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

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

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

Credit 1 mark for − 101 (kJ mol^{-1})

OR a correct cycle of balanced equations

M2 = − 1669 − 3(− 590)
= − 1669 + 1770
(This also scores M1)

M3 = **+ 101** (kJ mol^{-1})

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 <u>electrons closer to cations / positive ions / atoms / nucleus</u>

OR <u>cations / positive ions / atoms are smaller</u>

OR <u>cation / positive ion / atom or it has fewer (electron) shells / levels</u>

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

Ignore reference to shielding.

Relative strength of metallic bonding

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

OR

<u>stronger metallic</u> 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

(c) **M1** $\mathbf{2}Mg + O_2 \longrightarrow \mathbf{2}MgO$

M2 $Mg + \mathbf{2}H_2O \longrightarrow Mg(OH)_2 + H_2$

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]

M2. (a) $Ca(OH)_2$ OR $Mg(OH)_2$

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_2** (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_8 OR S_2

M2 I_2 (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) $CH_3CH_2CH=CH_2$

Structure of but-1-ene. Ignore name

Credit ''sticks'' for C-H bonds

1

(ii) $CH_3CH_2CH_2CH_2OH$

Structure of butan-1-ol. Ignore name

Credit ''sticks'' for C-H bonds

1

(iii) $CH_3CH_2CH_3$

Structure of propane. Ignore name

Ignore calculations and molecular formula

Credit ''sticks'' for C-H bonds

Ignore the molecular ion

1

(iv) CH_3CH_2Br OR C_2H_5Br

Structure of bromoethane.

Ignore name and structure of nitrile

Credit ''sticks'' for C-H bonds

1

[10]

M3. (a) (i) $Ba + \mathbf{2}H_2O \longrightarrow Ba(OH)_2 + H_2$

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) $Mg(OH)_2$

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 $BaSO_4$ / 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_4^{2-}

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) $Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$ 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^{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 $Mg(OH)_2$ / 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

1

(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

(c) (i) $Ba + \mathbf{2}H_2O \longrightarrow Ba(OH)_2 + H_2$

$Ba + 2H_2O \longrightarrow Ba^{2+} + 2OH^- + H_2$
Allow multiples
Ignore state symbols

1

(ii) M1 $Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$
*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 $\underline{BaSO_4 \text{ / barium sulfate is insoluble}}$ (and therefore not toxic)

*For **M2** NOT barium ions*

NOT barium

NOT barium meal and NOT "It"

Ignore radio-tracing

2

[13]

M7. Mg^{2+} and Cl^-

Do not allow names.

[1]