



A-Level Chemistry
**Effect of Temperature,
Concentration and Pressure**
Mark Scheme

Time available: 54 minutes
Marks available: 50 marks

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Mark schemes

1.

- (a) Idea that it is hard to judge to the nearest 0.01 second *or* Idea that it is hard to judge the exact moment (that it becomes too cloudy / the cross disappears) *or* the idea of reaction time

Ignore ideas relating to accuracy (unless qualified)

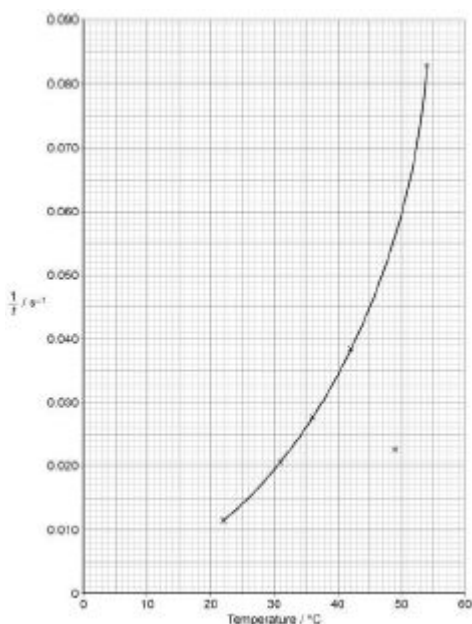
1

- (b) 0.083(3....)

1

- (c) **M1** points plotted correctly (allow $\pm 1/2$ small square for each)

M2 suitable best fit curve that misses point at 49°C and passes within one small square of the other five points



If any points plotted incorrectly: best fit line based on their plotted points which may need to be more than one square away from some points

*If no value calculated in (b), then **M1** and **M2** based on the other points (except the fifth anomalous point). A straight line may be allowed for **M2** for the first four points.*

*If incorrect value calculated in (b): **M1** based on all values being plotted correctly; **M2** based on suitable best fit line for the plotted points (except the fifth anomalous point).*

*Penalise **M2** if best fit line goes to 0,0.*

2

- (d)

1

value from their best fit line at 40°C

$$\text{eg } \frac{1}{0.0345} = 29 \text{ (s)}$$

Ignore units

1

- (e) as it forms a toxic gas or
 SO_2 is toxic/poisonous or
 to limit amount of SO_2 formed

Ignore reference to SO_2 being harmful

Ignore reference to acid rain / pollutant

1

- (f) reaction would take too long / too slow / take a long time / very slow

Ignore reaction may not occur

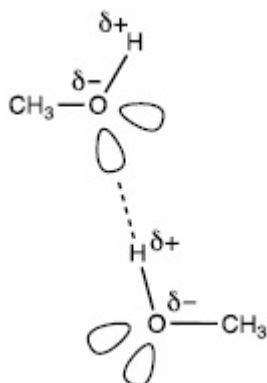
Allow idea that it makes judging the moment when the cross disappears more difficult

1

[7]

2.

(a)



M1 on at least one O atom two lone pairs and
 on at least one OH δ^+ on H and δ^- on O

1

M2 dotted line shown between lone pair on one molecule and the
 correct H on another

1

M3 $\text{O} \cdots \text{H}-\text{O}$ in straight line

1

Accept pair of dots or crosses for lone pair in place of orbital shape (orbital shape may or may not include two electrons)

Ignore any partial charges on C-H or C-O bonds

*For straight line in **M3**, allow a deviation of up to 15°*

If a different molecule containing hydrogen bonding due to O-H bond drawn (e.g. ethanol, water) or an incorrect attempt at the structure of methanol, then maximum of 2 marks (i.e. only penalise if would score all three marks otherwise)

- (b) Idea that lone pairs have greater repulsion than bonding pairs
There must be a comparison between the repulsion of a lone pair and bonding pair
Allow covalent bond = bonding pair

1

(c)

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.	
Level 3 5-6 marks	All stages are covered and the explanation of each stage is generally correct and virtually complete. (6 v 5) Answer is well structured, with no repetition or irrelevant points, and covers all aspects of the question. Accurate and clear expression of ideas with no errors in use of technical terms.
Level 2 3-4 marks	All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR two stages are covered and are generally correct and virtually complete (4 v 3) Answer has some structure and covers most aspects of the question. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. If any, only minor errors in use of technical terms.
Level 1 1-2 marks	Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete (2 v 1) Answer includes statements which are presented in a logical order and/or linked.
0 marks	Insufficient correct chemistry to gain a mark.

Stage 1

Describes the effect of catalyst use

1a use of a catalyst has no impact on equilibrium yield

1b use of a catalyst gives faster rate

1c use of catalyst lowers costs

Stage 2

Describes the effect of pressure

2a higher pressure gives a higher equilibrium yield

2b higher pressure gives a faster rate

2c the higher the pressure, the greater the cost

Stage 3

Describes the effect of temperature

3a lower temperature gives a higher equilibrium yield

3b higher temperature gives a faster rate

3c the higher the temperature, the greater the cost

Note that converse statements are fine (e.g. 1a higher temperature gives a lower equilibrium yield)

6

[10]

3.

(a) 111(.11 ...)

1

(b) temperature

1

(c) Find the average of the temperature at the start and end of the reaction

Allow idea of doing the reaction in a water bath

1

(d) **M1** suitable vertical scale

should use more than half the axis to cover the points from 6.45 to 111

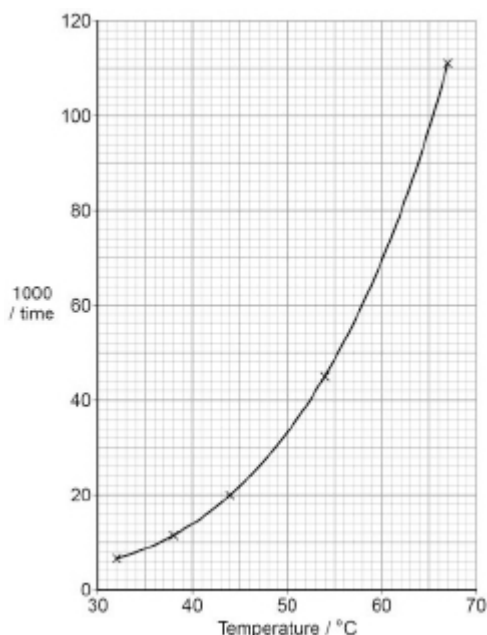
1

M2 points plotted correctly ($\pm \frac{1}{2}$ small square per point)

allow ECF for plotting of point found in part (a)

1

M3 best fit line drawn (within one small square of each point)



allow ECF for a line based on their plotted points, but only where the line continues to rise throughout the temperature range

1

(e) $\text{Time} = \frac{1000}{\text{value from graph at } 60^{\circ}\text{C}}$

Working needs to be shown that includes a value from the graph at 60 °C

Use the value their line shows at 60 °C ($\pm \frac{1}{2}$ small square)

1

(f) **M1** many more particles/ions have (energy \geq) activation energy

need the idea that it is many / much more particles; allow reference to atoms / molecules instead of particles / ions

1

M2 more of the collisions are successful

allow idea of more successful collisions per unit time / greater frequency of successful collisions

1

[9]

4.

(a) minimum energy

1

to start a reaction/ for a reaction to occur/ for a successful collision

1

(b) activation energy is high / few molecules/particles have sufficient energy to react/few molecules/particles have the required activation energy

(or breaking bonds needs much energy)

1

(c) molecules are closer together/ more particles in a given volume

1

therefore collide more often

1

(d) many

1

more molecules have energy greater than activation energy (QoL)

1

(e) speeds up a reaction but is chemically unchanged at the end

1

(f) increases the surface area

1

[9]

5.

(a) (i)

M1

High (temperature) OR Increase (the temperature)

If M1 is incorrect CE = 0 for the clip

*If M1 is blank, mark on and seek to **credit the correct information in the text***

M2

The (forward) reaction / to the right is endothermic or takes in / absorbs heat
OR

The reverse reaction / to the left is exothermic or gives out / releases heat

M3 depends on correct M2 and must refer to temperature / heat

M3 depends on a correct statement for M2

At high temperature, the (position of) equilibrium shifts / moves left to right to oppose the increase in temperature

For M3, the position of equilibrium shifts / moves

to absorb heat OR

to lower the temperature OR

to cool down the reaction

3

(ii)

M1

The reaction gets to equilibrium faster / in less time

OR

Produces a small yield faster / in less time

OR

Increases the rate (of reaction / of attainment of equilibrium)

Mark independently

M2

High pressure leads to **one** of the following

- more particles / molecules in a given volume
- particles / they are closer together
- higher concentration of particles / molecules

AND

- more collisions in a given time / increased collision frequency

Penalise M2 for reference to increased energy of the particles

2

(iii) **M1** Increase in / more / large(r) / big(ger) surface area / surface sites

Mark independently

For M1 accept "an increase in surface"

M2 increase in / more successful / productive / effective collisions (in a given time) (on the surface of the catalyst / with the nickel)

For M2 not simply "more collisions"

Ignore "the chance or likelihood" of collisions

2

(b) **M1**

No effect / None

*If **M1** is incorrect **CE = 0** for the clip*

*If **M1** is blank, mark on and seek to **credit the correct information in the text***

M2 requires a correct M1

Equal / same number / amount of moles / molecules / particles on either side of the equation

OR

2 moles / molecules / particles on the left and 2 moles / molecules / particles on the right

M2** depends on a correct statement for **M1

*In **M2** not "atoms"*

2

[9]

6.

(a) **M1** provides a different route / mechanism / pathway

Ignore reference to (frequency of) collisions, surface area or active sites

1

M2 with lower activation energy

Penalise reference to increasing energy of particles ($CE = 0$)

*Allow E_a / E_{act} or definition of activation energy in **M2***

1

(b) **M1** line 2 = steeper than original and finishes at same height

1

M2 line 3 = less steep than original and finishes at half the height

If two correct lines are drawn but neither labelled, then allow 1 mark.

If two correct lines are drawn and only one is labelled, then allow 2 marks.

If only one correct line is drawn and neither are labelled, then 0 marks.

If two correct lines are drawn but line 2 is labelled 1 and line 3 is labelled 2, then allow 1 mark

Allow some unevenness in drawing of lines in terms of height it levels off at, with up to a quarter of a box of unevenness

At the start, lines must separate from the original before the first vertical line.

In terms of the origin, lines must start within one half of a square of the origin.

For each line ignore the time at which the line becomes horizontal – it is the fact it is more or less steep than the original line that matters (along with the height at which it finishes)

1

- (c) **M1** more particles/molecules/reactants/ H_2O_2 /moles in given/same volume/space OR particles/molecules/reactants/ H_2O_2 /moles closer together

Penalise reference to changing the activation energy ($CE = 0$)

*For **M1** do not allow area*

1

- M2** successful collisions are more frequent

*For **M2***

successful collisions – allow reference to collisions with sufficient energy or collisions with the activation energy or effective collisions

more frequent – allow reference to per unit time, per second (but ignore reference to rate of collisions, ignore chance of collisions, ignore likelihood of collisions)

1

[6]