

M1.(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 $\text{Mg}(\text{OH})_2$ / 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]

- M2.(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

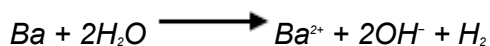
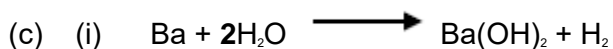
(ii) M1 Products lower than reactants on the profile

Mark independently

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

Mark independently

2



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 BaSO₄ / 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]

M3.(a) (If any factor is changed which affects an equilibrium), the (position of) equilibrium will shift / move so as to oppose / counteract the change.

Must refer to equilibrium

Ignore reference to "system" alone

A variety of wording will be seen here and the key part is the last phrase

OR

(When a system / reaction in equilibrium is disturbed), the (position of) equilibrium shifts / moves in a direction which tends to reduce the disturbance

An alternative to shift / move would be the idea of changing / altering the position of equilibrium

1

(b) (i) M1

A substance that speeds up the reaction / alters the rate but is chemically

unchanged at the end / not used up

Both ideas needed for M1

Credit can score for M1, M2 and M3 from anywhere within the answer

M2

Catalysts provide an alternative route / alternative pathway / different mechanism

M3

that has a lower activation energy / E_a

OR

lowers the activation energy / E_a

3

(ii) (Time is) less / shorter / decreases / reduces

Credit "faster", "speeds up", "quicker" or words to this effect

1

(iii) None

1

(c) (i) R

1

(ii) T

1

(iii) R

1

(iv) P

1

(v) Q

1

[11]

- M4.** (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 O₂
- 2
- (d) **M1** The (concentration / amount of) H₂O₂ or reactant falls / decreases / used up
Mark independently
- OR**
- The number of H₂O₂ 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) $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
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]