

**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 /  $n^{\text{th}}$  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

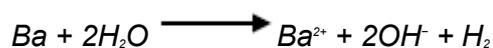
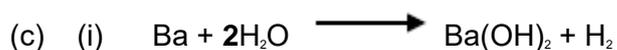
(ii) M1 Products lower than reactants on the profile

*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 BaSO<sub>4</sub> / 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 O<sub>2</sub> 2
- (d) **M1** The (concentration / amount of) H<sub>2</sub>O<sub>2</sub> or reactant falls / decreases / used up  
*Mark independently*
- OR**
- The number of H<sub>2</sub>O<sub>2</sub> 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]**