Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Mark Schemes

Q1.

(a) energy

Ignore reference to

- *any units (e.g. J, kJ, J mol^{-1}, kJ mol^{-1})*
- *particles*
- *molecules*
- *kinetic*

***NOT** mean energy or average energy*

***NOT** E*

1

(b) **M1** maximum peak height is lower and displaced to the right of the original

1

M2 all of the following

- starts at the origin but does not follow the original line
- shows separation as soon as possible from the original line
- crosses the original curve once only
- similar area to original curve
- an attempt has been made to draw the new curve correctly towards the energy axis above the original curve but not to touch the original curve (or axis)

1

(c) **M1** an increase in the number/amount/proportion/fraction of molecules with $E \geq E_a$ / with activation energy

or more molecules have $E \geq E_a$ / with activation energy

or more molecules have enough / sufficient energy (to react)

M1

Ignore

- *Molecules have more energy*
- *More energetic collisions*
- *More collisions*

Allow $E > E_a$ in place of $E \geq E_a$

Credit particles for molecules (but not atoms)

*Penalise for **M1** reference to increased activation energy*

1

M2 more successful / effective / productive collisions in a given time / period

or higher rate of successful / effective / productive collisions

or higher frequency of successful / effective / productive collisions

M2

Must refer to <u>both</u> idea of successful / effective / productive collisions and the rate / frequency of collisions

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Ignore 'chance of collision'

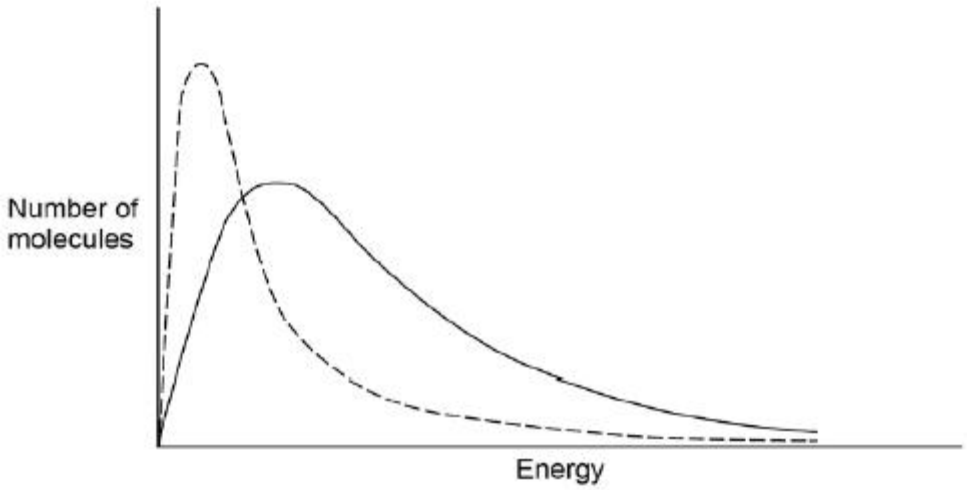
1

[5]

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Q2.

(a)



M1 Curve is higher and displaced to the left

M2 Only crosses the original curve <u>once</u>

2

(b) Rate of reaction decreases (no mark)

Fewer particles will have energy greater than or equal to the activation energy

1

Fewer <u>successful</u> collisions in a given time

Less frequent <u>successful</u> collisions

1

(c) The amount of gas present (or number of molecules) has been reduced / or the pressure has been reduced

1

Rate of reaction decreases (no mark)

Particles are spread further apart

1

Fewer collisions between gas particles so fewer <u>successful</u> collisions

1

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Q3.

(a) Consider experiments 1 and 2: [B constant]

[A] increases × 3: rate increases by 3^2 therefore 2nd order with respect to A

1

Consider experiments 2 and 3:

[A] increases × 2: rate should increase × 2^2 but only increases × 2

Therefore, halving [B] halves rate and so 1st order with respect to B

1

Rate equation: rate = $k[A]^2[B]$

1

(b) rate = $k\,[C]^2[D]$ therefore k = rate / $[C]^2[D]$

1

$$k = \frac{7.2\times10^{-4}}{(1.9\times10^{-2})^2 \times (3.5\times10^{-2})} = 57.0$$

Allow consequential marking on incorrect transcription

1

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

Any order

1

(c) rate = $57.0 \times (3.6 \times 10^{-2})^2 \times 5.4 \times 10^{-2} = 3.99 \times 10^{-3}$ (mol dm^{-3} s^{-1})

OR

Their $k \times (3.6 \times 10^{-2})^2 \times 5.4 \times 10^{-2}$

1

(d) Reaction occurs when molecules have $E \geq E_a$

1

Doubling T by 10 °C causes <u>many</u> more molecules to have this E

1

Whereas doubling [**E**] only doubles the number with this E

1

(e) $E_a = RT(\ln A - \ln k) / 1000$

Mark is for rearrangement of equation and factor of 1000 used correctly to convert J into kJ

1

$E_a = 8.31 \times 300\ (23.97 - (-5.03)) / 1000 = 72.3$ (kJ mol^{-1})

1

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