CHEMISTRY ONLINE
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CHEMISTRY

Physical Chemistry

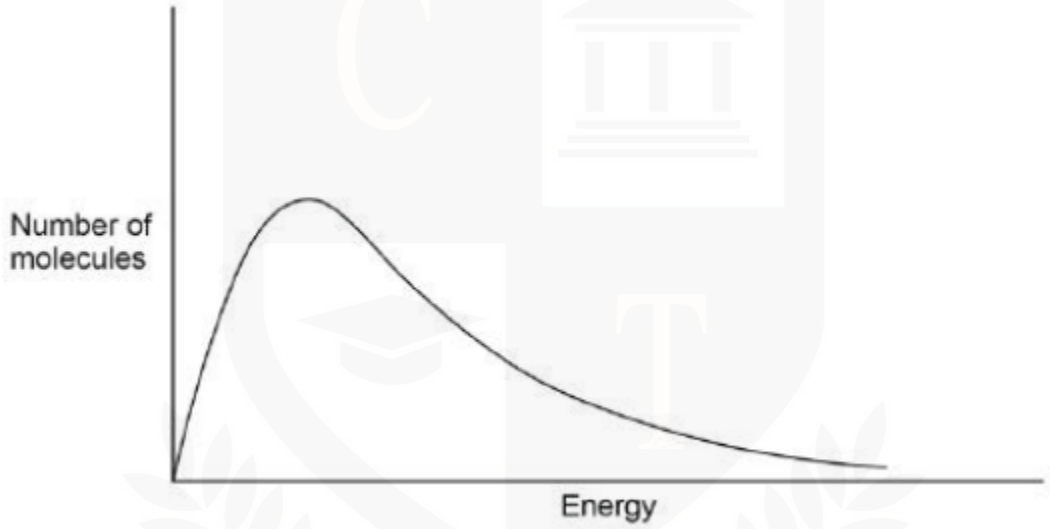
Level & Board	AQA (A-LEVEL)
TOPIC:	KINETICS
PAPER TYPE:	QUESTION PAPER - 4
TOTAL QUESTIONS	10
TOTAL MARKS	36

Kinetics - 4

1. Nitryl chloride reacts with nitrogen monoxide according to the equation:

$ClNO_2(g) + NO(g) \longrightarrow NO_2(g) + ClNO(g)$

The Maxwell–Boltzmann distribution curve in Figure 1 shows the distribution of molecular energies in 1 mol of this gaseous reaction mixture (sample 1) at 320 K.



(a) On the same axes, draw a curve for sample 1 at a lower temperature.

(2)

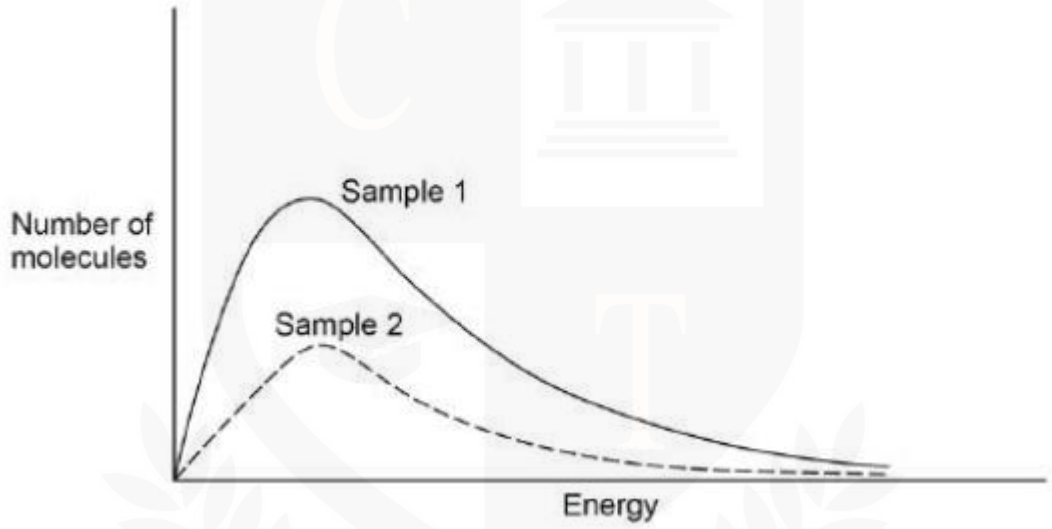
(b) Explain the effect that lowering the temperature would have on the rate of reaction.

(2)

(c) A Maxwell–Boltzmann distribution curve was drawn for a second sample of the reaction mixture in the same reaction vessel.

Figure 2 shows the results.

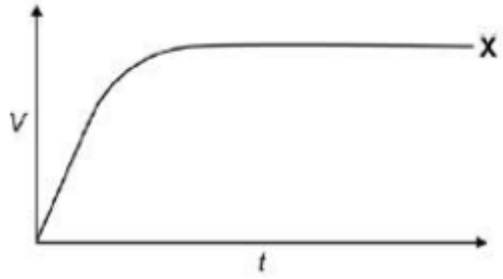
Deduce the change that was made to the reaction conditions.



Explain the effect that this change has on the rate of reaction.

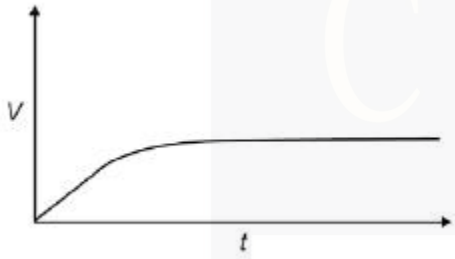
(3)

2. Line X in the diagram represents the volume (V) of gas formed with time (t) in a reaction between an excess of magnesium and aqueous sulfuric acid.

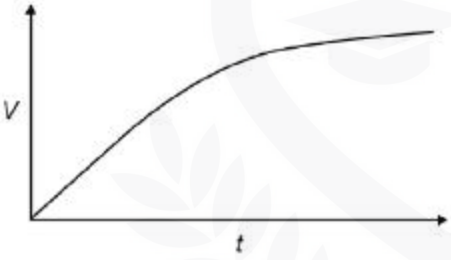


Which line represents the volume of hydrogen formed, at the same temperature and pressure, when the concentration of sulfuric acid has been halved?

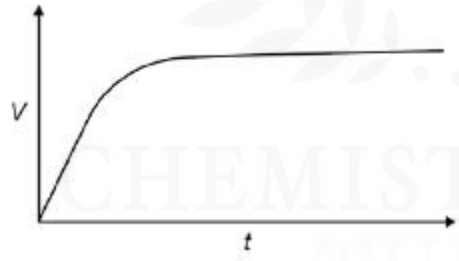
A.



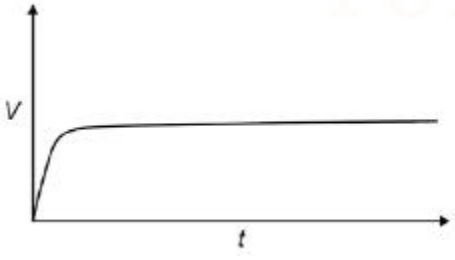
B.



C.

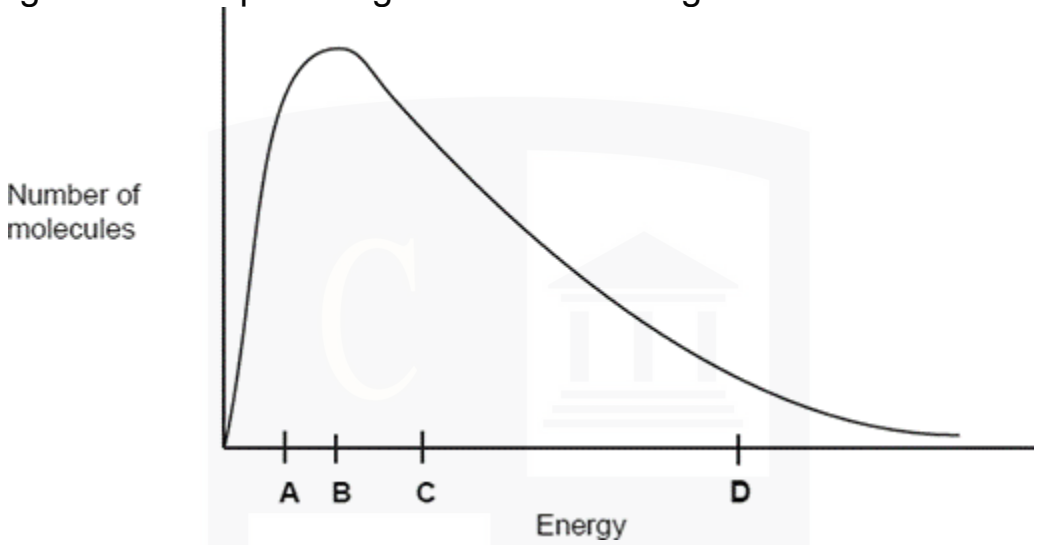


D.



(Total 1 mark)

3. This question is about the Maxwell–Boltzmann distribution of molecular energies in a sample of a gas shown in the figure below.



Which letter best represents the mean energy of the molecules?

A.
B.
C.
D.

(Total 1 mark)

4. This question is about the Maxwell–Boltzmann distribution of molecular energies in a sample of a gas shown in the following figure.

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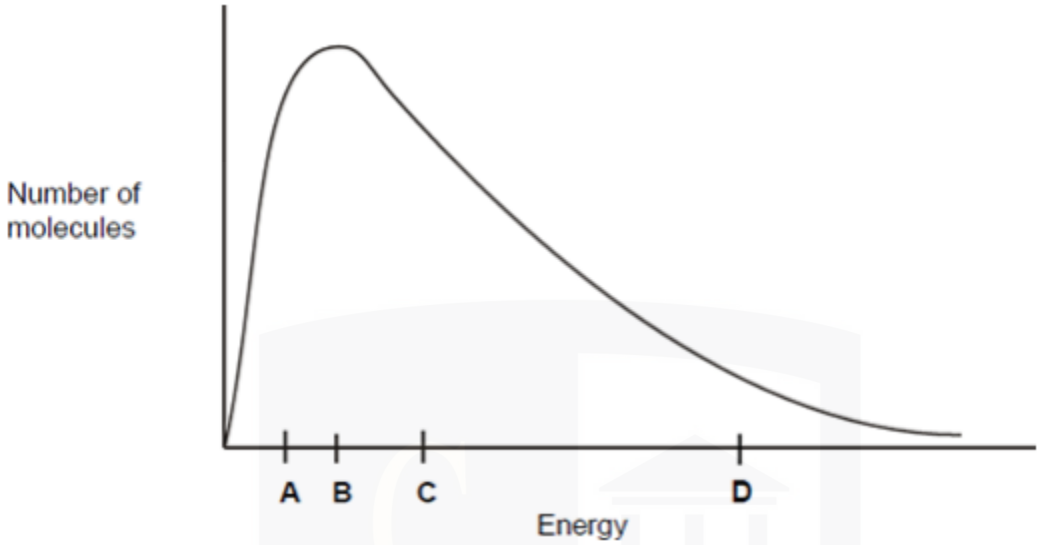


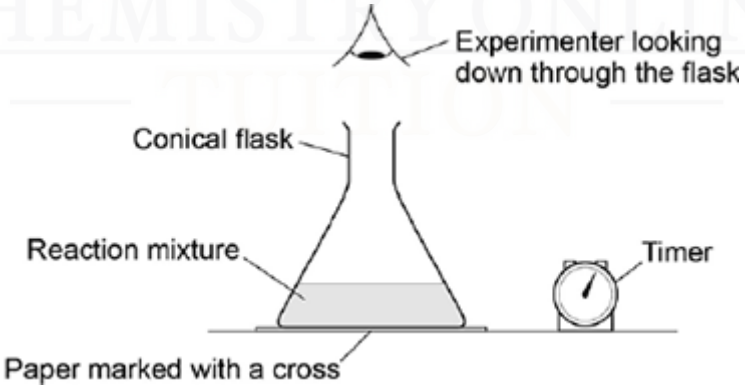
What does the area under the curve represent?

A. The total energy of the particles.
B. The total number of particles.
C. The number of particles that can react with each other.
D. The total number of particles that have activation energy.

(Total 1 mark)

5. The apparatus in the figure below was set up to measure the time taken for 20.0 cm^3 of sodium thiosulfate solution to react with 5.0 cm^3 of hydrochloric acid in a 100 cm3 conical flask at 20 °C.

The timer was started when the sodium thiosulfate solution was added to the acid in the flask.



The timer was stopped when it was no longer possible to see the cross on the paper.

What is likely to decrease the accuracy of the experiment?

A. Rinsing the flask with acid before each new experiment.
B. Stirring the solution throughout each experiment.
C. Using the same piece of paper for each experiment.
D. Using different measuring cylinders to measure the volumes of acid and sodium thiosulfate.

(Total 1 mark)

6. The experiment was repeated at 20 °C using a 250 cm^3 conical flask.

Which statement is correct about the time taken for the cross to disappear when using the larger conical flask?

A. The time taken will not be affected by using the larger conical flask.
B. The time taken will be decreased by using the larger conical flask.
C. The time taken will be increased by using the larger conical flask.
D. It is impossible to predict how the time taken will be affected by using the larger conical flask.

(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) Show how these data can be used to deduce the rate expression for the reaction between **A** and **B**.

(3)

The data in **Table 2** were obtained in two experiments on the rate of the reaction between compounds **C** and **D** 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}
4	1.9×10^{-2}	1.9×10^{-2}	1.9×10^{-2}
5	3.6×10^{-2}	3.6×10^{-2}	3.6×10^{-2}

The rate equation for this reaction is
$rate = k[\mathbf{C}]^2[\mathbf{D}]$

(b) Use the data from experiment 4 to calculate a value for the rate constant, k, at this temperature.

Deduce the units of k.

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(3)

(c) Calculate a value for the initial rate in experiment 5.

(1)

(d) The rate equation for a reaction is rate = k[E]

Explain qualitatively why doubling the temperature has a much greater effect on the rate of the reaction than doubling the concentration of E.

(3)

(e) A slow reaction has a rate constant
$k = 6.51 \times 10^{-3}$ mol^{-1} dm^3 at 300 K.
Use the equation

$\ln k = \ln A - E_a / RT$
to calculate a value, in kJ mol^{-1}, for the activation energy of this reaction.

The constant $A = 2.57 \times 10^{10}$ mol^{-1} dm^3.
The gas constant $R = 8.31$ J K^{-1} mol^{-1}.

(2)

8. For each of the following reactions, identify a catalyst and name the organic product of the reaction.

(a) The fermentation of an aqueous solution of fructose.

(2)

(b) The hydration of prop-1-ene.

(2)

9. How would you investigate the rate of decomposition for the decomposition of nitrogen dioxide?

(2)

10. This question is about catalyst.

(a) Define the term activation energy for a reaction.

(2)

(b) Give the meaning of the term catalyst.

(2)

(c) Explain in general terms how a catalyst works.

(2)

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