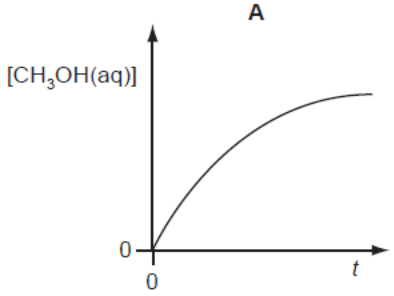
Q1 The reaction represented by the following equation was carried out.

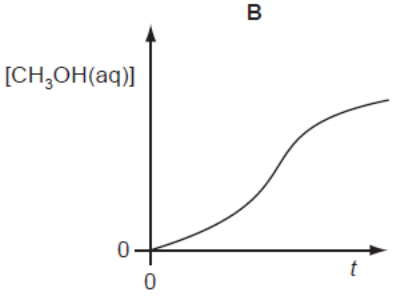
$$HCO_2CH_3(aq) + NaOH(aq) \rightarrow HCO_2Na(aq) + CH_3OH(aq)$$

Which graph best shows the relationship between $[CH_3OH(aq)]$ and t, the time from mixing of the reactants?

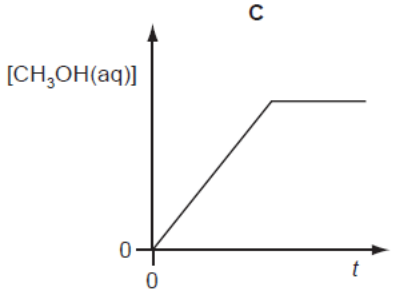
A



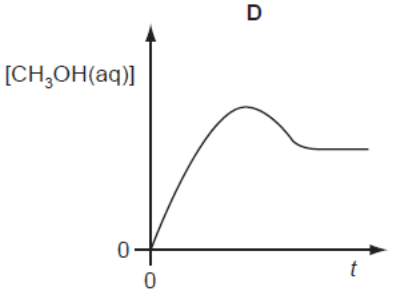
B



C

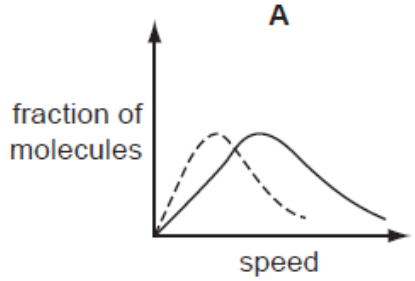


D

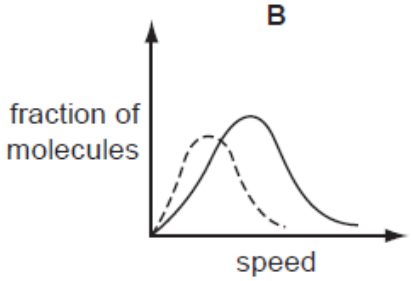


Q2 Which solid-line curve most accurately represents the distribution of molecular speeds in a gas at 500 K if the dotted-line curve represents the corresponding distribution for the same gas at 300 K?

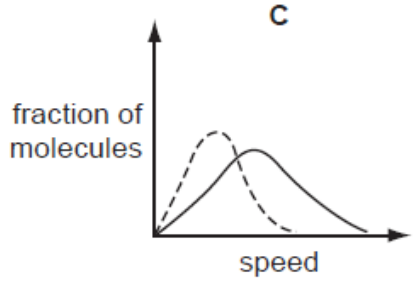
A



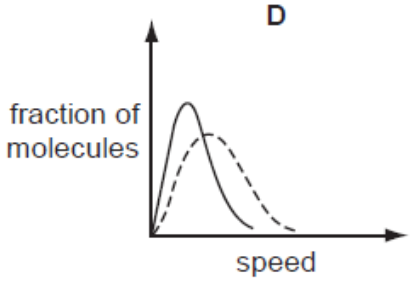
B



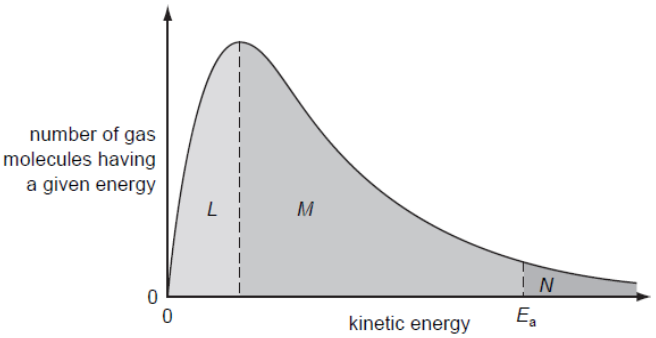
C



D

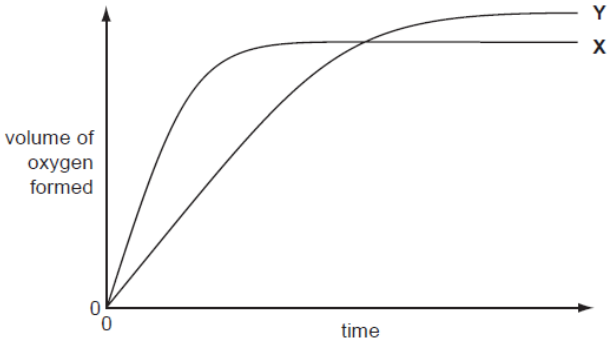


Q3 The Boltzmann distribution shows the number of molecules having a particular kinetic energy at constant temperature. If the temperature is decreased by 10 °C, what happens to the size of the areas labelled L, M and N?



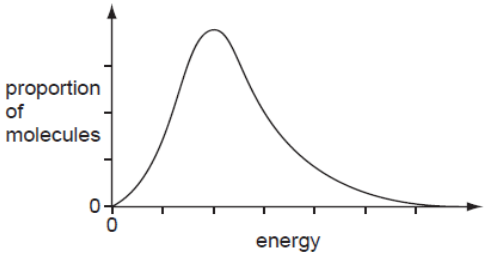
	L	M	N
A	decreases	decreases	decreases
B	decreases	increases	decreases
C	increases	decreases	decreases
D	increases	decreases	increases

Q4 In the diagram, curve X was obtained by observing the decomposition of 100 cm^3 of 1.0 mol dm^{-3} hydrogen peroxide, catalysed by manganese(IV) oxide.

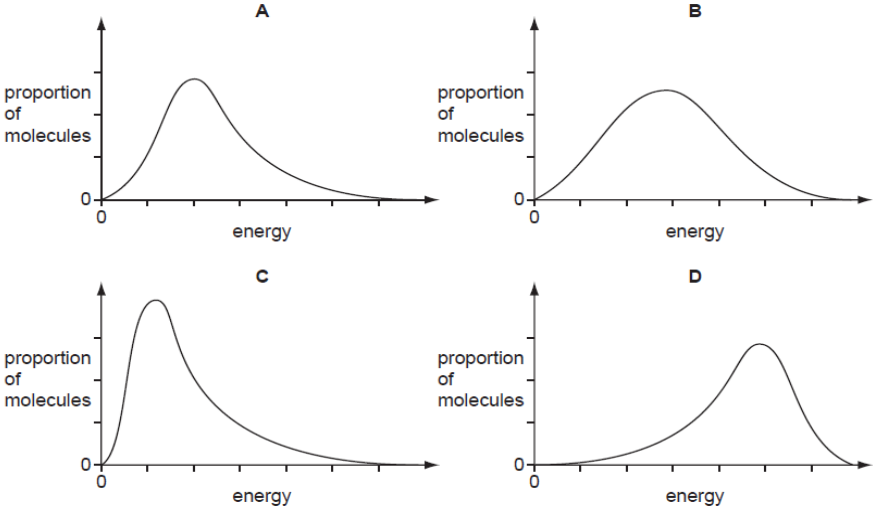


Which alteration to the original experimental conditions would produce curve Y?
A adding water
B adding some 0.1 mol dm^{-3} hydrogen peroxide
C using less manganese(IV) oxide
D lowering the temperature

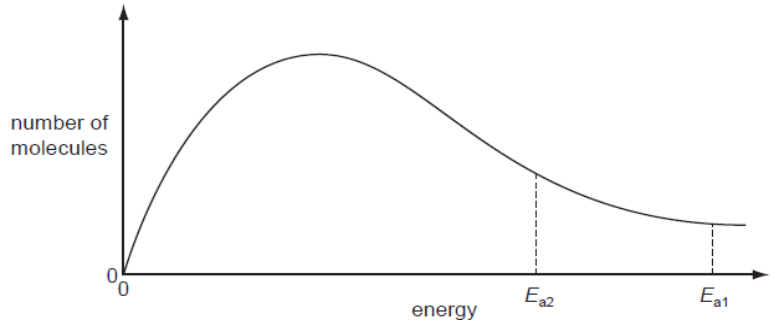
Q5 The molecular energy distribution curve represents the variation in energy of the molecules of a gas at room temperature.



Which curve applies for the same gas at a lower temperature?



Q6 The diagram shows the Maxwell-Boltzmann energy distribution curve for molecules of a mixture of two gases at a given temperature. For a reaction to occur the molecules must collide together with sufficient energy.

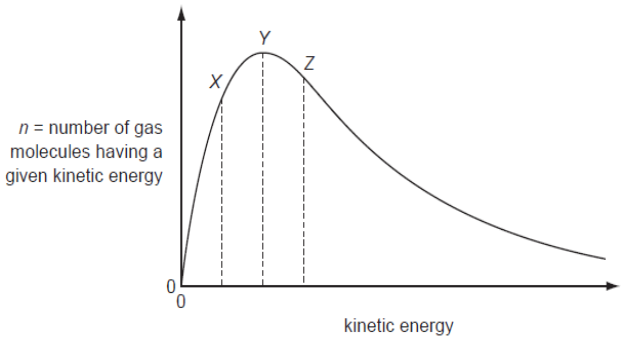


E_a is the activation energy for the reaction between the gases. Of the two values shown, one is for a catalysed reaction, the other for an uncatalysed one.
Which pair of statements is correct when a catalyst is used?

A	E_{a1}	catalysed reaction fewer effective collisions	E_{a2}	uncatalysed reaction more effective collisions
B	E_{a1}	uncatalysed reaction fewer effective collisions	E_{a2}	catalysed reaction more effective collisions
C	E_{a1}	catalysed reaction more effective collisions	E_{a2}	uncatalysed reaction fewer effective collisions
D	E_{a1}	uncatalysed reaction more effective collisions	E_{a2}	catalysed reaction fewer effective collisions

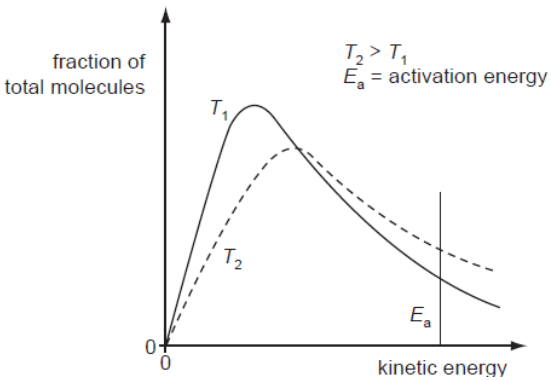
Q7 $Na_2S_2O_3$ reacts with dilute HCl to give a pale yellow precipitate. If 1 cm^3 of 0.1 mol dm^{-3} HCl is added to 10 cm^3 of 0.02 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms slowly.
If the experiment is repeated with 1 cm^3 of 0.1 mol dm^{-3} HCl and 10 cm^3 of 0.05 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms more quickly.
Why is this?
A The activation energy of the reaction is lower when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.
B The reaction proceeds by a different pathway when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.
C The collisions between reactant particles are more violent when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.
D The reactant particles collide more frequently when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

Q8 The Boltzmann distribution for a gas at constant temperature is shown below.
If the temperature of the gas is reduced by 10 °C the graph changes shape.
What happens to the values of n for the points marked X, Y and Z?



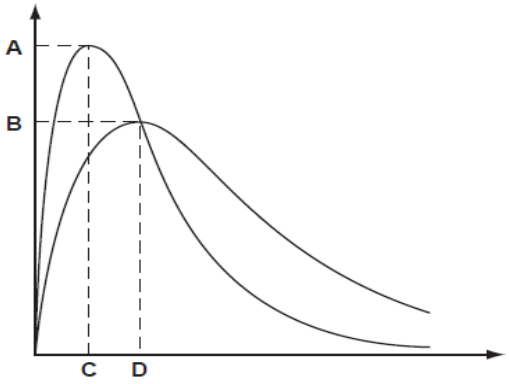
	X	Y	Z
A	higher	lower	higher
B	higher	lower	lower
C	lower	higher	lower
D	lower	lower	lower

Q9 The distribution of molecular kinetic energies within a gas at temperature T_1 and T_2 are shown in the diagram. Which statement correctly explains why a small increase in temperature leads to a significant increase in the rate of a gaseous reaction?



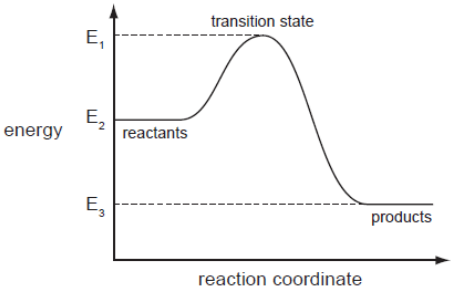
A The frequency of collisions between molecules is greater at a higher temperature.
B The activation energy of the reaction is less when the gases are at a higher temperature.
C The frequency of collisions between molecules with kinetic energy greater than the activation energy is greater at higher temperature.
D The proportion of molecules with more kinetic energy than the activation energy is lower at a higher temperature.

Q10 The diagram shows the Maxwell-Boltzmann energy distribution curves for molecules of a sample of a gas at two different temperatures. Which letter on the axes represents the most probable energy of the molecules at the lower temperature?



Q11 It is often said that the rate of a typical reaction is roughly doubled by raising the temperature by 10 °C. What explains this observation?
A Raising the temperature by 10 °C doubles the average kinetic energy of each molecule.
B Raising the temperature by 10 °C doubles the average velocity of the molecules.
C Raising the temperature by 10 °C doubles the number of molecular collisions in a given time.
D Raising the temperature by 10 °C doubles the number of molecules having more than a certain minimum energy.

Q12 The reaction pathway diagram below illustrates the energies of reactants, products and the transition state of a reaction.



Which expression represents the activation energy of the forward reaction?
A $E_1 - E_2$ B $E_1 - E_3$ C $E_2 - E_3$ D $(E_1 - E_2) - (E_2 - E_3)$

Q13 In the Haber process for the manufacture of ammonia, why is the heterogeneous catalyst iron in a finely divided state?
A to increase its surface area
B to produce the maximum reduction in the activation energy
C to reduce its loss during the reaction
D to reduce its surface area

Section B

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

Q14 Which statements about the properties of a catalyst are correct?
1 A catalyst increases the average kinetic energy of the reacting particles.
2 A catalyst increases the rate of the reverse reaction.
3 A catalyst has no effect on the enthalpy change of the reaction.

Q15 Solid calcium carbonate is added to 100 cm^3 of dilute hydrochloric acid and the rate of the reaction is measured. 100 cm^3 of distilled water is then added to a second 100 cm^3 portion of the acid, and the experiment repeated under the same conditions.
Why does the addition of water decrease the rate of the reaction?
1 Adding water reduces the frequency of collisions between reactant molecules.
2 Adding water reduces the proportion of effective collisions between reactant molecules.
3 Adding water reduces the proportion of reactant molecules possessing the activation energy.

Q16 Which statements are correct about the activation energy of a reaction?
1 It is different for the forward and back reactions in an exothermic process.
2 It is low for a reaction that takes place slowly.
3 It is unaffected by the presence of a catalyst.

Q17 Why does a mixture of hydrogen gas and bromine gas react together faster at a temperature of 500 K than it does at a temperature of 400 K?
1 A higher proportion of effective collisions occurs at 500 K.
2 Hydrogen molecules and bromine molecules collide more frequently at 500 K.
3 The activation energy of the reaction is lower at 500 K.

Q18 A student puts 10 cm^3 of 0.100 mol dm^{-3} sulfuric acid into one test-tube and 10 cm^3 of 0.100 mol dm^{-3} ethanoic acid into another test-tube. He then adds 1.0 g (an excess) of magnesium ribbon to each test-tube and takes suitable measurements. Both acids have the same starting temperature.
Neither reaction is complete after 2 minutes, but both are complete after 20 minutes.
Which statements are correct?
1 After 2 minutes, the sulfuric acid is at a higher temperature than the ethanoic acid.
2 After 2 minutes, the sulfuric acid has produced more gas than the ethanoic acid.
3 After 20 minutes, the sulfuric acid has produced more gas than the ethanoic acid.

1. A
2. C
3. C
4. B
5. C
6. B
7. D
8. B
9. C
10. C
11. D
12. A
13. A
14. C
15. D
16. D
17. B
18. A

Q1(a) Draw a diagram to show the Boltzmann distribution of molecular energies. Label the axes.

(b) Comment on the shape of the distribution curve.

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(c)(i) Explain the meaning of the term *activation energy*.

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(ii) Insert and label the activation energy in your diagram in **(a)**.
(d)(i) Use a dotted line added to your diagram in **(a)** to show how the distribution of molecular energies changes at a slightly higher temperature (label this curve $+\delta T$).
(ii) Use this new line to explain why reactions are faster at a higher temperature.

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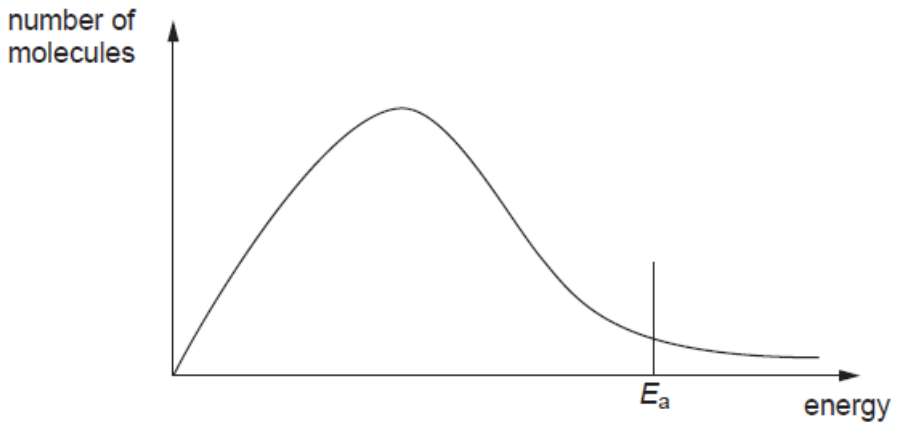
(NOV 2002)

Q2 The diagram below shows, for a given temperature T, a Boltzmann distribution of the kinetic energy of the molecules of a mixture of two gases that will react together, such as nitrogen and hydrogen.
The activation energy for the reaction, E_a, is marked.



(a) On the graph above,
(i) draw a new distribution curve, **clearly labelled T** , for the same mixture of gases at a higher
temperature, **T** ;
(ii) mark clearly, as H, the position of the activation energy of the reaction at the higher temperature, **T**

(b) Explain the meaning of the term ***activation energy***.

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(June 2010 P21)