Q1.   (a)   Define the term *activation energy* for a chemical reaction.

(2)

(b)   Draw, with labelled axes, a curve to represent the Maxwell–Boltzmann distribution of molecular energies in a gas. Label this curve **T₁**. On the same axes, draw a second curve to represent the same sample of gas at a lower temperature. Label this curve **T₂**.

Use these curves to explain why a small decrease in temperature can lead to a large decrease in the rate of a reaction.
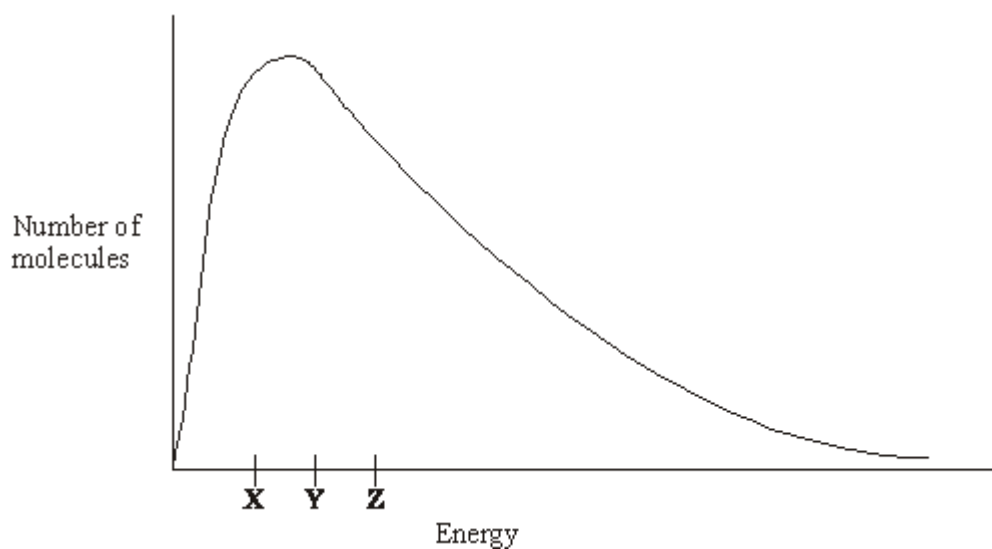
(8)

(c)   Give **one** reason why most collisions between gas-phase reactants do not lead to a reaction. State and explain **two** ways of speeding up a gas-phase reaction other than by changing the temperature.

(5)
(Total 15 marks)

Q2.   The diagram below shows the Maxwell–Boltzmann distribution of molecular energies in a sample of a gas.

(a)   (i)   State which one of **X**, **Y** or **Z** best represents the mean energy of the molecules.

....

(ii)   Explain the process that causes some molecules in this sample to have very low energies.

....

....

(3)

(b)   On the diagram above, sketch a curve to show the distribution of molecular energies in the same sample of gas at a higher temperature.

(2)

(c)   (i)   Explain why, even in a fast reaction, a very small percentage of collisions leads to a reaction.

....

....

(ii)   Other than by changing the temperature, state how the proportion of successful collisions between molecules can be increased. Explain why this method causes an increase in the proportion of successful collisions.

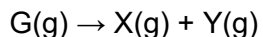*Method for increasing the proportion of successful collisions* ....

....

Explanation …...

....

(4)
(Total 9 marks)

Q3.   Gas **G** decomposes as shown in the equation below.

$$G(g) \rightarrow X(g) + Y(g)$$

(a)   Draw, on the axes below, a Maxwell–Boltzmann distribution curve for a sample of **G** in which only a small proportion of molecules has energy greater than the activation energy, E_a.
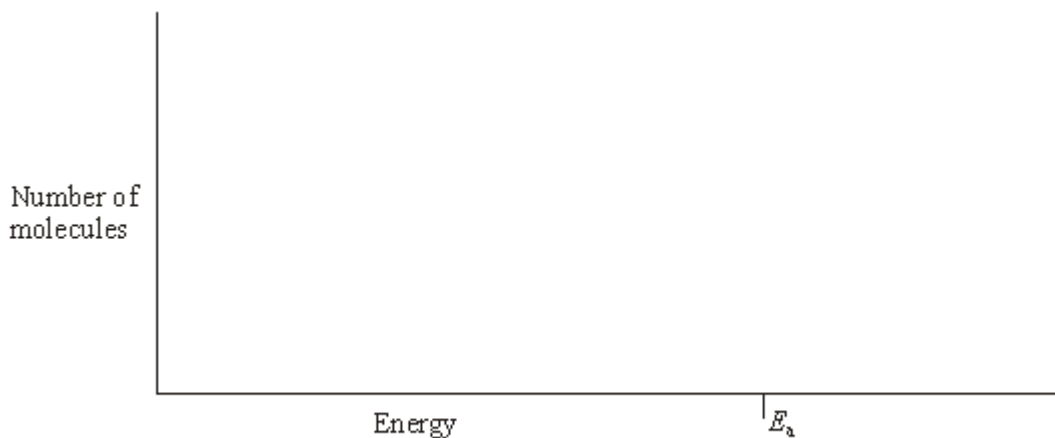
(3)

(b)   Define the term *activation energy*.

....

....

(2)

(c)   At any time, most of the molecules of **G** have energy less than the activation energy.
Suggest why, at a constant temperature, most of **G** eventually decomposes.

....

....

(2)

(d)   State the effect, if any, of adding a catalyst on the time required for **G** to decompose, compared with a similar sample without a catalyst. Explain in general terms how the catalyst has this effect.

Time for decomposition ....

Explanation ....

....