture requires heat
- It is endothermic

- (b) Calcium has a higher melting point than strontium, because  
*Ignore general Group 2 statements.*

**Correct reference to size of cations / proximity of electrons**

M1 (For Ca) delocalised electrons closer to cations / positive ions / atoms / nucleus

**OR** cations / positive ions / atoms are smaller

**OR** cation / positive ion / atom or it has fewer (electron) shells / levels

*Penalise M1 if either of Ca or Sr is said to have more or less delocalised electrons OR the same nuclear charge.*

*Ignore reference to shielding.*

**Relative strength of metallic bonding**

M2 (Ca) has stronger attraction between the cations / positive ions / atoms / nucleus and the delocalised electrons

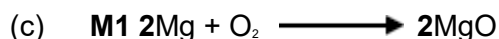
**OR**

stronger metallic bonding

(assume argument refers to Ca but credit converse argument for Sr)

**CE= 0** for reference to molecules or Van der Waals forces or intermolecular forces or covalent bonds.

2



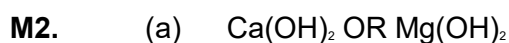
*Credit multiples of the equations.*

**M3** Magnesium hydroxide is used as an antacid / relieve indigestion (heartburn) / neutralise (stomach) acidity / laxative

*Not simply "milk of magnesia" in M3*

3

[10]



*Ignore name*

*Could be ionic*

1

- (b) NaF or sodium fluoride

OR

NaCl or sodium chloride

*Either formula or name can score*

*Do not penalise the spelling "fluoride"*

*When both formula and name are written,*

- penalise contradictions*
- if the attempt at the correct **formula** is incorrect, ignore it and credit **correct name** for the mark unless contradictory*
- if the attempt at the correct name is incorrect, ignore it and credit **correct formula** for the mark unless contradictory*

1

(c) NaClO OR NaOCl

*Ignore name (even when incorrect)*

*The correct formula must be clearly identified if an equation is written*

1

(d) Br<sub>2</sub> (ONLY)

*Only the correct formula scores;*

*penalise lower case "b", penalise upper case "R", penalise superscript*

*Ignore name*

*The correct formula must be clearly identified if an equation is written*

1

(e) M1 S OR S<sub>8</sub> OR S<sub>2</sub>

M2 I<sub>2</sub> (ONLY)

*Ignore names*

*penalise lower case "i" for iodine,*

*penalise superscripted numbers*

*Mark independently*

*The correct formula must be clearly identified in each case if an equation is written*

2

(f) (i) CH<sub>3</sub>CH<sub>2</sub>CH=CH<sub>2</sub>

*Structure of but-1-ene. Ignore name*

*Credit "sticks" for C-H bonds*

1

- (ii)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$   
*Structure of butan-1-ol. Ignore name*  
*Credit "sticks" for C-H bonds*

1

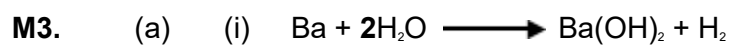
- (iii)  $\text{CH}_3\text{CH}_2\text{CH}_3$   
*Structure of propane. Ignore name*  
*Ignore calculations and molecular formula*  
*Credit "sticks" for C-H bonds*  
*Ignore the molecular ion*

1

- (iv)  $\text{CH}_3\text{CH}_2\text{Br}$  OR  $\text{C}_2\text{H}_5\text{Br}$   
*Structure of bromoethane.*  
*Ignore name and structure of nitrile*  
*Credit "sticks" for C-H bonds*

1

[10]



*Ignore state symbols*

*Credit multiples and correct ionic equations*

1

- (ii) (Reactivity with water) increase(s) / increasing / increased (down the Group / from Mg to Ba)

*Accept "greater" or "gets more" or similar words to that effect.*

*Ignore reference to "increase in solubility / gets more soluble"*

1

- (b)  $\text{Mg}(\text{OH})_2$

Accept  $Mg^{2+}(OH)_2 / Mg(HO)_2$   
Insist on brackets and correct case

1

(c) **M1** Barium meal / barium swallow / barium enema or (internal) X-ray or to block X-rays

**M2** BaSO<sub>4</sub> / barium sulfate is insoluble (and therefore not toxic)

Accept a correct reference to **M1** written in the explanation in **M2**, unless contradictory

For **M2** NOT barium ions

NOT barium

NOT barium meal and NOT "It"

Ignore radio-tracing

2

[5]

**M4.(a)** (i) Increases

1

(ii) Decreases

1

(iii) Increases

1

(b) Calcium has a higher melting point than strontium, because  
*CE = 0 for reference to molecules or intermolecular forces or covalent bonds*

**Correct reference to size of cations/proximity of electrons**

**M1** (For Ca) delocalised electron(s) closer to cations / positive ions / nucleus  
*Ignore "Van der Waals forces (between atoms)" but penalise if between "molecules"*

**OR** cations / positive ions / atoms are smaller

**OR** cation / positive ion / atom or it has fewer (electron) shells / levels

*Ignore general Group 2 statements*

*Answers must be specific*

**Relative strength of metallic bonding**

**M2** (For Ca) has stronger attraction between the cations / positive ions / nucleus and the delocalised electron(s)

*Penalise M1 if Ca or Sr is said to have more or less delocalised electrons*

**OR**

stronger metallic bonding

(assume argument refers to Ca but accept converse argument for Sr)

*Ignore reference to shielding*

2

(c) (i) Sulfuric acid / it contains sulfate ions / SO<sub>4</sub><sup>2-</sup>

**OR**

*Do not penalise an additional but incorrect formula for sulfate ion.*

Sulfuric acid would form a (white) precipitate

*If only the formula of the sulfate ion is given, it must be correct*

1

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

*Ignore state symbols*

*No multiples*

1

[7]

**M5.(a)** As concentration increases the amount of heat given out increases / temperature increases (**M1**)

*Any order.*

*Ignore references to an exothermic reaction.*

1

More successful collisions or reactions in a given time **OR** more particles have the activation energy **(M2)**

*Allow could be a second /  $n^{\text{th}}$  order reaction.*

1

(An increase in temperature or more heat given out) increases the rate of a reaction **(M3)**

1

(b) The magnesium is coated with an oxide / MgO **(M1)**

*Allow magnesium hydroxide.*

1

MgO / the coating / the corrosion product has to be removed before Mg will react

**OR** Mg and MgO / the coating / the corrosion product react at different rates

**OR** Initially MgO / the coating / the corrosion product reacts not Mg **(M2)**

*Ignore inert coating.*

1

(c) Any **two** from:

*Any order.*

Slower with hot water or faster with steam

The hot water produces  $\text{Mg}(\text{OH})_2$  / the hydroxide **OR** steam produces MgO / the oxide

(Slow) bubbling with hot water **OR** bright white light / flame / white solid with steam

2 max

(d) Magnesium sulfate is soluble and calcium sulfate is insoluble / slightly soluble / magnesium sulfate is more soluble / calcium sulfate is less soluble / correct trend in solubility **(M1)**

*Any order.*

**M1** requires a comparison of the two solubilities.

Calcium sulfate coats the surface of the calcium **(M2)**

Coating prevents further contact with / reaction by the acid **(M3)**

'Calcium sulfate forms a protective coating' scores **M2** only.

3

[10]

**M6.(a)** (i) Change in concentration (of a substance / reactant / product) in unit time / given time / per (specified) unit of time

*This may be written mathematically **OR** may refer to the gradient of a graph of concentration / volume against time*

**OR**

Amount of substance formed / used up in unit time / given time / per (specified) unit of time

*Ignore additional information including reference to collisions*

1

(ii) **At W**

**M1 (QoL)**

The rate / it is zero

**M2**

The magnesium has all reacted / has been used up

*Ignore reference to the acid being used up*

**OR**

No more collisions possible between acid and Mg

**OR**

Reaction is complete / it has stopped

**OR**

No more hydrogen / product is produced

2

(iii) **M1**

Twice / double as many particles / hydrogen ions (in a given volume)

*Penalise reference to (hydrochloric acid) molecules in **M1***

*Penalise reference to "HCl particles" in **M1***



**OR**

Twice / double as much hydrochloric acid

M2

Twice / double as many effective / successful collisions (in a given time)

**OR**

Twice / double as many collisions with either sufficient energy to react

**OR** with  $E \geq E_a$

**OR**

double the successful / effective collision frequency

2

- (b) (i) The activation energy is the minimum energy for a reaction to go / start

**OR**

Minimum energy for a successful/ effective collision

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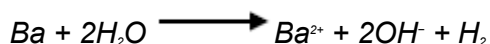
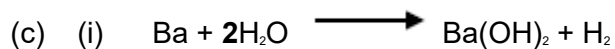
- (ii) M1 Products lower than reactants on the profile

*Mark independently*

M2 Activation energy ( $E_a$ ) shown and labelled correctly from reactants to peak of curve

*Mark independently*

2



*Allow multiples*

*Ignore state symbols*

1



*Ignore state symbols in M1*

*Not multiples in M1*

M2 White precipitate / solid

*Extra ions must be cancelled*  
*Penalise contradictory observations in M2*

2

- (iii) M1 Barium meal / barium swallow / barium enema  
*Accept a correct reference to M1 written in the explanation in M2, unless contradictory*
- OR** used in X-rays **OR** to block X-rays **OR** X-ray contrast medium **OR** CT scans
- M2 BaSO<sub>4</sub> / barium sulfate is insoluble (and therefore not toxic)  
*For M2 NOT barium ions*  
*NOT barium*  
*NOT barium meal and NOT "It"*  
*Ignore radio-tracing*

2

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**M7.**Mg<sup>2+</sup> and Cl<sup>-</sup>

*Do not allow names.*

[1]