M1.(a) Sensible scales

Plotted points (including 0,0) must cover more than half the graph paper.

If axis wrong way round lose this mark but mark on consequentially.

Do not allow broken axis.

1

Plots points correctly

1

(b) Ring around the origin

1

(c) Line through points is smooth

Line must pass within ± 1 small square of each plotted point except the anomaly (allow one plot ± 2 small square – at 40 or 60s).

1

Line through points is best fit and ignores anomaly (allow one plot ± 2 small square)

Lose this mark if student's line is doubled.

Kinked line loses this mark.

Lose this mark if the line does not pass through the origin + / – 1 small square.

Lose this mark if the line deviates to anomaly.

1

(d) Draws suitable tangent

Must touch the curve at 30s and must not cross the curve.

Lose this mark if the tangent is unsuitable but mark on.

1

Chooses appropriate x and y values from their graph

Mark consequentially if axes plotted the wrong way around.

Allow information clearly shown on graph.

1

Correctly calculates y / x

Difference in x values and y values must be at least 10 small squares in either direction.

1

Gives answer with correct units (mol dm^{-3} s^{-1}) or correct variant

Lose this mark if answer not to minimum of 2 significant figures and no units or incorrect units are given.

If student has used axis the wrong way round, the unit mark can be awarded for either the correct unit based on their graph or for the correct unit for rate.

1

[9]

M2.(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]

M3.(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) <u>shown and labelled</u> 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 <u>White precipitate / solid</u>
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 <u>$BaSO_4$ / barium sulfate is insoluble</u> (and therefore not toxic)
*For **M2** NOT barium ions*
NOT barium
NOT barium meal and NOT "It"
Ignore radio-tracing

2

[13]

M4. (a) (i) **M1** drawn curve <u>starts at reactants</u> and <u>ends at products</u>
Tapered lines into the original curve gain credit for M1

M2 curve peak is <u>below</u> the one drawn in the question
(and may show one/two humps)

Mark M1 and M2 independently

2

(ii) Exothermic (reaction)

Ignore "ΔH is negative"

1

(iii) Σ bond (enthalpy) <u>reactants</u> < Σ bond (enthalpy) <u>products</u>

The sum for H_2 and I_2/reactants is <u>less than/lower than/smaller than</u> the sum for 2HI/products
OR
The sum for 2HI/products is <u>more than/larger than/bigger than</u> the sum for H_2 and I_2/reactants

Accept "It OR the sum will be <u>smaller</u> or <u>less</u>"

1

(iv) **M1** p

2

M2 $-(q - p)$

OR

$p - q$

OR

$-q + p$

M2 demands that the sign for an exothermic reaction is part of the outcome mathematically.
Ignore case

(b) (i) Increase/speed up/faster (rate of attainment of equilibrium)

OR

Increase/speed up/faster rate of <u>both</u> forward <u>and</u> reverse reaction

OR

Increase/speed up/faster rate of reaction

Credit "It took less time"

1

(ii) **M1** Increase/speed up/faster (rate of attainment of equilibrium)

M2 More particles/molecules in a given volume/space
OR the particles/molecules are closer together
OR an increase in concentration.

M3 More/higher chance of successful/effective/productive collisions (between particles)
OR more collisions/higher chance of collisions (of particles) with $E>E_{Act}$

If M1 is blank, mark on and credit M1 in the text

If M1 is given as "decrease"/"no effect"/"no change" then CE = 0 for clip

In M1, if increase both the forward and reverse reaction, but no mention of rate, penalise M1 but mark on.

In M1, if increase either forward rate or reverse rate only, then penalise M1 but mark on.

Penalise M3 if an increase in the value of E_{Act}/energy of particles is stated.

Max 1 for M2 and M3 if reference to "atoms"

3

[10]

M5. (a) **Award in either order for curve**

"Steeper" requires line to be on the left of the original line, starting from the origin

M1 curve is steeper than original and starts at the origin

M2 curve levels at the top line on the graph

2

(b) **Award in either order for curve**

"Shallower" requires line to be on the right of the original line, starting from the origin

M1 curve is shallower than original and starts at the origin

M2 curve levels at the first line on the graph

2

(c) **M1** curve would be steeper than original

"Steeper" requires line to be on the left of the original line, starting from the origin

M2 curve levels at the same original volume of O_2

2

(d) **M1** The (concentration / amount of) H_2O_2 or reactant falls / decreases / used up

Mark independently

OR

The number of H_2O_2 or reactant molecules/ particles falls / decreases

M2

The rate of reaction / rate of decomposition / rate of formation of oxygen / frequency of collisions / (effective) collisions in a given time decreases / is slower

2

(e) (i) $\mathbf{2}H_2O_2 \rightarrow \mathbf{2}H_2O + O_2$

Ignore state symbols

Accept only this equation or its multiples

Extra species must be crossed through

1

(ii) hydrogen bromide / it does not appear in the overall equation

OR

hydrogen bromide / it is not used up in the reaction / unchanged at the end of the reaction

OR

hydrogen bromide / it is regenerated / re-formed (in Step 2)

1

[10]