

Mark schemes

1

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

1

order with respect to **Q** is 1

1

(b) (i) rate = $k[\mathbf{R}][\mathbf{S}]^2$

(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

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

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]

2

(a) (i) Experiment 2 2.60×10^{-3}

1

Experiment 3 0.60×10^{-2}

1

Experiment 4 11.4×10^{-2}

1

$$(ii) \quad k = \frac{10.4 \times 10^{-3}}{(4.80 \times 10^{-2})(6.60 \times 10^{-2})^2}$$

$$= 49.7$$

(Allow 49.8 and 50)

$$\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$$

(b) No change

1
1
1
1

[7]

3

(a) (i) 2 (1)

(ii) 0 (1)

2

(b) (i) Value of k : $k = \frac{\text{rate}}{[\text{NO}]^2 [\text{O}_2]} = \frac{6.5 \times 10^{-4}}{(5.012 \times 10^{-2})^2 (2.0 \times 10^{-2})} = 13$

Units of k : $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$ (1)

(ii) $\text{rate} = 13 (6.5 \times 10^{-2})^2 (3.4 \times 10^{-2})$
 $= 1.9 \times 10^{-3} \quad (\text{mol dm}^{-3} \text{s}^{-1})$ (1)

If k wrong, the mark in (ii) may be gained conseq for their
 $k \times 1.437 \times 10^{-4}$

4

[6]

4

(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)

conseq on rate equation

4

[6]

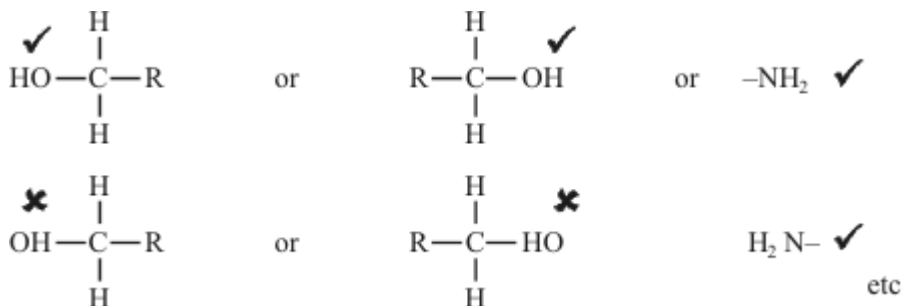
Organic points

(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. $\begin{array}{c} | \\ \text{---C---} \\ | \end{array}$) once per paper



Penalise once per paper

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

5

[1]

6

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

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

6

- (b) (change in) temperature **(1)**

1

[7]**7**

- (a) Order with respect to iodine: 0 **(1)**
 Overall order: 2 **(1)**

2

(b) Rate constant: $k = \frac{2 \times 10^{-5}}{(1.5) \times (3 \times 10^{-2})} = 4.4(4) \times 10^{-4}$ **(1)**

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

3

- (c) Appears in rate equation **(1)**
OR implied by mention of concentration or order
 does not appear in (stoichiometric / overall) equation **(1)**

2

(d) $\text{pH} = -\log_{10} [\text{H}^+]$ **(1)**
 $= 1.25$
 $[\text{H}^+] = 0.056(2)$ **(1)**

$\therefore \text{rate} = (4.44 \times 10^{-4}) \times (1.50) \times (0.0562)$

$= 3.75 \times 10^{-5}$ **(1)** ($\text{mol dm}^3 \text{ s}^{-1}$)

(3.7 — 3.8)

Can score all 3 conseq on k from part (b)

3

[10]

8

- (a) (i) (Experiment 1 \rightarrow 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 \times 10⁻⁴) \times (0.20)² \times (0.10)
= 4.4(1) \times 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 \times (0.2)² \times (0.1) = 36(.3)

conseq scores (1) in (ii)

4

[6]**9****[1]****10****[1]**