M1. (a) **M1** The yield of zinc oxide <u>increases/greater</u>

If M1 is given as "decrease" OR "no effect" then CE= 0

M2 Removal of the carbon dioxide results in the **<u>equilibrium</u>**

Either

Shifting/moving/goes to the right
shifting/moving/goes L to R
favours the forward reaction/towards the products

M3 (By Le Chatelier's principle) the reaction/equilibrium will respond so as <u>to replace the CO_2/lost product</u>
OR <u>to make more CO_2</u>
OR <u>to increase concentration of CO_2</u>

For M3, not simply "to oppose the change/to oppose the loss of CO_2/to oppose the removal of carbon dioxide."

3

(b) **M1** Process 2 produces/releases SO_2
OR Process 2 produces/releases CO

M2 It/Process 3 avoids the release of SO_2 OR CO
OR It/Process 3 (captures and) converts SO_2 to H_2SO_4

M3 SO_2 causes acid rain OR is toxic/poisonous
OR CO is toxic/poisonous

3

Ignore "global warming" and "greenhouse gases" and "the ozone layer"

If both CO and SO_2 claimed to form acid rain, treat as contradiction

(c) **M1** Process 3 (is expensive because it) uses <u>electrolysis</u>
OR due to high <u>electricity/electrical</u> consumption

M2 this is justified because the product/zinc is pure

Ignore "energy"

Penalise "pur<u>er</u>"

2

(d) **M1** $Zn^{2+} + 2e^- \longrightarrow Zn$

Ignore state symbols

M2 the negative electrode OR the cathode

Ignore absence of negative charge on electron
Accept electrons subtracted from RHS

2

(e) **M1** The reaction of ZnO with sulfuric acid
OR the second reaction in Extraction process 3

M2 neutralisation or acid-base

OR alternatively

M1 The reaction of zinc carbonate in Extraction process 1
M1 could be the equation written out in both cases

M2 (thermal) decomposition
M2 depends on correct M1

M3 It/carbon is <u>oxidised/gains oxygen/changes oxidation state/number from 0 to +2/increase in oxidation state/number</u> in Process 2
Do not forget to award this mark
Ignore reference to electron loss but penalise electron gain
Ignore "carbon is a reducing agent"

3

(f) **M1** $Zn + H_2O \longrightarrow ZnO + H_2$

M2 <u>Zinc oxide and hydrogen</u>

OR as an alternative

M1 $Zn + 2H_2O \longrightarrow Zn(OH)_2 + H_2$

M2 <u>Zinc hydroxide and hydrogen</u>
Mark independently
If ZnO_2 is given for zinc oxide in the equation, penalise M1 and mark on
If ZnOH is given for zinc hydroxide in the equation, penalise M1 and mark on
Ignore state symbols
Credit multiples of the equation
If M1 is blank, either of the M2 answers could score
To gain <u>both</u> marks, the names must match the correct equation given.

2

[15]

M2. (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 energy of the particles/ions/H^+/molecules

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 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

Ignore general Group 2 statements

Penalise M1 if Sr or Ba is said to have more or less 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]

M3.(a) <u>Fractional</u> distillation (under reduced pressure)

1

(b) $BaSO_4$ insoluble / remove by filtration

Do not allow answers which refer to reaction rate

1

(c) Both contain OH group

Allow OH stretch in ir spectrum of each compound
Do not allow 'same bonds'

1

[3]

M4.(a) Correct completion of table
(7.2 – 9.4 – 10.3 – 11.5 – 12.2 – 13.1)

Any error loses the mark.

1

Appropriate scales for axes

No penalty for missing labels but the graph must cover at least half of the available area.

1

All points plotted correctly

Allow ±1 small square.

1

Line of best fit acceptable

Must be a reasonably smooth curve but make allowance for freehand drawing passing within one small square of each point.

Do not penalise minor doubling of line.

1

(b) Maximum mass at (44.0 / 4) = 11.0 g
giving a max. pressure of 1.7 ± 0.1 MPa

Allow this pressure range only.

Check that candidate's answer matches graph.

1

(c) 7.2 g of NaCl in 250 cm^3 represents 28.8 g dm^{-3}

Allow 0.49 but not 0.5; otherwise do not penalise precision of answer

1

Molarity = 0.492 mol dm^{-3}

Conseq. to their graph value for 100 kPa to 2 or 3 sig.

1

(d) Measuring cylinder = (1 / 250) × 100 = 0.4%
Balance = (0.1 / 7.2) × 100 = 1.4%

Both values correct for the first mark.

Balance error conseq. on their 100 kPa mass value.

Ignore precision of answers.

1

Combined error 1.8%

*When error being calculated is **not** stated, allow **if** the calculations are in the same order as in the question (measuring cylinder, balance).*

If only combined error given then 1 mark only.

1

(e) (i) The points are good enough to be able to draw a smooth curve because the line passes through / close to all points.

Mark consequentially on candidate's graph

1

(ii) There are no anomalous points

Mark consequentially on candidate's graph

1

(f) The experiment only seeks an approximate figure for the maximum pressure

Allow words to that effect.

1

(g) (i) Toxic (to marine life)

Allow phrasing which implies a detrimental effect on marine ecology.

1

(ii) Mixing the effluent with (sea) water to dilute it

Penalise any method which removes the salt or which implies storage.

1

(h) $2Br^- + Cl_2 \rightarrow 2Cl^- + Br_2$

Allow NaBr or KBr

1

(i) The cost of removing water / heating would be too high

Discount answers based on toxicity or speed of reaction.

Allow answers based on cost of using sulfuric acid.

1

(j) (i) Carbon

Allow C, soot, graphite, coal.

1

(ii) Formed by the decomposition of organic material / living organisms in the sea water

Allow 'erosion of coal beds'.

1

(iii) Dissolve the solid formed in water

Do not allow melting of the solid.

1

Filter off the insoluble particles

1

(k) $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

Allow $Ca(OH)_2 + 2H^+ \rightarrow Ca^{2+} + 2H_2O$

Allow multiples.

1

(l) In agriculture / to raise the pH of soil / (Lime-based) mortars in construction

Allow words to that effect.

1

[22]