Kinetics

Question Paper

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Kinetics
Booklet	Question Paper

Time Allowed: **53 minutes**

Score: **/44**

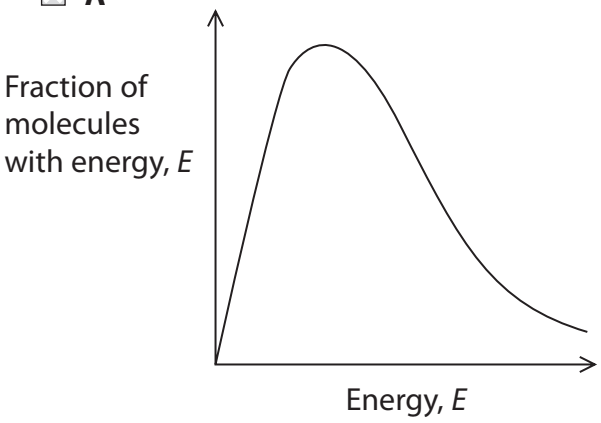
Percentage: **/100**

Grade Boundaries:

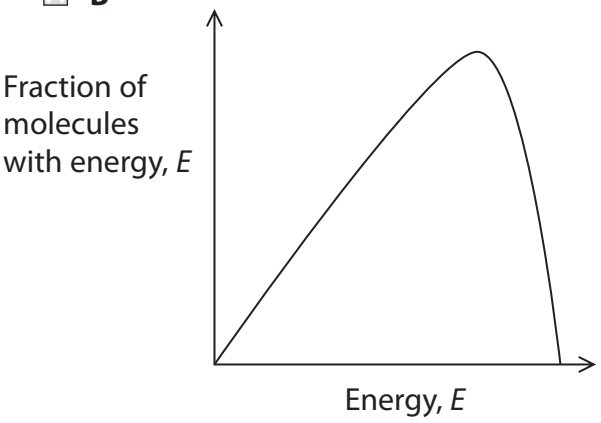
A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Which diagram shows a Maxwell-Boltzmann distribution of molecular energies?

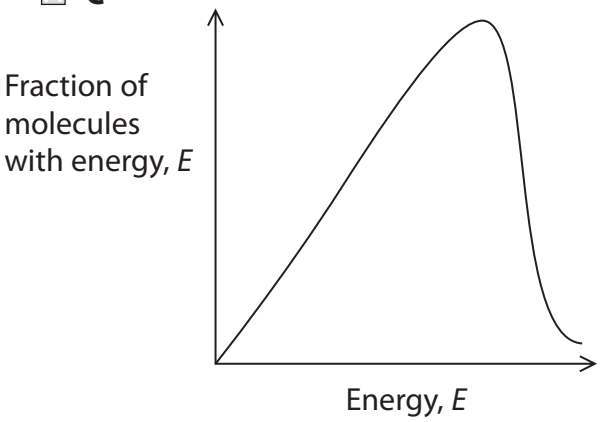
☒ **A**



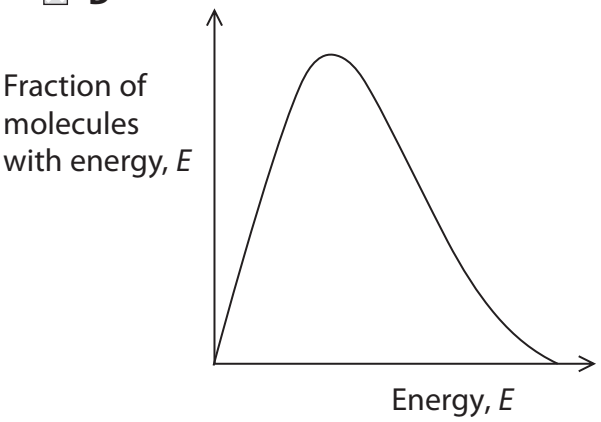
☒ **B**



☒ **C**



☒ **D**



(Total for Question 1 = 1 mark)

2 The rate of the reaction between sodium thiosulfate solution and dilute hydrochloric acid increases as the concentration of sodium thiosulfate increases.

Which of these occurs when the concentration of the sodium thiosulfate solution increases at constant temperature?

	Activation energy	Particles
☒ **A**	decreases	collide more frequently
☒ **B**	decreases	collide with more energy
☒ **C**	stays the same	collide more frequently
☒ **D**	stays the same	collide with more energy

(Total for Question 2 = 1 mark)

3 Consider the following exothermic reaction.

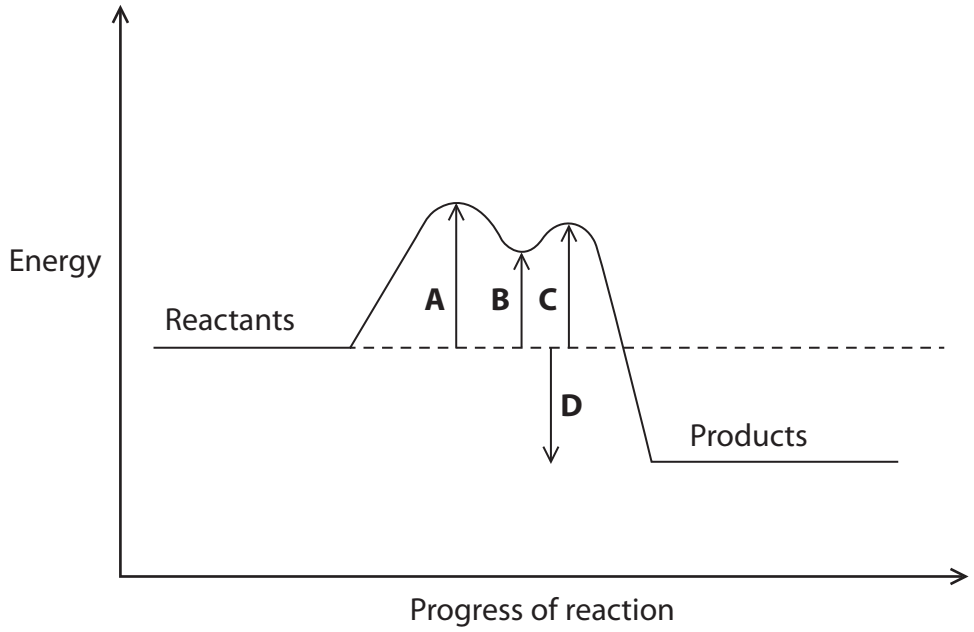
$$A(s) + B(aq) \rightarrow C(aq) + D(g)$$

If the mass of A, and the volume and concentration of the solution of B are constant, which of these changes in conditions will result in the fastest initial rate?

	Size of solid particles of A	Temperature
☒ **A**	doubled	decreased by 10 °C
☒ **B**	doubled	increased by 10 °C
☒ **C**	halved	decreased by 10 °C
☒ **D**	halved	increased by 10 °C

(Total for Question 3 = 1 mark)

4 The reaction profile for an exothermic catalysed reaction is shown.



Which arrow represents the activation energy for this reaction?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 4 = 1 mark)

5 A lump of malachite, $CuCO_3.Cu(OH)_2$, reacts with 40 cm^3 of 0.50 mol dm^{-3} hydrochloric acid. The rate of reaction can be increased significantly by

☒ **A** increasing the pressure.

☒ **B** crushing the malachite lump.

☒ **C** replacing the acid with 80 cm^3 of 0.25 mol dm^{-3} hydrochloric acid.

☒ **D** using a magnetic stirrer to agitate the mixture.

(Total for Question 5 = 1 mark)

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6 Consider the following reaction carried out with 0.10 g of magnesium ribbon and excess hydrochloric acid.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

Which method should be used to follow the rate of this reaction?

☒ **A** Measure the pH of the solution, using a pH meter.

☒ **B** Measure the colour of the solution, using a colorimeter.

☒ **C** Measure the volume of gas being formed, using a gas syringe.

☒ **D** Measure the mass of the mixture, using a balance which weighs to two decimal places.

(Total for Question 6 = 1 mark)

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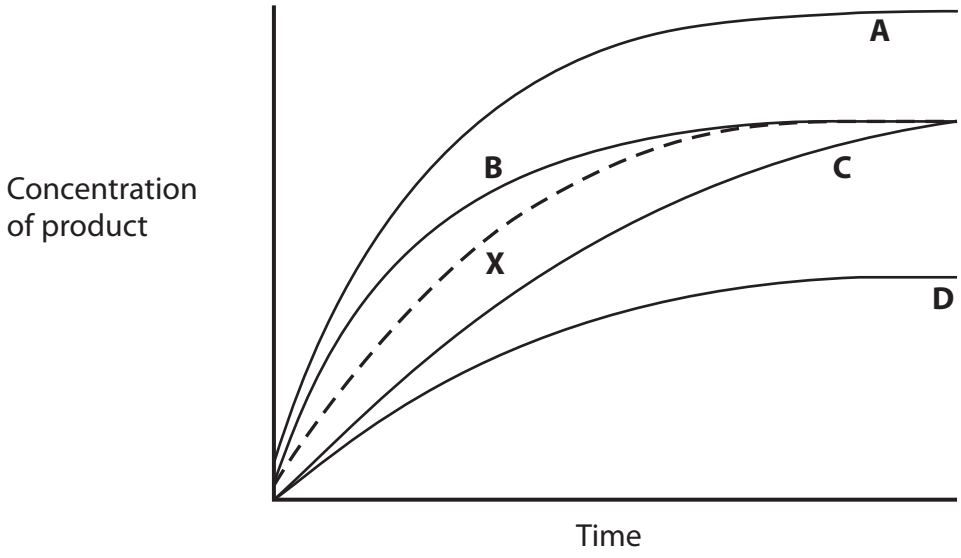
7 In a reaction, the change in concentration of a product with time is shown by the dashed line **X** on the graph below.



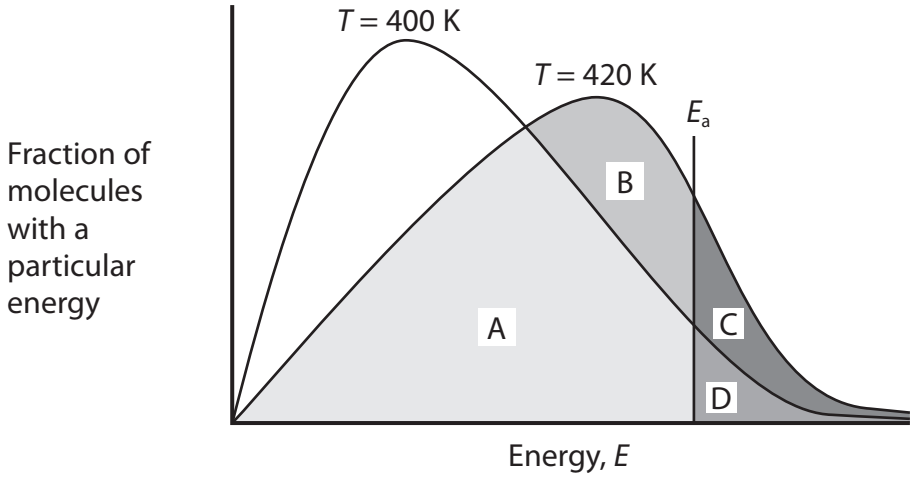
Which of the lines, **A** to **D**, shows the effect of adding a catalyst to this reaction?

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 7 = 1 mark)

8 A Maxwell-Boltzmann distribution graph can be used to illustrate the effect of increasing temperature on the rate of a chemical reaction.

Which area on the graph below indicates the **increase** in the number of molecules that have sufficient energy to react, when the temperature changes from 400 K to 420 K?



☒ **A** Area B + C

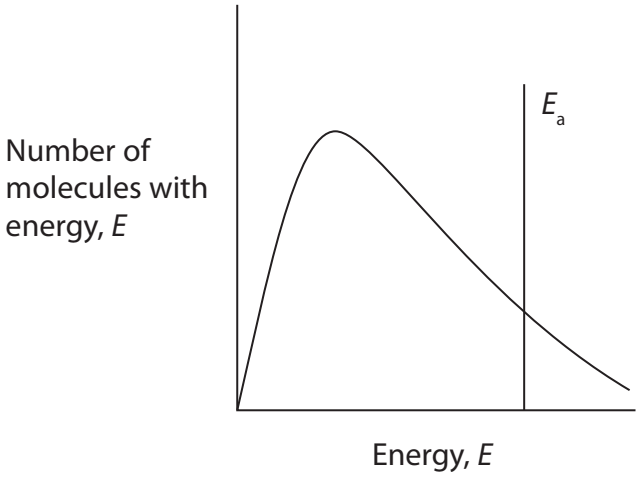
☒ **B** Area C + D

☒ **C** Area C

☒ **D** Area D

(Total for Question 8 = 1 mark)

9 The diagram below is a Maxwell-Boltzmann distribution of molecular energies.



(a) If the temperature was raised, what would be the effect on the shape of the curve?

(1)

☒ **A** The peak would shift to the left and be higher.

☒ **B** The peak would shift to the left and be lower.

☒ **C** The peak would shift to the right and be higher.

☒ **D** The peak would shift to the right and be lower.

(b) Which of the following would shift the activation energy line to the left?

(1)

☒ **A** An increase in reactant concentration.

☒ **B** The removal of the product.

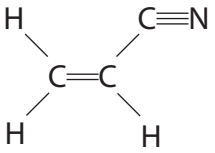
☒ **C** The addition of a catalyst.

☒ **D** An increase in temperature.

(Total for Question 9 = 2 marks)

10 Poly(propenenitrile) is used in the manufacture of acrylic fibres for clothes.
Poly(propenenitrile) is an addition polymer made from propenenitrile.

The structure of propenenitrile is shown.



(a) Give a balanced equation, using displayed formulae, to show the formation of poly(propenenitrile) from propenenitrile.

(3)

(b) Why does the reaction in (a) have an atom economy of 100%?

(1)

.....

.....

*(c) Propenenitrile is manufactured from propene, C_3H_6, as shown in the following equation.

$$C_3H_6(g) + NH_3(g) + 1\frac{1}{2}O_2(g) \rightleftharpoons CH_2CHCN(g) + 3H_2O(g) \qquad \Delta H = -550 \text{ kJ mol}^{-1}$$

The process is carried out at a temperature of 450°C and a pressure of 2.5 atm, in the presence of a suitable catalyst.

State and explain the effect on the position of equilibrium when each of the following changes is made to these reaction conditions.

(i) The temperature is increased.

(2)

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.....

.....

.....

(ii) The pressure is increased.

(2)

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.....

*(d) Chemical manufacturers also use reaction conditions to control the rates of chemical reactions.

(i) The curves in (d)(ii) and (d)(iii) show the distribution of molecular energies at a temperature, T_1.

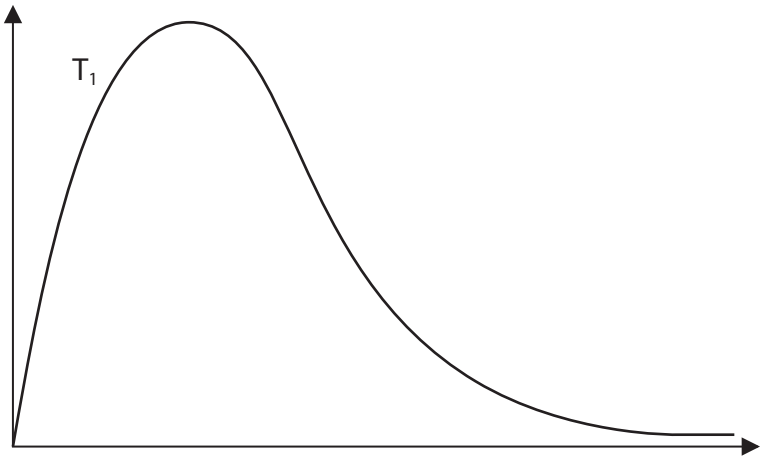
Label the axes on the diagrams in (d)(ii) and (d)(iii).

(1)

(ii) On the diagram below, draw a curve to show the distribution of molecular energies at a higher temperature, T_2.

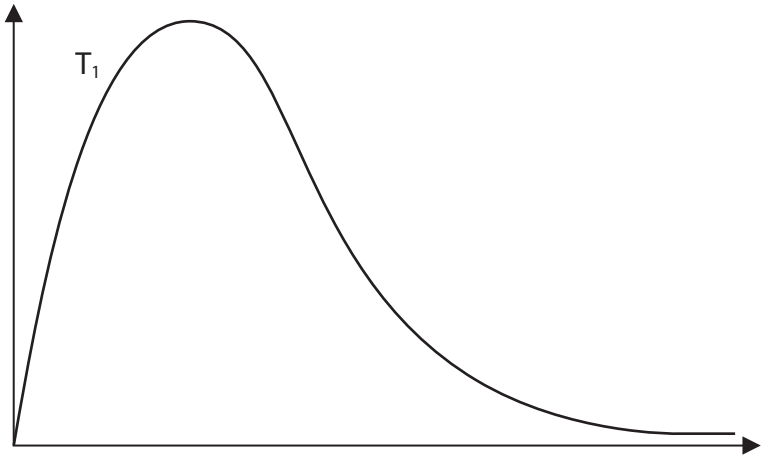
Use your diagram, with further labelling as necessary, to explain why the rate of a chemical reaction increases when the temperature is increased.

(3)



(iii) Use the diagram below, with further labelling as necessary, to explain why the rate of a chemical reaction increases when a catalyst is added at temperature T_1.

(2)



(Total for Question 10 = 14 marks)

11 This question is about Group 2 elements and their compounds.

*(a) Give **two** reasons why the first ionization energy of calcium is less than that of magnesium, even though the atomic number of calcium is greater than that of magnesium.

(2)

(b) A flame test was carried out on a solid calcium compound. Explain the origin of the flame colour in terms of electron movement.

(3)

(c) (i) Calcium oxide reacts with dilute nitric acid to form calcium nitrate. Write the equation for this reaction. State symbols are not required.

(1)

(ii) Identify **two** ways, one of which should be an observation, in which the thermal decomposition of anhydrous calcium nitrate is different from that of anhydrous potassium nitrate.

(2)

(d) (i) Calcium reacts with water to produce calcium hydroxide and a gas. Give the name or formula of this gas.

(1)

.....

(ii) An aqueous solution of calcium hydroxide is used for a common laboratory test. Give the observation for a positive result for this test and complete the equation for the reaction that occurs. State symbols are **not** required.

(2)

Observation .....

$$Ca(OH)_2 + \text{.....} \rightarrow \text{.....} + H_2O$$

(iii) Give the name or formula of a Group 2 hydroxide which is more soluble than calcium hydroxide.

(1)

.....

(e) (i) Describe what you would see if a solution of barium chloride was added to dilute sulfuric acid. State why this observation would differ if magnesium chloride solution was used instead of barium chloride.

(2)

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(ii) Barium compounds are toxic. However, it is safe to give patients a 'barium meal' of barium sulfate when trying to diagnose intestinal disorders. Suggest why this is so.

(1)

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*(f) Calcium carbonate, $CaCO_3$, readily reacts with hydrochloric acid. State **two** factors, other than a change in temperature, which would affect the rate of this reaction.

Neither pressure nor the use of a catalyst should be considered.

Explain how each of the **two** factors you have chosen alters the reaction rate.

(4)

(g) Suggest why pressure has little or no effect on the rate of the reaction of calcium oxide and hydrochloric acid, the equation for which is given below.

$$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$$

(1)

(Total for Question 11 = 20 marks)