

Reaction Kinetics – 2023 AS Chemistry 9701

1. Nov/2023/Paper_9701/11/No.14

In reaction 1, a student measures the initial rate of production of $\text{CO}_2(\text{g})$ when $\text{CuCO}_3(\text{s})$ is added to 50 cm^3 of $0.1 \text{ mol dm}^{-3} \text{ HNO}_3(\text{aq})$.

In reaction 2, the student repeats the experiment using 50 cm^3 of $0.5 \text{ mol dm}^{-3} \text{ HNO}_3(\text{aq})$ and the same mass of $\text{CuCO}_3(\text{s})$.

In reaction 1 and reaction 2, the acid is in excess and samples of the same CuCO_3 powder are used.

Which row is correct?

	$\frac{\text{rate of reaction 1}}{\text{rate of reaction 2}}$	$\frac{\text{initial number of effective collisions in reaction 1 per second}}{\text{initial number of effective collisions in reaction 2 per second}}$
A	greater than 1	greater than 1
B	greater than 1	less than 1
C	less than 1	greater than 1
D	less than 1	less than 1

2. Nov/2023/Paper_9701/11/No.15

The forward reaction of a reversible reaction is exothermic and has an activation energy of $+30 \text{ kJ mol}^{-1}$.

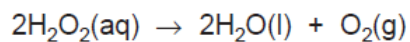
The reverse reaction proceeds by a mechanism that is the exact reverse of the mechanism of the forward reaction.

Which statement about the activation energy of the reverse reaction is correct?

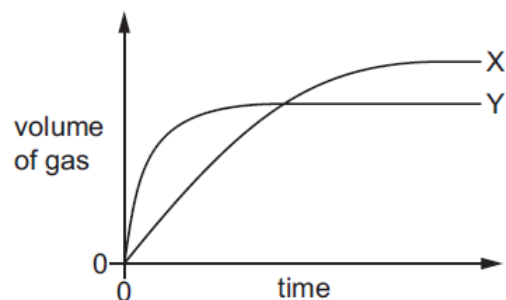
- A The activation energy for the reverse reaction is equal to -30 kJ mol^{-1} .
- B The activation energy for the reverse reaction is greater than 0 kJ mol^{-1} but less than $+30 \text{ kJ mol}^{-1}$.
- C The activation energy for the reverse reaction is equal to $+30 \text{ kJ mol}^{-1}$.
- D The activation energy for the reverse reaction is greater than $+30 \text{ kJ mol}^{-1}$.

3. Nov/2023/Paper_9701/12/No.16

The decomposition of hydrogen peroxide in the presence of MnO_2 produces water and oxygen gas.



The volume of gas collected when 0.2g of MnO_2 is added to two different hydrogen peroxide solutions at 20 °C is shown on the graph as curves X and Y.

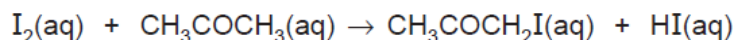


Which row shows the conditions that will result in curves X and Y?

	curve X			curve Y		
	volume of $\text{H}_2\text{O}_2 / \text{cm}^3$	concentration of $\text{H}_2\text{O}_2 / \text{mol dm}^{-3}$	form of MnO_2	volume of $\text{H}_2\text{O}_2 / \text{cm}^3$	concentration of $\text{H}_2\text{O}_2 / \text{mol dm}^{-3}$	form of MnO_2
A	50	0.1	lumps	50	0.2	powder
B	25	0.2	powder	25	0.1	lumps
C	50	0.1	lumps	20	0.2	powder
D	20	0.2	powder	40	0.1	lumps

4. June/2023/Paper_9701/11/No.11

Iodine and propanone react according to the following equation.



If the concentration of propanone is increased, keeping the total reaction volume constant, the initial rate of the reaction also increases.

What could be the reason for this?

- A A greater proportion of collisions are successful at the higher concentration.
- B The particles are further apart at the higher concentration.
- C The particles have more energy at the higher concentration.
- D There are more collisions per second between particles at the higher concentration.

5. June/2023/Paper_9701/11/No.15

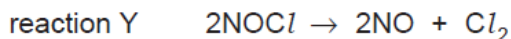
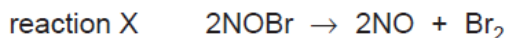
The temperature of a sample of an inert gas is increased.

What effect does this have on the number of molecules with the most probable energy and on the number of molecules with higher energy?

	number of molecules with the most probable energy	number of molecules with higher energy
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

6. June/2023/Paper_9701/12/No.15

The equations for two reactions are shown.



The two reactions have similar reaction mechanisms.

The initial rate of reaction X is greater than that of reaction Y when measured under identical conditions of temperature, pressure and reactant concentration.

Which statements explain this difference?

- 1 The activation energy for reaction X is less than that of reaction Y.
- 2 The Br-Br bond is weaker than the Cl-Cl bond.
- 3 A higher frequency of collisions between molecules of NOBr occur than between molecules of NOCl.

A 1 and 2

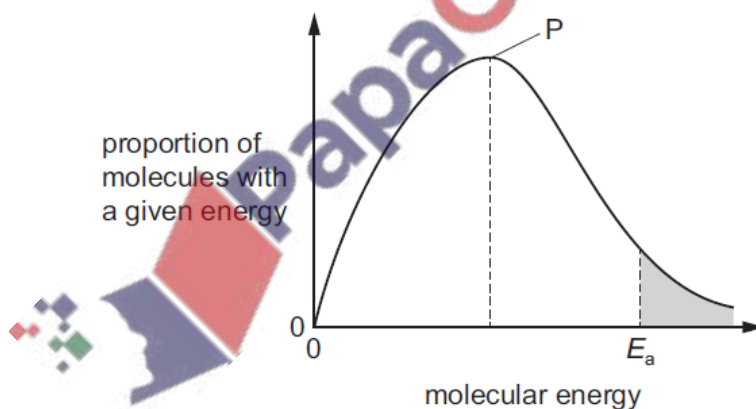
B 2 and 3

C 1 only

D 3 only

7. June/2023/Paper_9701/12/No.16

The diagram shows the Boltzmann distribution of energies in a gas. The gas can take part in a reaction with an activation energy, E_a . The gas is maintained at a constant temperature.



Which statement is correct?

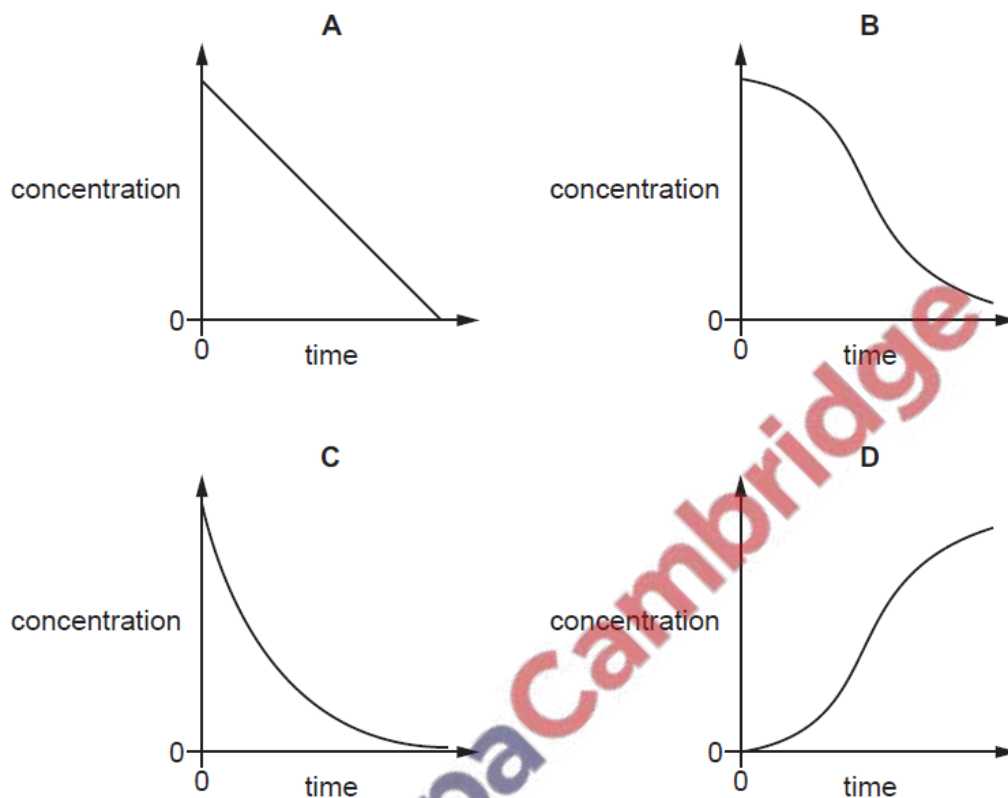
- A If a catalyst is added, peak P will be lower and E_a will move to the left.
- B If a catalyst is added, peak P will be lower and E_a will move to the right.
- C If a catalyst is added, peak P will be the same and E_a will move to the left.
- D If a catalyst is added, peak P will be the same and E_a will move to the right.

8. June/2023/Paper_9701/13/No.18

The rate of an exothermic reaction is followed by measuring the concentration of a reactant at regular time intervals.

During the experiment the temperature of the reaction mixture is **not** controlled.

Which graph shows the change in concentration of reactant against time?



9. June/2023/Paper_9701/13/No.19

For a particular reversible reaction the backward reaction is endothermic.

The activation energy of the backward reaction is 160 kJ mol^{-1} .

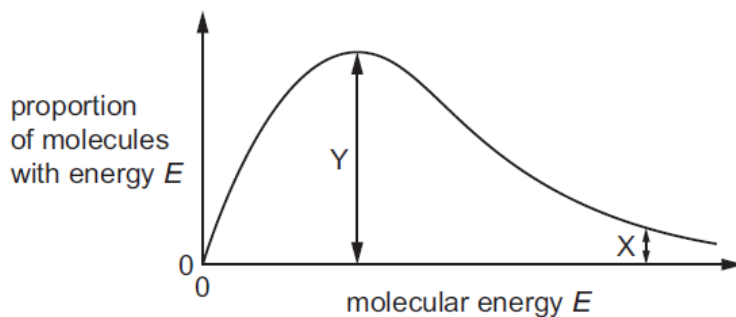
It can be assumed that the backward reaction proceeds by a mechanism that is the exact reverse of the mechanism for the forward reaction.

Which statement about the activation energy of the forward reaction is correct?

- A The activation energy of the forward reaction is equal to -160 kJ mol^{-1} .
- B The activation energy of the forward reaction is greater than 0 kJ mol^{-1} but less than $+160 \text{ kJ mol}^{-1}$.
- C The activation energy of the forward reaction is equal to $+160 \text{ kJ mol}^{-1}$.
- D The activation energy of the forward reaction is greater than $+160 \text{ kJ mol}^{-1}$.

10. June/2023/Paper_9701/13/No.21

The diagram shows the Boltzmann distribution of the energy of gaseous molecules at a particular temperature.

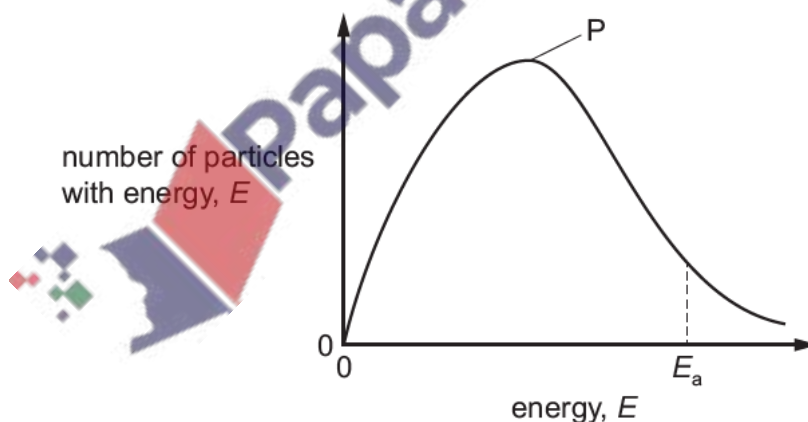


Which statement is correct?

- A If the temperature of the gas is raised, the height of the maximum of the curve increases.
- B If the temperature of the gas is raised, the maximum of the curve moves to the right.
- C The length of the line labelled X shows the activation energy for the reaction.
- D The length of the line labelled Y shows the enthalpy change of the reaction.

11. March/2023/Paper_9701/12/No.2

The diagram shows the Boltzmann distribution for one mole of a gas. The gas takes part in a reaction with an activation energy, E_a .



Which statement correctly describes the effect of an increase in temperature?

- A Peak P will be higher and fewer molecules will have energy $> E_a$.
- B Peak P will be higher and more molecules will have energy $> E_a$.
- C Peak P will be lower and fewer molecules will have energy $> E_a$.
- D Peak P will be lower and more molecules will have energy $> E_a$.

12. March/2023/Paper_9701/12/No.3

A student carries out four experiments to investigate the rate of reaction between 3.0g of calcium carbonate and hydrochloric acid.



- experiment 1 CaCO_3 powder + 2.0 mol dm^{-3} HCl at 35°C
experiment 2 CaCO_3 powder + 2.0 mol dm^{-3} HCl at 35°C
experiment 3 large chips of CaCO_3 + 1.0 mol dm^{-3} HCl at room temperature
experiment 4 large chips of CaCO_3 + 1.0 mol dm^{-3} HCl at 35°C

The student collects the $\text{CO}_2(\text{g})$ and times how long it takes to produce the same volume of gas for each experiment.

What could be the correct times for the four experiments?

	experiment 1 /s	experiment 2 /s	experiment 3 /s	experiment 4 /s
A	5	10	30	95
B	5	10	95	30
C	5	30	95	10
D	95	30	10	5