

M1.(a) Log (1 / time) on the y-axis + log (vol) on x-axis
If axes unlabelled use data to decide that log (1 / time) is on the y-axis

1

Sensible scales

Lose this mark if the plotted points do not cover at least half of the paper

Lose this mark if the graph plot goes off the squared paper

Lose this mark if plots a non-linear / broken scale

Lose this mark if uses an ascending y-axis of negative numbers

1

Plots points correctly \pm one square

1

Line through the points is smooth

Lose this mark if the candidate's line is doubled

1

Line through the points is best fit – ignores last point

Must recognise that point at 25 cm³ is an anomaly

If wrong graph, mark consequentially on anomaly if correctly plotted.

*A kinked graph loses smooth **and** best fit marks*

1

(b) Uses appropriate x and y readings

Allow taken from table or taken or drawn on graph

Must show triangle on graph or such as $\frac{1.65 - 1.2}{1.4 - 0.9}$

1

Correctly calculates gradient 0.95 ± 0.02

Ignore positive or negative sign
Correct answer only with no working scores this mark

1

Answer given to 2 decimal places

1

(c) First order or order is 1

Allow consequential answer from candidate's results

1

(d) Thermostat the mixture / constant temperature / use a water bath
or Colorimeter / uv-visible spectrometer / light sensor to monitor colour change

1

Reaction / rate affected by temperature change
or Eliminates human error in timing / more accurate time of colour change

1

[11]

M2. (a) (i) Experiment 2: $0.4(0) \times 10^{-3}$ (1)
Experiment 3: 0.15 (1)
Experiment 4: 0.28 (1)

$$(ii) \quad k = \frac{4.8 \times 10^{-3}}{(0.20)^2 \times (0.30)} = 0.4(0) \text{ mol}^{-2} \text{ dm}^6 \text{ s}^{-1}$$

(1) (1) (1)

6

(b) (change in) temperature (1)

1

[7]

M3. (a) (i) (Experiment 1 → 2) [A] doubled, ([B] constant),
rate doubled **(1)**
stated or shown numerically

(ii) 2 **(1)**
or shown as ... [B]²

2

(b) (i)
$$k = \frac{9.30 \times 10^{-5}}{(0.75)^2 \times (1.50)} = 1.1(0) \times 10^{-4}$$

(1) **(1)**

units of k: mol⁻² dm⁶ s⁻¹ **(1)**

(ii) rate = (1.10 × 10⁻⁴) × (0.20)² × (0.10)
= 4.4(1) × 10⁻⁷ (mol dm⁻³ s⁻¹)
(1) for the answer

Ignore units

Conseq on (i)

Upside down expression for k scores zero in (i) for 9073

but rate = 9073 × (0.2)² × (0.1) = 36(.3)

conseq scores (1) in (ii)

4

[6]

M4. (a) order with respect to **P** is 2

1

order with respect to **Q** is 1

1

(b) (i) rate = k[R][S]²

(if wrong expression, no further marks)

1

$$\text{rate} = (4.2 \times 10^{-4}) \times 0.16 \times 0.84^2$$

1

$$= 4.7 \times 10^{-5} \text{ (mol dm}^{-3} \text{ s}^{-1}\text{)}$$

ignore units even if wrong

1

$$(ii) \quad k = \frac{\text{rate}}{[R][S]^2} = \frac{8.1 \times 10^{-5}}{0.76 \times 0.98^2}$$

1

$$= 1.1 \times 10^{-4}$$

1

(iii) T_1

**If calculated value for $k > 4.2 \times 10^{-4}$, then answer to (iii) is T_2*

1

[8]

M5. (a) Power (or index or shown as x in $[]^x$) of concentration term
(in rate equation) **(1)**

1

(b) **2 (1)**

1

(c) (i) Order with respect to **A**: **2 (1)**

Order with respect to **B**: **0 (1)**

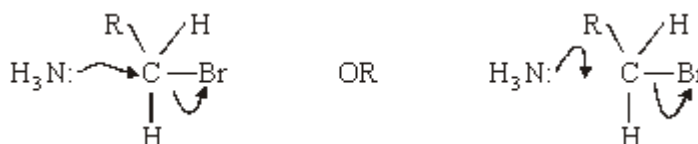
(ii) Rate equation: (rate =) $k [A]^2$ **(1)**

Allow conseq on c(i)

Units for rate constant: $\text{mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$ **(1)**

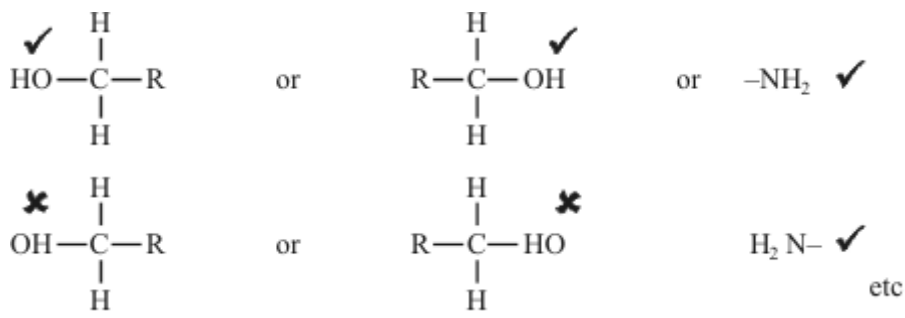
Organic points

- (1) Curly arrows: must show movement of a pair of electrons, i.e. from bond to atom or from lp to atom / space e.g.



- (2) Structures

penalise sticks (i.e. $\begin{array}{c} | \\ -C- \\ | \end{array}$) once per paper



Penalise once per paper

allow CH_3- or $-\text{CH}_3$ or $\begin{array}{c} \text{CH}_3 \\ | \end{array}$ or CH_3
 or $\text{H}_3\text{C}-$

M6. (a) 2 or two or second

$$(b) \quad k = \frac{1.24 \times 10^{-4}}{(4.40)(0.82)}$$

*mark is for insertion of numbers into a correctly rearranged rate equ, k = etc
if upside down, (or use of I₂ data) score only units mark*

1

$$= 3.44 \times 10^{-5} \text{ (min 3sfs)}$$

1

$$\text{mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$$

any order

1

(c) no change or no effect or stays the same or 1.24×10^{-4}

1

(d) 1 or 2 or 1 and 2

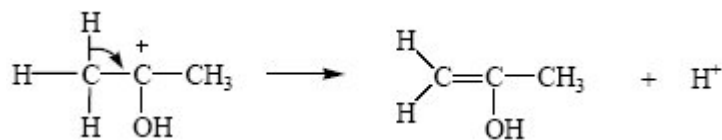
if wrong no further mark but mark on from no answer

1

rate equ doesn't involve I₂ or only step which includes 2 species in rate equ

1

(e)



any second arrow loses the mark

1

[8]

M7. (a) (i) 2

1

(ii)	0		1
(b)	(i)	rate/[NO ₂] ² [O ₂]	1
		13	1
		mol dm ⁻³	1
(ii)		1.9 × 10 ⁻³	1
(iii)		Step 2	1

[7]