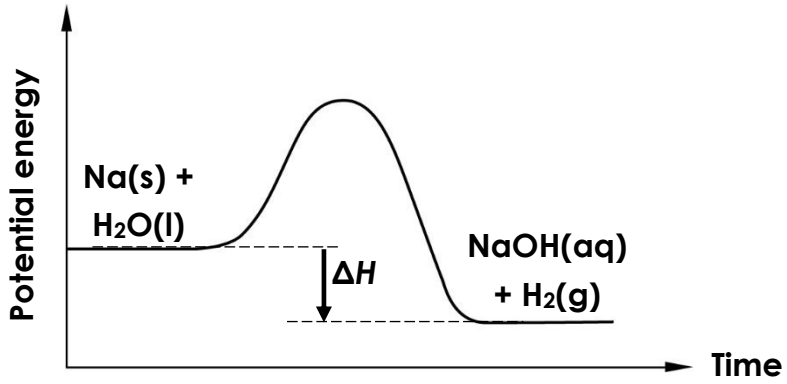
Summary Quiz (Chapter 43)

Section A: Multiple Choice

1. According to the collision theory, for a reaction to occur, the reactant particles must
   (1) collide in the correct orientation.
   (2) move in the same direction.
   (3) possess kinetic energy equal to or greater than the activation energy of the reaction.

   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3)

2. A student drew the energy profile of the reaction between sodium and cold water as follows.



   What is/are the mistake(s) in the above reaction profile?
   (1) ΔH should be positive.
   (2) The equation is not balanced.
   (3) The x-axis of the profile should be reaction coordinate.

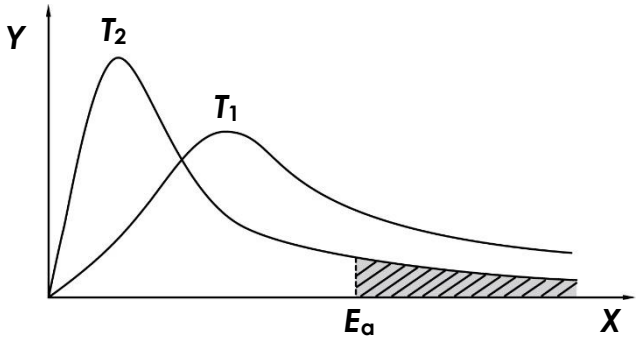
   A. (1) only
   B. (2) only
   C. (1) and (3) only
   D. (2) and (3) only

3. Which of the following statements about an energy profile is INCORRECT?
   A. The step with the highest activation energy is the rate-determining step.
   B. The enthalpy change of the reaction can be obtained from the energy profile.
   C. The species with the highest energy is called the transition state.
   D. The activation energy of a reaction is always positive.

4. The rate constants for a reaction at 500°C and 750°C are 0.113 s^{-1} and 0.150 s^{-1} respectively. What is the activation energy for this reaction?
   (Given: R = 8.31 J K^{-1} mol^{-1})

   A. 7.44 kJ mol^{-1}
   B. 14.4 kJ mol^{-1}
   C. 57.6 kJ mol^{-1}
   D. 115.2 kJ mol^{-1}

Questions 5 and 6 refer to the following Maxwell-Boltzmann distribution curves of a system at different temperatures.



5. What do *X* and *Y* represent respectively?

	X	Y
A.	Kinetic energy	Number of reacting particles
B.	Potential energy	Number of reacting particles
C.	Number of reacting particles	Kinetic energy
D.	Number of reacting particles	Potential energy

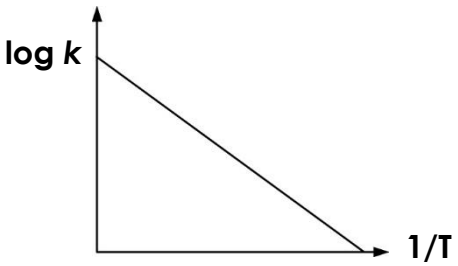
6. Which of the following statements about the curve is INCORRECT?
   A. There is no maximum energy for the particle.
   B. T_2 is larger than T_1.
   C. More effective collisions occur at T_1.
   D. The area under curve T_1 is equal to that under curve T_2.

Questions 7 and 8 refer to the reaction: $2H_2O_2 \longrightarrow 2H_2O + O_2$

7. Which of the following statements about the reaction are correct?
   (1) This is a decomposition reaction.
   (2) The progress of the reaction can be followed by measuring the change in mass of the reaction mixture.
   (3) The reaction can be catalysed by manganese(IV) oxide.

   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3)

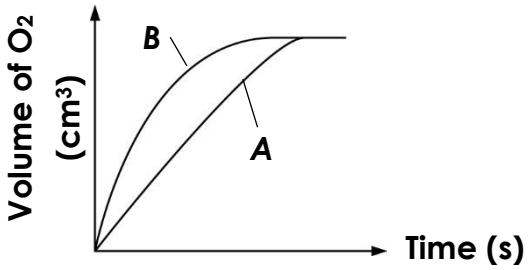
8. The rate constants of the reaction are found at different temperatures and the following graph is obtained:



According to the Arrhenius equation, which of the following is the slope of the above straight line?

A. $-E_a / R$
B. E_a / R
C. $-E_a / 2.3R$
D. $E_a / 2.3R$

9. In the graph below, curve *A* is obtained when 120 cm^3 1 M H_2O_2 decomposes at 298 K. Which of the following changes would give curve *B*?



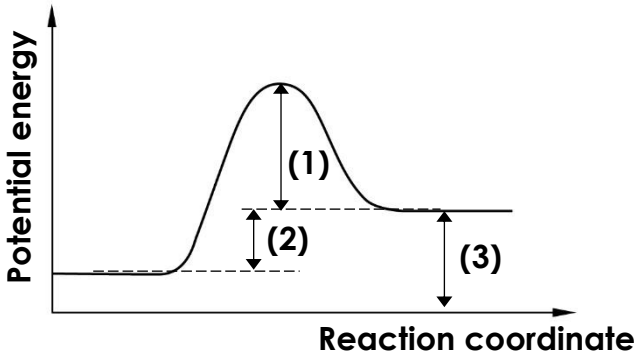
(1) 50 cm^3 distilled water is added to H_2O_2.
(2) Finely divided manganese(IV) oxide is added to H_2O_2.
(3) 10 g of ice is added to H_2O_2.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

10. Which of the following statements about a catalyst is/are correct?
(1) It reacts with one of the reactants to form the product.
(2) The catalyst remains chemically unchanged at the end of the reaction.
(3) When a greater amount of catalyst is used, the rate of the reaction always increases.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

11. The diagram below is the energy profile of a reaction in the absence of a catalyst. Which of the following quantities indicated in the diagram are NOT affected by the presence of a catalyst?



A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

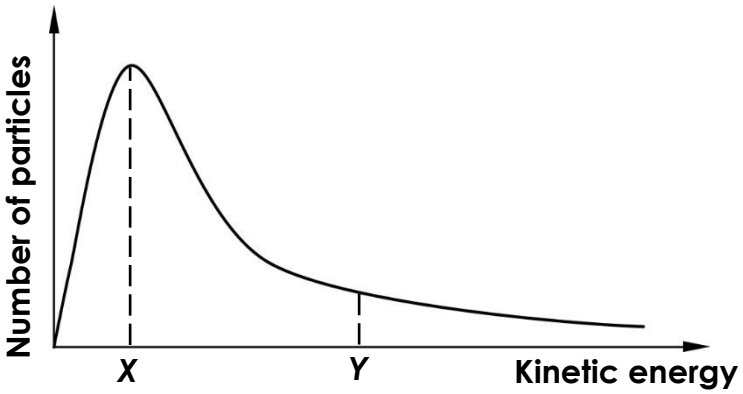
12. For the esterification between ethanol and ethanoic acid, what are the effects on the activation energy and the number of effective collisions per unit time when a few drops of concentrated sulphuric acid are added?

	Activation energy	Number of effective collisions
A.	No change	Increases
B.	No change	No change
C.	Decreases	No change
D.	Decreases	Increases

13. Which of the following statements about a catalyst in a reversible reaction are correct?
    (1) It speeds up the forward reaction.
    (2) It speeds up the backward reaction.
    (3) It provides an alternative pathway with lower activation energy for the reaction to proceed.

    A. (1) and (2) only
    B. (1) and (3) only
    C. (2) and (3) only
    D. (1), (2) and (3)

14. The following diagram shows a typical Maxwell-Boltzmann distribution curve.



    Which of the following statements about graph are correct?
    (1) *X* represents the most probable kinetic energy of the particles.
    (2) The area under the curve remains unchanged when the temperature increases.
    (3) When adding a catalyst to the reaction system, *Y* shifts to the left.

    A. (1) and (2) only
    B. (1) and (3) only
    C. (2) and (3) only
    D. (1), (2) and (3)

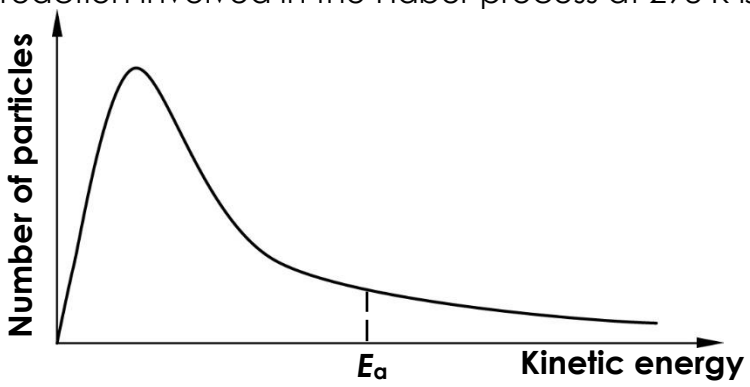
15. Which of the following metals is commonly used as catalysts in industry?
    A. Calcium
    B. Lithium
    C. Platinum
    D. Uranium

16. Alcoholic drinks can be produced by the fermentation of glucose. Which of the following statements about the fermentation are correct?
    (1) The process is carried out in the absence of oxygen.
    (2) Colourless gas bubbles are produced during the process.
    (3) Enzymes are used to catalyse the process.

    A. (1) and (2) only
    B. (1) and (3) only
    C. (2) and (3) only
    D. (1), (2) and (3)

Section B: Structural Question

1. Haber process is used to produce ammonia. The Maxwell-Boltzmann distribution curve of the reaction involved in the Haber process at 298 K is shown below:



(a) Define 'activation energy'.

(b) Write an equation for the reaction involved in the Haber process.

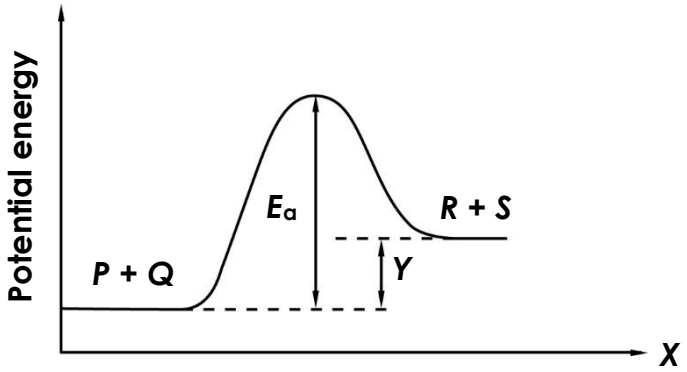
(c) Finely divided iron is used as the catalyst in the Haber process.

(i) In the above curve, mark the activation energy of a catalysed reaction and label it as '*E*'.

(ii) Hence, explain why finely divided iron can catalyse the synthesis of ammonia.

(iii) State and explain the effect of iron on the yield of ammonia.

2. The energy profile of a chemical reaction is shown below:



(a) What does *Y* represent?

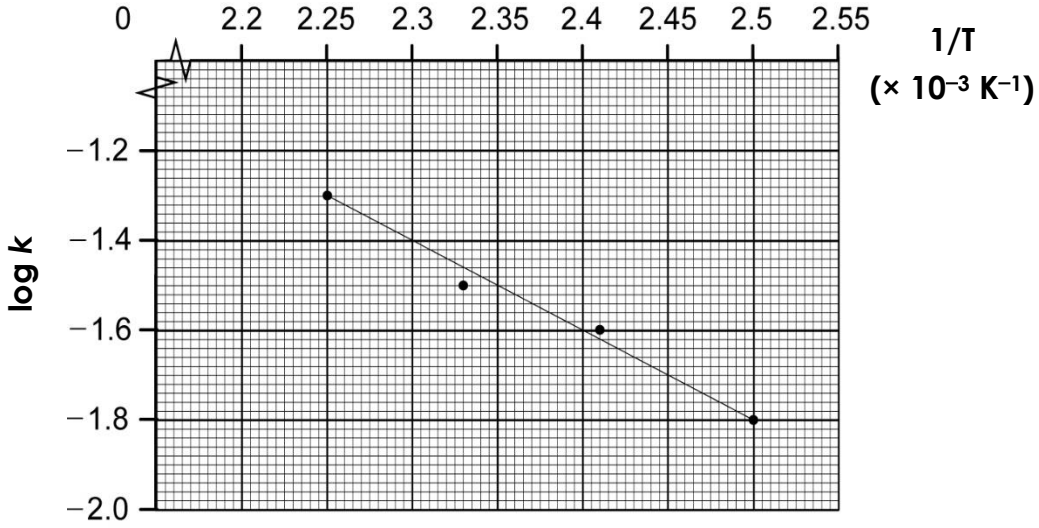
(b) State the effect of increasing temperature on the value of E_a.

(c) The Arrhenius equation shows the relationship between temperature and rate constant:

$$k = Ae^{-\frac{E_a}{RT}}$$

(i) What does *A* represent?

(ii) To determine the E_a of the reaction, the reaction is performed at different temperatures and the values of rate constant (*k*) are obtained. The following graph is plotted.



Calculate the activation energy of the reaction.
(Given: R = 8.31 J K^{-1} mol^{-1})

(iii) If the value of *Y* is 11.3 kJ mol^{-1}, determine the E_a of the reverse reaction $R + S \longrightarrow P + Q$.

The End

Suggested Answer

Section A

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

Section B

1. (a) Enthalpy change of reaction

   (b) There is no effect on the value of E_a.

   (c) (i) *A* is Arrhenius constant.

   (ii) Slope of the graph
   $= - E_a / 2.3R$
   $= - (-1.70 - (-1.38)) / (2.45 \times 10^{-3} - 2.29 \times 10^{-3})$
   $= -2000$

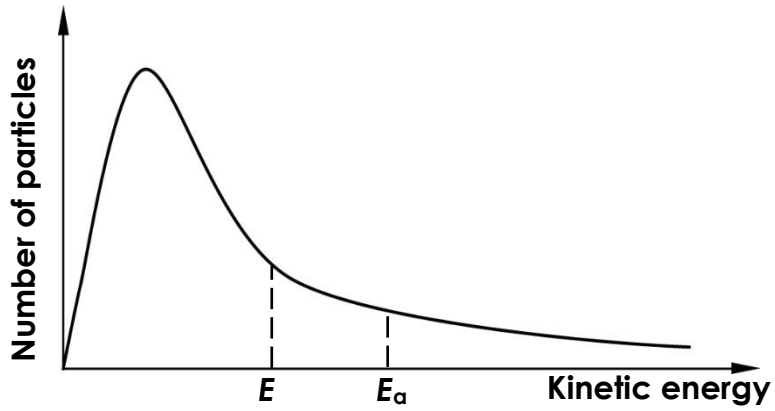
   $E_a = (2000 \times 2.3 \times 8.31)$ J mol^{-1} = 38.2 kJ mol^{-1}

   (iii) E_a of the reverse reaction
   $= E_a - Y$
   = (38.2 – 11.3) kJ mol^{-1}
   = 26.9 kJ mol^{-1}

2. (a) Activation energy is the minimum energy required for a chemical reaction to occur.

   (b) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(c) (i)



(ii) In the presence of catalyst, the number of particles having energy equal to or greater than the activation energy is larger than that without catalyst.

There is an increased number of effective collisions per unit time. Hence, the reaction rate is higher.

(iii) The yield of ammonia does not change.

The catalyst increases the rates of both forward and backward reactions in an equilibrium to the same extent. It does not affect the equilibrium position of the reaction.

The End