

Chapter 4: Chemical Kinetics

NCERT Exemplar · Class 12 · Chemistry

I. Multiple Choice Questions (Type-I)

Question 1

The role of a catalyst is to change _____.

A.

gibbs energy of reaction.

B.

enthalpy of reaction.

C.

activation energy of reaction.

D.

equilibrium constant.

Answer

Correct option: C

Solution

Option (iii) is the answer.

Question 2

In the presence of a catalyst, the heat evolved or absorbed during the reaction

_____.

A.

increases.

B.

decreases.

C.

remains unchanged.

D.

may increase or decrease.

Answer

Correct option: C

Solution

Option (iii) is the answer.

Question 3

Activation energy of a chemical reaction can be determined by _____.

temperatures.

A.

determining the rate constant at standard temperature.

B.

determining the rate constants at two

C.

determining the probability of collision.

D.

using catalyst.

Answer

Correct option: B

Solution

Option (ii) is the answer.

Question 4

Consider Fig. 4.1 and mark the correct option.

A.

The activation energy of forwarding reaction is $E_1 + E_2$ and the product is less stable than reactant.

B.

The activation energy of forwarding reaction is $E_1 + E_2$ and product is more stable than reactant.

C.

The activation energy of both forward and backward reaction is $E_1 + E_2$ and reactant is more stable than the product.

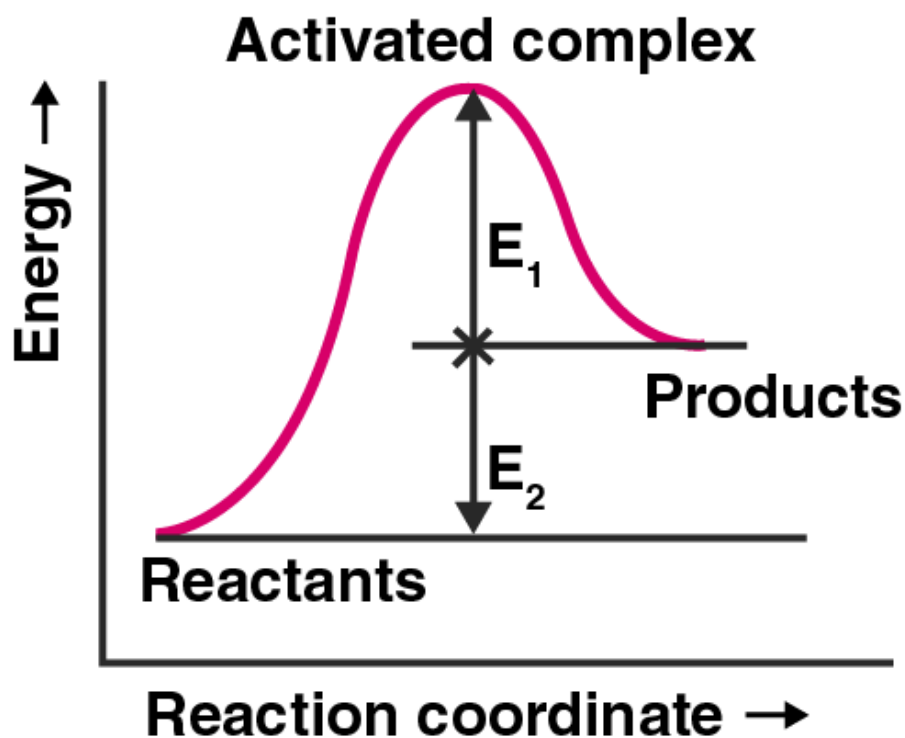
D.

The activation energy of the backward reaction is E_1 and the product is more stable than reactant.

Answer

Correct option: A

Solution



Option (i) is the answer.

Question 5

Consider a first order gas phase decomposition reaction given below :



The initial pressure of the system before decomposition of A was p_i . After lapse of time 't', total pressure of the system increased by x units and became ' p_t '. The rate constant k for the reaction is given as _____.

A.

$$k = 2.303/t \log p_i/p_{i-x}$$

B.

$$) k = 2.303/t \log p_i/2p_i-p_t$$

C.

$$) k = 2.303/t \log P_i/2P_i-2P_t$$

D.

$$) k = 2.303/t \log P_i/P_{i+x}$$

Answer

Correct option: B

Solution

Option (ii) is the answer.

Question 6

According to Arrhenius equation rate constant k is equal to $A e^{-E/RT}$. Which of the following options represents the graph of $\ln k$ vs $1/T$

Solution

Option (i) is the answer.

Question 7

Consider the Arrhenius equation given below and mark the correct option.

$$k = A e^{-E/RT}$$

and decreasing temperature.

and decreasing temperature.

and decreasing temperature.

and increasing temperature

A.

Rate constant increases exponentially with increasing activation energy

B.

Rate constant decreases exponentially with increasing activation energy

C.

Rate constant increases exponentially with decreasing activation energy

D.

Rate constant increases exponentially with decreasing activation energy

Answer

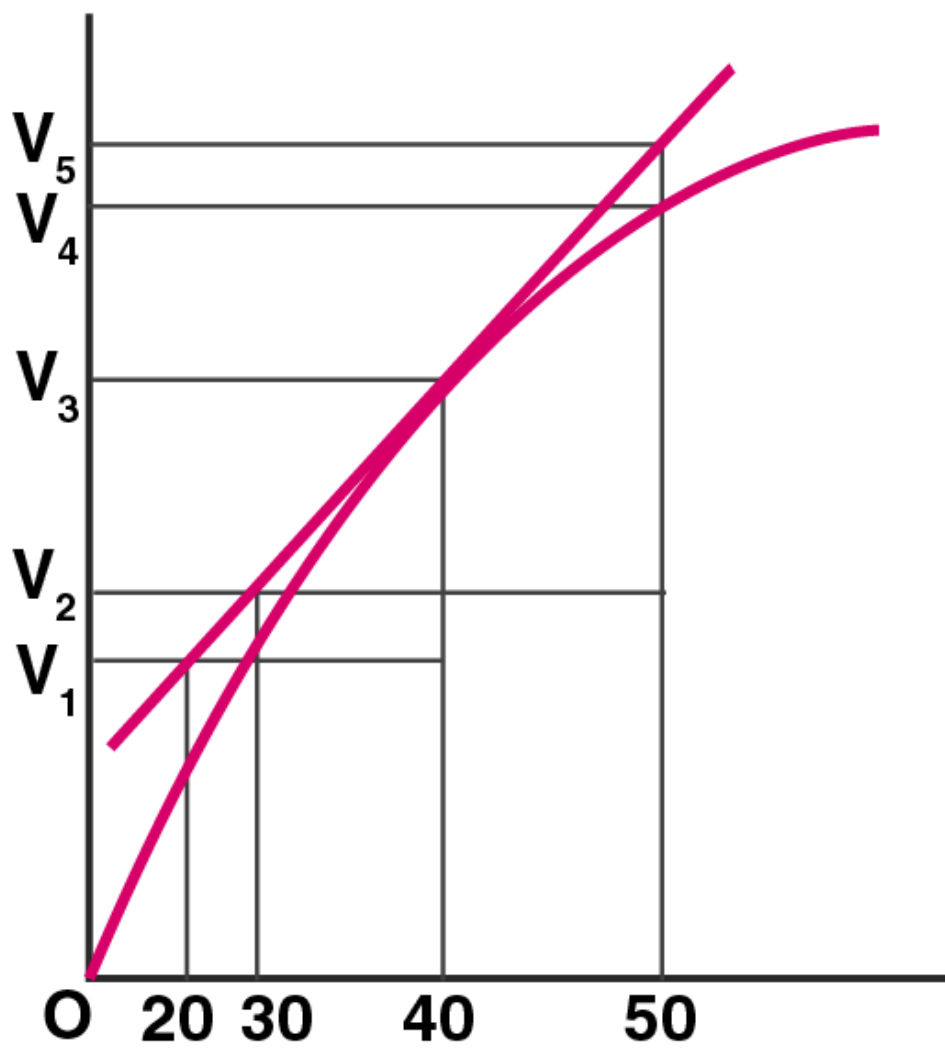
Correct option: D

Solution

Option (iv) is the answer.

Question 8

A graph of volume of hydrogen released vs time for the reaction between zinc and dil.HCl is given in Fig. 4.2. On the basis of this mark the correct option.



(i) Average rate up to 40s is $V_3 - V_2 / 40$

(ii) Average rate up to 40s is $V_3 - V_2 / 40 - 30$

(ii) Average rate up to 40 seconds is $V_3 / 40$

(iv) Average rate up to 40 seconds is $V_3 - V_1 / 40 - 20$

Solution

Option (iii) is the answer.

Question 9

Which of the following statements is not correct about an order of a reaction.

coefficients of reactants in the balanced chemical equation for a reaction.

of the reactants in the rate law expression.

A.

The order of a reaction can be a fractional number.

B.

Order of a reaction is experimentally determined quantity.

C.

The order of a reaction is always equal to the sum of the stoichiometric

D.

The order of a reaction is the sum of the powers of the molar concentration

Answer

Correct option: C

Solution

Option (iii) is the answer.

Question 10

Consider the graph given in Fig. 4.2. Which of the following options does not show the instantaneous rate of reaction at 40th second?

A.

V5-V2/50-30

B.

V4-V2/50-30

C.

V3-V2/40-30

D.

V3-V1/40-20

Answer

Correct option: B

Solution

Option (ii) is the answer.

Question 11

Which of the following statements is correct?

of reactants decreases.

the reactant(s).Solution:

Option (i) is the answer.

A.

The rate of a reaction decreases over time as the concentration

B.

The rate of a reaction is the same at any time during the reaction.

C.

The rate of a reaction is independent of temperature change.

D.

The rate of a reaction decreases with increase in the concentration of

Solution

Solution coming soon.

Question 12

Which of the following expressions is correct for the rate of reaction given

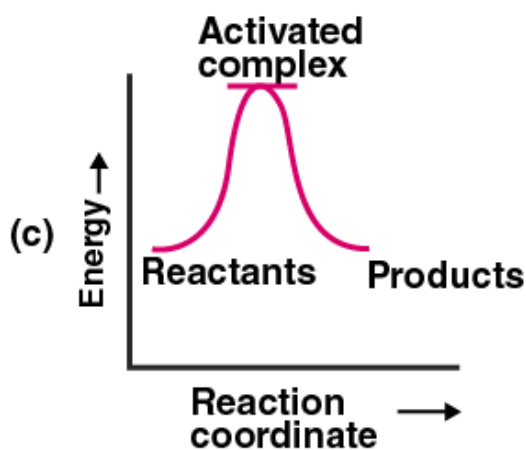
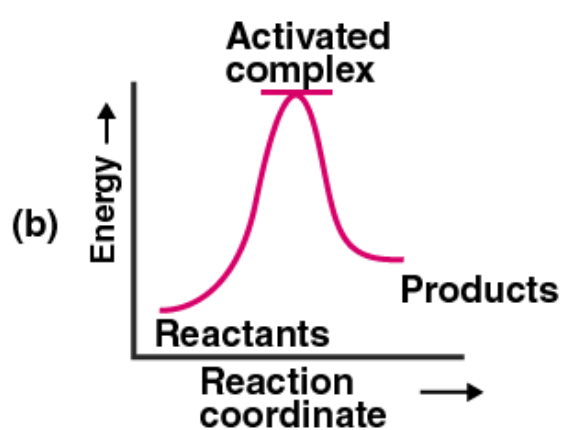
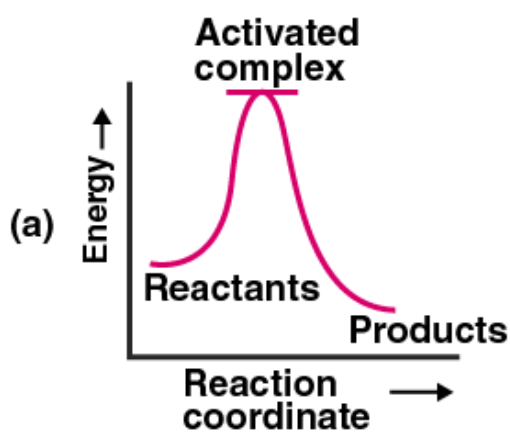
Solution

Solution coming soon.

below?

Question 13

Which of the following graph represents the exothermic reaction?



A.

(a) only

B.

(b) only

C.

(c) only

D.

(a) and (b)

Answer

Correct option: A

Solution

Option (i) is the answer.

Question 14

The rate law for the reaction $A + 2B \rightarrow C$ is found to be

$$\text{Rate} = k [A][B]$$

The concentration of reactant 'B' is doubled, keeping the concentration of 'A' constant, the value of rate constant will be_____.

(i) the same

(ii) doubled

(iii) quadrupled

(iv) halved

Solution

Option (i) is the answer.

Question 15

Which of the following statements is incorrect about the collision theory of

chemical reaction?

their structural features.

results into the product formation.

orientation for the collision to be effective.

A.

It considers reacting molecules or atoms to be hard spheres and ignores

B.

A number of effective collisions determine the rate of reaction.

C.

The collision of atoms or molecules possessing sufficient threshold energy

D.

Molecules should collide with sufficient threshold energy and proper

Answer

Correct option: C

Solution

Option (iii) is the answer.

Question 16

A first-order reaction is 50% completed in 1.26×10^{14} s. How much time

would it take for 100% completion?

(i) 1.26×10^{15} s

(ii) 2.52×10^{14} s

(iii) 2.52×10^{28} s

(iv) infinite

Solution

Option (iv) is the answer.

Question 17

Compounds 'A' and 'B' react according to the following chemical equation.



The concentration of either 'A' or 'B' was changed keeping the concentrations of one of the reactants constant and rates were measured as a function of initial concentration. Following results were obtained. Choose the correct option for the rate equations for this reaction.

Experiment	Initial Concentration of [A]/ mol L^{-1}	Initial concentration of [B]/ mol L^{-1}	Initial rate concentration of [C]/ $\text{mol L}^{-1} \text{ s}^{-1}$
1	0.30	0.30	0.10
2	0.30	0.60	0.40
3	0.60	0.30	0.20

(i) Rate = $k [\text{A}]^2 [\text{B}]$

(ii) Rate = $k [\text{A}] [\text{B}]^2$

(iii) Rate = $k [\text{A}] [\text{B}]$

(iv) Rate = $k [\text{A}]^2 [\text{B}]^0$

Solution

Option (ii) is the answer.

Question 18

Which of the following statement is not correct for the catalyst?
reaction.

between reactants and products.

A.

It catalyses the forward and backward reaction to the same extent.

B.

It alters ΔG of the reaction.

C.

It is a substance that does not change the equilibrium constant of a

D.

It provides an alternate mechanism by reducing activation energy

Answer

Correct option: B

Solution

Option (ii) is the answer.

Question 19

The value of rate constant of a pseudo first order reaction _____.

(i) depends on the concentration of reactants present in a small amount.

(ii) depends on the concentration of reactants present in excess.

(iii) is independent of the concentration of reactants.

(iv) depends only on temperature.

Solution:

Option (ii) is the answer.

Solution

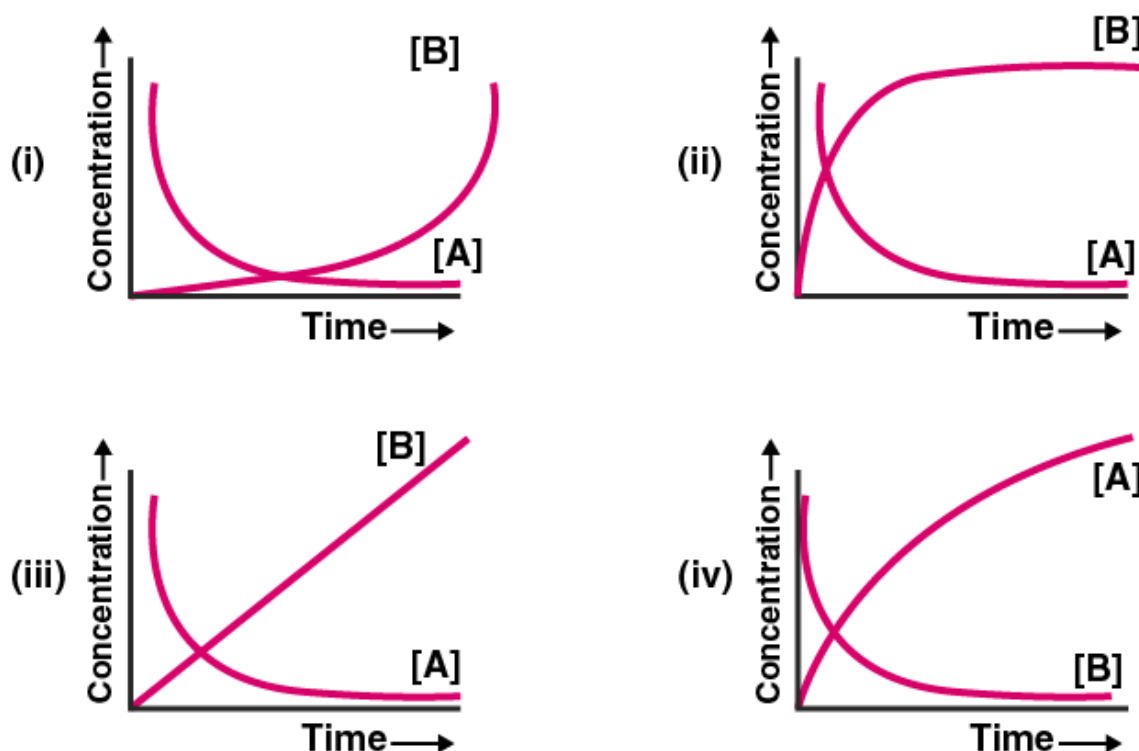
Solution coming soon.

Question 20

Consider the reaction $A \rightarrow B$. The concentration of both the reactants and

the products varies exponentially with time. Which of the following figures

correctly describes the change in concentration of reactants and products with time?



Solution

Option (ii) is the answer.

Question 21

II. Multiple Choice Questions (Type-II)

Note: In the following questions two or more options may be correct.

21. Rate law cannot be determined from the balanced chemical equation if _____.

A.

the reverse reaction is involved.

B.

it is an elementary reaction.

C.

it is a sequence of elementary reactions.

D.

any of the reactants is in excess

Answer

Correct option: A

Solution

Option (i), (iii) and (iv) are the answers.

Question 22

Which of the following statements apply to a balanced chemical equation of an elementary reaction?

A.

Order is the same as molecularity.

B.

Order is less than the molecularity.

C.

Order is greater than the molecularity.

D.

Molecularity can never be zero.

Answer

Correct option: A

Solution

Option (i) and (iv) are the answers.

Question 23

In any unimolecular reaction _____.

- (i) only one reacting species is involved in the rate-determining step.
- (ii) the order and the molecularity of the slowest step are equal to one.
- (iii) the molecularity of the reaction is one and order is zero.
- (iv) both molecularity and order of the reaction are one.

Solution

Option (i) and (ii) is the answer.

Question 24

For a complex reaction _____.

- (i) order of an overall reaction is the same as molecularity of the slowest step.
- (ii) order of an overall reaction is less than the molecularity of the slowest step.
- (iii) order of an overall reaction is greater than molecularity of the slowest step.
- (iv) the molecularity of the slowest step is never zero or non-integer.

Solution

Option (i) and (iv) are the answers.

Question 25

At high pressure, the following reaction is zero order.



Which of the following options are correct for this reaction?

- (i) Rate of reaction = Rate constant

- (ii) Rate of the reaction depends on the concentration of ammonia.
- (iii) Rate of decomposition of ammonia will remain constant until ammonia disappears completely.
- (iv) Further increase in pressure will change the rate of reaction.

Solution

Option (i), (iii) and (iv) are the answers.

Question 26

During decomposition of an activated complex

- (i) energy is always released
- (ii) energy is always absorbed
- (iii) energy does not change
- (iv) reactants may be formed

Solution

Option (i) and (iv) are the answers.

Question 27

According to Maxwell Boltzmann distribution of energy, _____.

- (i) the fraction of molecules with most probable kinetic energy decreases at higher temperatures.
- (ii) the fraction of molecules with most probable kinetic energy increases at higher temperatures.
- (iii) most probable kinetic energy increases at higher temperatures.
- (iv) most probable kinetic energy decreases at higher temperatures.

Solution

Option (i) and (iii) are the answers.

Question 28

In the graph showing Maxwell Boltzman distribution of energy, _____.

- (i) the area under the curve must not change with an increase in temperature.
- (ii) the area under the curve increases with increase in temperature.
- (iii) the area under the curve decreases with increase in temperature.
- (iv) with the increase in the temperature, curve broadens and shifts to the right-hand side.

Solution

Option (i) and (iv) are the answers.

Question 29

Which of the following statements are in accordance with the Arrhenius equation?

Option (i) and (ii) are the answers.

A.

Rate of a reaction increases with increase in temperature.

B.

Rate of a reaction increases with a decrease in activation energy.

C.

Rate constant decreases exponentially with an increase in temperature.

D.

Rate of reaction decreases with a decrease in activation energy.

Solution

Solution coming soon.

Question 30

Mark the incorrect statements.

A.

Catalyst provides an alternative pathway to a reaction mechanism.

B.

Catalyst raises the activation energy.

C.

A catalyst lowers the activation energy.

D.

Catalyst alters enthalpy change of the reaction.

Answer

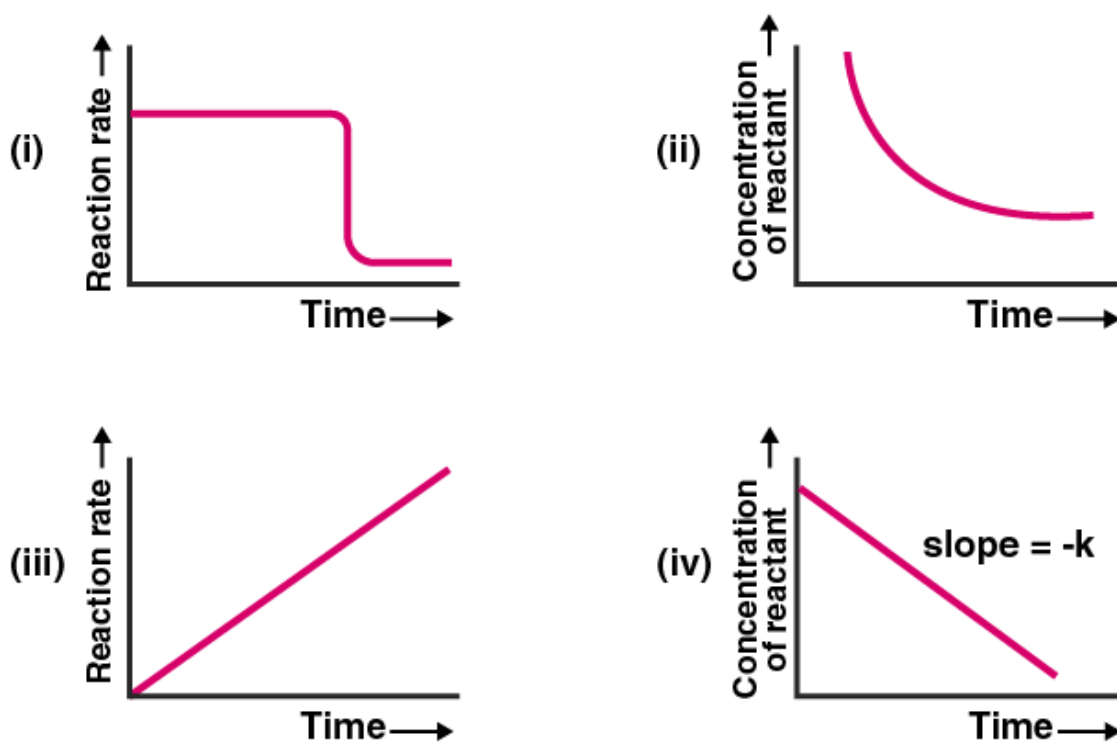
Correct option: B

Solution

Option (ii) and (iv) are the answers.

Question 31

Which of the following graphs is correct for a zero-order reaction?

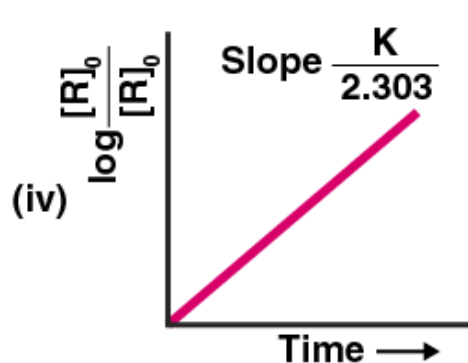
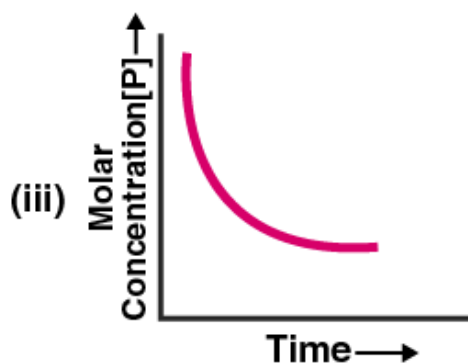
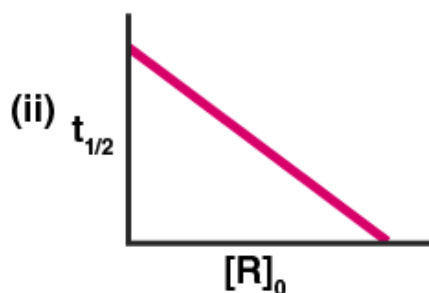
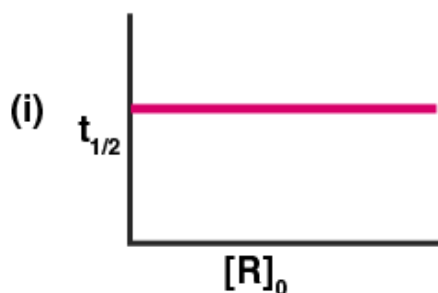


Solution

Option (ii) and (iv) are the answers.

Question 32

Which of the following graphs is correct for a first-order reaction?



Solution

Option (i) and (iv) are the answers.

III. Short Answer Type

Question 33

State a condition under which a bimolecular reaction is a kinetically first-order reaction.

Solution

A condition under which the order of a chemical reaction can be altered is by taking the solvent or the reactant in the excess amount due to which its concentration does not change much.

Consider a bimolecular reaction



$$\text{Rate} = k[A][B]$$

When concentration B is large rate becomes $k'[A]$

Where $k'=k[B]$

The order of the reaction will be equal to one.

Question 34

Write the rate equation for the reaction $2A + B \rightarrow C$ if the order of the reaction is zero.

Solution

The rate equation for the reaction $2A + B \rightarrow C$

$$\text{Rate} = k[A]^0[B]^0$$

The powers of the concentration of the reactants will be equal to zero. In the zero-order reactions, the rate of the equation is equal to the rate constant.

Question 35

How can you determine the rate law of the following reaction?



Solution

The rate of the reaction can be determined by

$$\text{Rate} = k[\text{NO}]^2[\text{O}_2]^1$$

It can be measured by the rate of the reaction as a function of initial concentration by keeping the concentration of one of the reactants constant and changing the other reactant.

Question 36

For which type of reactions, order and molecularity have the same value?

Solution

For an elementary reaction, the order is the same as molecularity. Elementary reactions are those reactions which occur in a single step.

Question 37

In a reaction, if the concentration of reactant A is tripled, the rate of reaction becomes twenty-seven times. What is the order of the reaction?

Solution

Consider a rate of a reaction with reactant A

$$\text{Rate} = k[A]^\alpha$$

$$27 \times \text{Rate} = k[A]^\alpha$$

By dividing the equations we get $\alpha = 3$

Therefore the order of the reaction becomes three.

Question 38

Derive an expression to calculate the time required for completion of the zero-order reaction.

Solution

Consider a reaction,



Here R is the reactant and P is the product.

$$\text{Rate} = k[R] \quad 0 \leq t \leq t$$

$$(\text{Instantaneous rate}) -dR/dt = k, \quad dR = -kdt$$

On integrating both sides,

$$\int dR = -k \int dt$$

$$\text{At } t = 0,$$

$$R = R_0$$

Here $[R]$ = concentration of reactant at time 't'.

$$R = 0$$

This reaction is known as the integrated rate equation of zero order.

After completion of zero order reaction $[R] = 0$

Using $[R] = 0$ in (i)

0

$$t = [R_0]/k$$

Question 39

For a reaction $A + B \rightarrow \text{Products}$, the rate law is — $\text{Rate} = k [A][B]^{3/2}$ Can the reaction be an elementary reaction? Explain.

Solution

The reaction cannot be an elementary reaction because the order is different. For an elementary reaction, the molecularity and order should be the same.

Question 40

For a certain reaction large fraction of molecules has energy more than the threshold energy, yet the rate of reaction is very slow. Why?

Solution

The two most important conditions for a reaction to occur according to the collision theory are:

1. Energy is greater than activation energy and proper orientation of reactant molecules at the time of the collision.

So when the reaction occurs then molecules that don't have a proper orientation decreases the rate of a reaction.

Question 41

For a zero-order reaction will the molecularity be equal to zero? Explain.

Solution

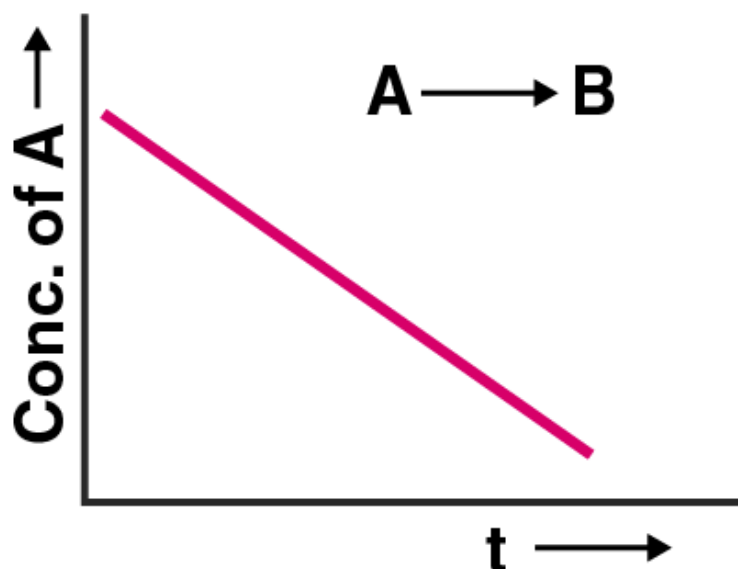
The molecularity of any reaction is the number of reacting species taking part in an elementary reaction. The zero molecularity means there is no reactant so the reaction does not occur. Therefore molecularity cannot be zero for a reaction.

Question 42

For a general reaction $A \rightarrow B$, plot of concentration of A vs time is given in

Fig. 4.3. Answer the following question based on this graph.

- (i) What is the order of the reaction?
- (ii) What is the slope of the curve?
- (iii) What are the units of the rate constant?

**Solution**

- (i) It is a zero-order reaction as the graph is satisfying the equation $[A] = [A_0] - kt$.
- (ii) The slope of the curve is the negative of the rate constant that is denoted by $-k$.
- (iii) Unit of the rate constant is Ms^{-1} or $\text{mol L}^{-1}\text{s}^{-1}$.

Question 43

The reaction between $\text{H}_2(\text{g})$ and $\text{O}_2(\text{g})$ is highly feasible yet allowing the gases to stand at room temperature in the same vessel does not lead to the formation of water. Explain.

Solution

According to Maxwell Boltzmann energy distribution curve when temperature T becomes $T+10$ degree Celsius then the effective collision and energy of molecules increases resulting in the formation of a product.

Question 44

Why does the rate of a reaction increase with a rise in temperature?

Solution

Rate of reaction increases with the rise in temperature because at the higher temperature the fraction of particles collision to cross the energy barrier will be large. Therefore the rate also becomes faster.

Question 45

Oxygen is available in plenty in the air yet fuels do not burn by themselves at room temperature. Explain.

Solution

Oxygen is available in plenty of air yet fuels do not burn by themselves at room temperature because reactants must have a minimum amount of energy known as the activation energy to form a product.

Question 46

Why is the probability of reaction with molecularity higher than three very rare?

Solution

For a reaction having more than three molecules, the proper orientation is not possible that makes these reactions rare. Therefore the probability of more than three molecules colliding simultaneously will be small.

Question 47

Why does the rate of any reaction generally decrease during the reaction?

Solution

The rate of a reaction decreases because the reactants will proceed to convert into the products. The rate of a reaction always depends on the concentration of the reactants.

Question 48

Thermodynamic feasibility of the reaction alone cannot decide the rate of the reaction. Explain with the help of one example.

Solution

Thermodynamic feasibility of the reaction alone cannot decide the rate of the reaction because for a reaction to occur it is important for the molecules to have an energy greater than the activation energy.

For example,

Diamond $\rightarrow$ Graphite $\Delta G = -ve$

ΔG negative means that the reaction is feasible but this reaction is a slow process as energy is less than the activation energy.

Question 49

Why in the redox titration of KMnO_4 vs oxalic acid, we heat oxalic acid solution before starting the titration?

Solution

We heat oxalic acid solution because without heating it is a slow process as energy greater than the activation energy is required for a reaction. So to increase the energy, the temperature must be increased which is only possible by heating the oxalic acid solution.

Question 50

Why can't molecularity of any reaction be equal to zero?

Solution

Zero molecularity means there is no reactant, as a result of which a reaction cannot occur. So if there is a reaction then its molecularity will be greater than zero.

Question 51

Why is molecularity applicable only to elementary reactions and order is applicable for elementary as well as complex reactions?

Solution

Molecularity is applicable only for elementary reactions as they are the single-step reactions and the rate depends on the concentration of each molecule, whereas in case of complex reactions there are multiple reactions involved and thus molecularity holds no meaning.

Question 52

Why can we not determine the order of a reaction by taking into consideration the balanced chemical equation?

Solution

Order is an experimental quantity. For example, in complex reactions, the rate and order are dependent on the slow step reactions, so in such cases, the order is not completely dependent on the balanced chemical equations. We cannot determine the order by taking into consideration the balanced chemical equation.

Class 12 Chemistry NCERT Exemplar Problems on Chemical Kinetics

Chemical kinetics is the study and discussion of chemical reactions with respect to reaction rates, the effect of various variables, the formation of intermediates and the re-arrangement of atoms. Solve the NCERT Exemplar Class 12 Chemistry Chapter 4 Chemical Kinetics for a better understanding of the chapter. Chemical kinetics is a fundamental topic which is important for the Class 12 board examination.

Key points in this exemplar solution are as follows:

1. The Rate of a Chemical Reaction – Formula Derivation and Numerical Problems
2. Factors Influencing the Rate of a Reaction
 1. Dependence of Rate on Concentration

- 2. Rate Expression and Rate Constant
 - 3. Order of a Reaction
 - 4. Molecularity of a Reaction
 - 3. Integrated Rate Equations
 - 1. Zero Order Reactions
 - 2. First-Order Reactions
 - 3. Half-Life of a Reaction
 - 4. Pseudo First Order Reaction
 - 5. Temperature Dependence of the Rate of a Reaction
 - 1. Effect of Catalyst Ex 4.6 – Collision Theory of Chemical Reactions
-