CHEMISTRY ONLINE
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CHEMISTRY

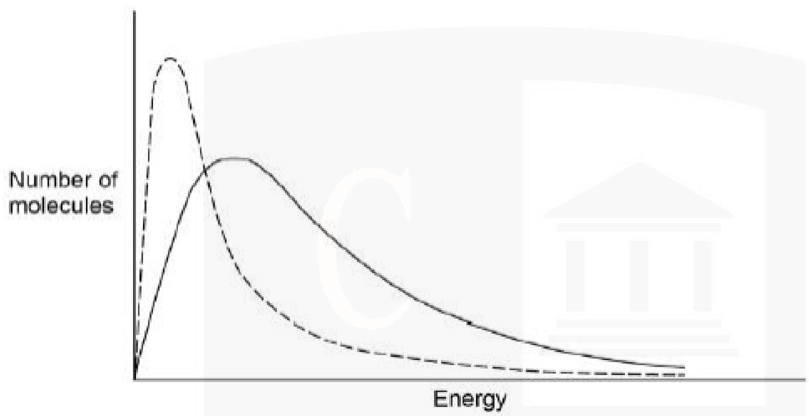
Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	KINETICS
PAPER TYPE:	SOLUTION - 4
TOTAL QUESTIONS	10
TOTAL MARKS	36

Kinetics - 4

1.

(a)



(2)

(b)
Lowering the temperature would decrease the rate of reaction rate of reaction as fewer particles will have energy greater than or equal to the activation energy so, fewer successful collisions in a given time.

(2)

(c)
Rate of reaction decreases as the amount of gas present (or number of molecules) has been reduced in this way the pressure also has been reduced so, particles are spread further apart now fewer collisions between gas particles occur and rate decreases due to fewer successful collisions.

(3)

2. (A)

(Total 1 mark)

3. (C)

(Total 1 mark)

4. (B)

(Total 1 mark)

5. (A)

(Total 1 mark)

6. (C)

(Total 1 mark)

7. This question involves the use of kinetic data to deduce the order of a reaction and calculate a value for a rate constant.
The data in Table 1 were obtained in a series of experiments on the rate of the reaction between compounds A and B at a constant temperature

Experiment	Initial concentration of A / mol dm^{-3}	Initial concentration of B / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.12	0.26	2.10×10^{-4}
2	0.36	0.26	1.89×10^{-3}
3	0.72	0.13	3.78×10^{-3}

(a)
Consider experiments 1 and 2: [B constant]
[A] increases × 3
When [A] triples (from 0.12 to 0.36)
The rate increases by a factor of approximately 9
($1.89\times10^{-3}/2.10\times10^{-4}$
=9
: rate increases by 3^2
Therefore 2nd order with respect to A
Consider experiments 2 and 3:
[A] increases × 2
When [B] doubles (from 0.13 to 0.26), the rate also doubles $3.78\times10^{-3}/1.89\times10^{-3}=2$
: rate should increase × 2^2 but only increases × 2
Therefore, halving [B] halves rate and so 1st order with respect to B
Rate equation: rate = $k[A]^2\,[B]$

(3)

(b)
rate = $k\,[C]^2\,[D]$ therefore
$k = \text{rate} / [C]^2\,[D]$
$\frac{7.2\times10^{-4}}{1.9\times10^{-2^{2}}\ 3.5\times10^{-2}}$ = 57 $mol^{-2}dm^{+6}\,s^{-1}$

(3)

(c)

Rate

$= 57.0 \times (3.6 \times 10^{-2})^2 \times 5.4 \times 10^{-2}$

$= 3.99 \times 10^{-3}$ ($mol\ dm^{-3}\ s^{-1}$)

(1)

(d)

Reaction occurs when molecules have E>Ea

Doubling T by 10 °C causes many more molecules to have this E

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

(3)

(e)

Given:

$k=6.51\times10^{-3}\ mol^{-1}\ dm^3$ (rate constant)

$A=2.57\times10^{10}\ mol^{-1}\ dm^3$(pre-exponential factor)

$R=8.31\ J\ K^{-1}\ mol^{-1}$ (gas constant)

T=300 K (temperature)

$\ln(A/k)=-\ Ea/RT$

$Ea=-R.T.\ln(k/A)$

$Ea=-8.31J\ K^{-1}\cdot 300K\cdot \ln\ (6.51\times10^{-3}/\ 2.57\times10^{10})$

$Ea=-8.31J\ K^{-1}\cdot 300K\ \ln(2.534\times10^{-13})$

$Ea=-8.31J\ K^{-1}\cdot 300K\ (-29.283)$

Ea=72,869.49J/mol

=72.86949kJ/mol

(2)

8.

(a)

Fermentation of an Aqueous Solution of Fructose:

Catalyst: Yeast

Organic Product: Ethanol (and carbon dioxide)

I am Sorry !!!!!

(2)

(b)

Hydration of Prop-1-ene:

Catalyst: Sulfuric acid (H_2SO_4) or Phosphoric acid (H_3PO_4)
Organic Product: Propan-2-ol (Isopropanol)

(2)

9.

To investigate the rate of decomposition of nitrogen dioxide (NO_2):

- Use a reaction vessel to initiate and monitor the decomposition.
- Measure NO_2 concentration at intervals using sensors or spectrophotometers.
- Record changes in concentration against time.
- Calculate rates of decomposition using collected data.
- Repeat experiments for reliability and analyze rate behavior to determine reaction kinetics.

(2)

10.

(a)

Activation energy (E_a) refers to the minimum amount of energy required for a chemical reaction to occur. It represents the energy barrier that reactant molecules must overcome to transform into products during a chemical reaction. This energy is needed to break the existing chemical bonds in the reactants and initiate the formation of new bonds to create the products.

(2)

(b)

A catalyst is a substance that alters the rate of a chemical reaction without itself undergoing any net chemical change at the end of the reaction.
It works by providing an alternative reaction pathway that decreases the activation energy required for the reaction to proceed, thereby accelerating the rate of the reaction without being consumed in the process.

(2)

(c)

Catalysts works by providing an alternative reaction pathway that involves a lower activation energy compared to the uncatalyzed reaction. They interact with the reactant molecules, allowing them to undergo a different mechanism that requires less energy to convert into products.

By lowering the activation energy barrier, a catalyst increases the chance of successful collisions between reactant molecules, enabling the reaction to occur at a faster rate. After facilitating the reaction, the catalyst remains unchanged and can be reused in subsequent reactions.

(2)