Mark schemes

1

(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**

rate = $(4.2 \times 10^{-4}) \times 0.16 \times 0.84^2$ **1**

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

ignore units even if wrong **1**

(ii) $k = \dfrac{\text{rate}}{[R][S]^2} = \dfrac{8.1 \times 10^{-5}}{0.76 \times 0.98^2}$ **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) $k = \frac{10.4 \times 10^{-3}}{(4.80 \times 10^{-2})(6.60 \times 10^{-2})^2}$

1

= 49.7

(Allow 49.8 and 50)

1

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

1

(b) No change

1

[7]

3

(a) (i) 2 **(1)**

(ii) 0 **(1)** 2

(b) (i) *Value of k*: $k = \frac{rate}{[NO]^2[O_2]} = \frac{6.5 \times 10^{-4}}{(5.012 \times 10^{-2})^2(2.0 \times 10^{-2})} = 13$

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

(ii) rate = $13\ (6.5 \times 10^{-2})^2\ (3.4 \times 10^{-2})$

$= 1.9 \times 10^{-3}$ $(mol\ dm^{-3}\ s^{-1})$ **(1)**

If k wrong, the mark in (ii) may be gained conseq for their k × 1.437 × 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: $mol^{-1}\ dm^3\ s^{-1}$ **(1)**

conseq on rate equation

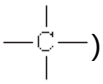
4

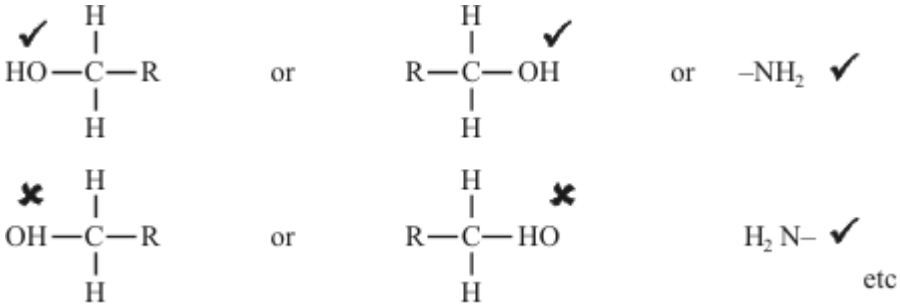
[6]

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. ) once per paper



Penalise once per paper

allow CH_3– or $–CH_3$ or  or CH_3
or H_3C–

5

[1]

6

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

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

(1) **(1)** **(1)**

6

(b) (change in) <u>temperature</u> **(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: $mol^{-1}\ dm^3\ s^{-1}$ **(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) $pH = -\log_{10}[H^+]$ **(1)**
$= 1.25$
$[H^+] = 0.056(2)$ **(1)**

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

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

(3.7 — 3.8)
Can score all 3 conseq on k from part (b)

3

[10]

8

(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: $mol^{-2}\ dm^6\ s^{-1}$ **(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 × (0.2)² × (0.1) = 36(.3)
conseq scores (1) in (ii)

4

[6]

9 C

[1]

10 D

[1]