A-Level Chemistry

Collision Theory

Mark Scheme

Time available: 58 minutes
Marks available: 55 marks

1.

(a) As <u>concentration increases</u> the amount of heat given out increases / temperature increases **(M1)**

Any order.

Ignore references to an exothermic reaction.

1

More <u>successful</u> collisions or reactions <u>in a given time</u> **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 <u>oxide / MgO</u> **(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 <u>and</u> 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.*

<u>Calcium sulfate</u> 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]

2. (a) Sulfur OR S OR S_8

Sulphur

1

(b) **M1** The activation energy is the minimum / least / lowest

Mark these independently

1

M2 Energy for a reaction to occur / to go / to start

OR

Energy for a successful / effective collision

1

(c) Explanation:

M1 Twice as many / double number of particles

M1 NOT molecules

1

M2 More / twice / double (effective) collisions (in a given time)

OR

Double / greater / increased collision frequency

1

(d) (i) (Measured) change in concentration (of a substance) in unit time / given time

May be written mathematically

OR the gradient of the concentration (against) time

1

(ii) The measured change / amount (of precipitate) / cloudiness is fixed or constant or unchanged

1

[7]

3. (a) the minimum energy;

1

Energy required for a reaction to occur;

(or to start a reaction or for successful collisions)

1

(b) axes labelled:- y: number *(or fraction or %)* of molecules *(or particles)*
x: energy *(or KE);*

1

curve starts at origin;

1

skewed to right;

1

approaches x axis as an asymptote;

(penalise a curve that levels off > 10% of max peak height or a curve that crosses the energy axis)

1

second curve displaced to the left (and does not cross T_1 curve for a second time)

1

and peak higher;

1

many fewer molecules;

1

fewer molecules have $E > E_a$ *;*

(can score this mark from suitably marked curves)

1

(c) molecules *(or particles or collisions)* do not have enough energy;

(or orientation may be wrong)

1

increase the pressure;

1

(or increase the concentration or reduce the volume)
increases the collision frequency;

(or more collisions)
(do not allow if stated to be due to increase in energy implied by temperature increase)

1

add a catalyst;

1

lowers activation energy (or E_a) *(Q of L mark);*

1

[15]

4. (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

(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 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 $BaSO_4$ / 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]

5. (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) $\underline{H_2O_2 \text{ or reactant}}$ falls / decreases / used up

Mark independently

OR

The number of $\underline{H_2O_2 \text{ or reactant}}$ molecules/ particles falls / decreases

M2

The <u>rate</u> of reaction / <u>rate</u> of decomposition / <u>rate</u> of formation of oxygen / <u>frequency of collisions</u> / (effective) <u>collisions in a given time</u> 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 <u>used up</u> in the reaction / <u>unchanged at the end</u> of the reaction

OR

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

1

[10]