M1.(a) (i) d (block) **OR** D (block)

Ignore transition metals / series.

Do not allow any numbers in the answer.

1

(ii) Contains positive (metal) ions or protons or nuclei and <u>delocalised / mobile / free / sea of</u> electrons

Ignore atoms.

1

<u>Strong attraction</u> between them or <u>strong metallic</u> bonds

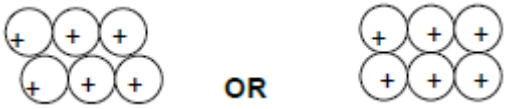
Allow 'needs a lot of energy to break / overcome' instead of 'strong'.

If strong attraction between incorrect particles, then CE = 0 / 2.

If molecules / intermolecular forces / covalent bonding / ionic bonding mentioned then CE=0.

1

(iii)



M1 is for regular arrangement of atoms / ions (min 6 metal particles).

M2 for + sign in each metal atom / ion.

Allow 2^+ sign.

2

(iv) <u>Layers / planes / sheets of atoms or ions</u> can slide over one another

QoL.

1

(b) (i) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ (4s^0)$

Only.

1

(ii) $NiCl_2.6H_2O$ + **6** $SOCl_2$ ⟶ $NiCl_2$ + **6** SO_2 + **12** HCl

Allow multiples.

1

NaOH / NH_3 / $CaCO_3$ / CaO

Allow any name or formula of alkali or base.

Allow water.

1

[9]

M2.(a) White powder / solid / ash / smoke

Ignore ppt / fumes

1

Bright / white light / flame

Allow glows white / glows bright

1

$Mg + H_2O \rightarrow MgO + H_2$

Ignore state symbols

Ignore reference to effervescence or gas produced

1

(b) Mg^{2+} / magnesium ion has higher charge than Na^+

Allow Mg^{2+} ions smaller / greater charge density than Na^+ ions

Allow Mg atoms smaller than Na (atoms)

Allow magnesium has more delocalised electrons

Must be a comparison

Ignore reference to nuclear charge

1

Attracts delocalised / free / sea of electrons more strongly / metal–metal bonding stronger / metallic bonding stronger

Wrong type of bonding (vdW, imf), mention of molecules CE

= 0

1

(c) **Structure:** Macromolecular / giant molecule / giant covalent

Mark independently

1

Bonding: Covalent / giant covalent

1

Physical Properties:

Any **two** from: Hard/
Brittle / not malleable
Insoluble
Non conductor

Ignore correct chemical properties

Ignore strong, high boiling point, rigid

2

(d) **Formula:** P_4O_{10}

Mention of ionic or metallic, can score M1 only

1

Structure: Molecular

If macromolecular, can score M1 & M3 only

1

Bonding: Covalent / shared electron pair

1

van der Waals' / dipole–dipole forces <u>between molecules</u>

Allow vdW, imf and dipole–dipole imf but do not allow imf alone

1

(e) $SO_2 + H_2O \rightarrow H^+ + HSO_3^-$

Products must be ions

Allow $SO_2 + H_2O \rightarrow 2H^+ + SO_3^{2-}$

Allow two equations showing intermediate formation of H_2SO_3 *that ends up as ions*

Ignore state symbols

Allow multiples

1

(f) $P_4O_{10} + 6MgO \rightarrow 2Mg_3(PO_4)_2$

OR $P_4O_{10} + 6MgO \rightarrow 6Mg^{2+} + {}_4PO_4^{3-}$

OR $P_2O_5 + 3MgO \rightarrow Mg_3(PO_4)_2$ etc

Ignore state symbols

Allow multiples

1

[15]

M3. (a) Antacid

OR

to neutralise acidity

OR

eases indigestion

Credit suitable reference to indigestion or to laxative or to relief of constipation

1

(b) **M1** Decrease in T decreases the <u>energy</u> of the <u>particles/ions/H^+/molecules</u>

M2 (also scores M1) Decrease in the number of/less particles/ions/ H^+/molecules with $E \geq E_{Act}$ or E ≥ minimum energy to react

*In **M1** and **M2**, credit "atoms" but ignore "calcium carbonate", ignore "calcium", ignore any ion formula except* H^+

M3 Few(er)/Less effective/productive/successful collisions

QoL

3

(c) (i) Strontium has a higher melting point than barium, because

Correct reference to size of cations/proximity of electrons
M1 (For Sr) delocalised <u>electrons closer to cations/positive ions/atoms/nucleus</u>

OR

cations/positive ions/atoms are smaller

OR

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

Ignore general Group 2 statements

Penalise M1 if Sr or Ba is said to have <u>more or less</u> delocalised electrons

Ignore reference to shielding

***CE = 0** for reference to molecules or intermolecular forces or covalent bonds*

Relative strength of metallic bonding
M2 (Sr) has <u>stronger</u> attraction between the <u>cations/positive ions/ atoms/nucleus</u> and the delocalised <u>electrons</u>

OR

<u>stronger metallic</u> bonding
(assume argument refers to Sr but accept converse argument for Ba) 2

Ignore "Van der Waals forces (between atoms)" but penalise if "between molecules"

(ii) $Sr + \mathbf{2}H_2O \rightarrow Sr(OH)_2 + H_2$

Or multiples

1

(d) $\mathbf{2}Mg + TiCl_4 \rightarrow \mathbf{2}MgCl_2 + Ti$

Or multiples

1

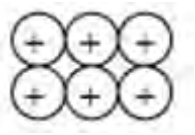
[9]

M4. (a) (i) Metallic

Allow body centred cubic

1

(ii)

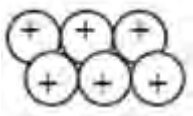


One mark for regular arrangement of particles. Can have a space between them

Do not allow hexagonal arrangement

1

OR



Na^+ Na^+ Na^+

Na^+ Na^+ Na^+

One mark for + in each

Ignore electrons

If it looks like ionic bonding then CE = 0/2

1

(b) (i) Ionic

CE = 0 for (b)(i) and (b)(ii) if not ionic

1

(ii) Strong (electrostatic) attraction

Any mention of IMF or molecules / metallic / covalent in (b)(ii) then CE 0/2

1

Between oppositely charged ions / particles

Or + and – ions

1

(c) Iodide / I^- bigger (ion) (so less attraction to the Na+ ion)

Need comparison

Do not allow iodine is a bigger atom

Ignore I^- has one more c^- shell

CE = 0 if IMF / covalent / metallic mentioned

1

[7]

M5.(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) <u>electricity</u>

- <u>Reaction / process / It / the mixture requires heat</u>
- <u>It is endothermic</u>

(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]

M6.(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 <u>electron(s) closer to cations / positive ions / nucleus</u>

Ignore "Van der Waals forces (between atoms)" but penalise if between "molecules"

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

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

Ignore general Group 2 statements

Answers must be specific

Relative strength of metallic bonding

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

Penalise M1 if Ca or Sr is said to have <u>more or less</u> delocalised electrons

OR

<u>stronger metallic bonding</u>

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

Ignore reference to shielding

2

(c) (i) Sulfuric acid / it contains <u>sulfate ions / SO_4^{2-}</u>

OR

Do not penalise an <u>additional</u> but incorrect formula for sulfate ion.

<u>Sulfuric acid</u> would form a (white) <u>precipitate</u>

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]