NEET Important Questions with Solutions from Chemical Kinetics

Q.1. Which of the following statements is incorrect about the order of a reaction?

A) The order of a reaction is determined experimentally.

B) It is the sum of the powers of the concentration terms in the rate law expression.

C) It does not necessarily depend on the stoichiometric coefficients.

D) The order of a reaction can not have a fractional value.

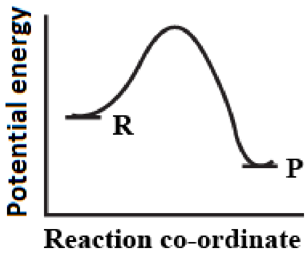
Answer: The order of a reaction can not have a fractional value.

Solution: The order of a reaction has the following characteristics:

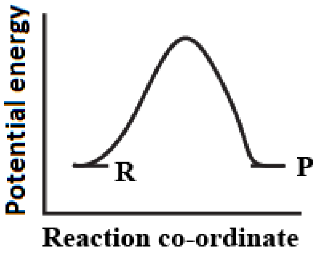
- The reaction order represents the number of species whose concentration directly affects the rate of the reaction.
- The order of a reaction can be obtained by adding all the exponents of the concentration terms in the rate law expression.
- The order of a reaction is determined experimentally.
- The order of a reaction does not necessarily depend on the stoichiometric coefficients. The order of a reaction and the stoichiometric coefficient can be different or the same.
- The order of a reaction can have positive, negative, zero, and fractional values.

Q.2. An endothermic reaction with high activation energy for the forward reaction is given by the diagram.

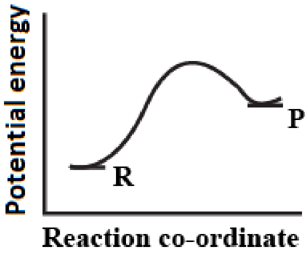
A)



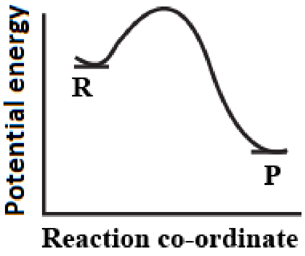
B)



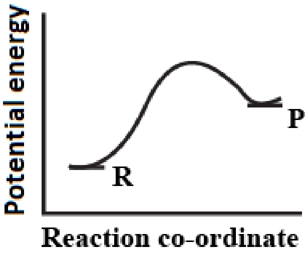
C)



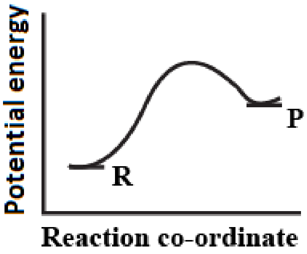
D)



Answer:



Solution: The activation energy for a forward reaction is the amount of free energy that must be added to go from the reactant energy level to transition state energy level. Endothermic reactions are the reactions which involve the absorption of heat. High activation energy means the potential energy of the product must be higher than reactants.



Q.3. The activation energy for a simple chemical reaction $\mathrm{A} \rightarrow \mathrm{B}$, is $\mathrm{E_a}$ in the forward direction. The activation energy for the reverse reaction

A) is always less than $\mathrm{E_a}$.

B) can be less than or more than $\mathrm{E_a}$.

C) is always the double of $\mathrm{E_a}$.

D) is the negative of $\mathrm{E_a}$.

Answer: can be less than or more than $\mathrm{E_a}$.

Solution: Since the nature of the reaction (that is exothermic or endothermic) is not given, $\mathrm{E_a}$ for the reverse reaction can be more(exothermic) or less(endothermic).

$$\Delta \mathrm{H}=\mathrm{E_{a(f)}}-\mathrm{E_{a(r)}};\ \text{if }\ \Delta\mathrm{H}=-\mathrm{ve};\ \text{exothermic};\ \mathrm{E_{a(r)}}>\mathrm{E_{a(f)}}$$

$$\Delta \mathrm{H}=\mathrm{E_{a(f)}}-\mathrm{E_{a(r)}};\ \text{if }\ \Delta\mathrm{H}=+\mathrm{ve};\ \text{endothermic};\ \mathrm{E_{a(r)}}<\mathrm{E_{a(f)}}$$

Q.4. Activation energy of a chemical reaction can be determined by

A) evaluating the rate constant at a standard temperature.

B) evaluating the two different velocities of a reaction at a given temperatures.

C) evaluating the rate constants at two different temperatures.

D) changing the concentration of the reactants.

Answer: evaluating the rate constants at two different temperatures.

Solution: We know that the activation energy of a chemical reaction is given by the formula, $\log\frac{k_2}{k_1}=\frac{E_a}{2.303\,R}\left[\frac{T_2-T_1}{T_1T_2}\right]$.

The formula is obtained from the Arrhenius equation, where k_1 is the rate constant at the temperature T_1, k_2 is the rate constant at the temperature T_2 and E_a is the activation energy.

Therefore, the activation energy of a chemical reaction is determined by evaluating the rate constant at two different temperatures.

Q.5. The molecularity of the reaction is determined by _____.

A) one molecule

B) two molecules

C) three molecules

D) total number of molecules in RDS (Rate determining step)

Answer: total number of molecules in RDS (Rate determining step)

Solution: The molecularity of the reaction is governed by the rate-determining step of the total molecule involved in the reaction condition. Molecularity may be one, two, three, and four has less chance of reacting to each of the molecules in the reaction.

Q.6. For the reaction, $5\,Br^-_{(aq)}+BrO^-_{3(aq)}+6\,H^+_{(aq)}\rightarrow 3\,Br_{2(aq)}+3\,H_2O_{(l)}$ if $-\frac{\Delta[Br^-]}{\Delta t}=0.05\ mol\ L^{-1}\ min^{-1}$, $-\frac{\Delta[BrO_3^-]}{\Delta t}$ in $mol\ L^{-1}\ min^{-1}$ is ______.

A) 0.005

B) 0.05

C) 0.5

D) 0.01

Answer: 0.01

Solution:

$$5\,Br^-_{(aq)}+BrO^-_{3(aq)}+6H^+_{(aq)}\rightarrow 3\,Br_{2(aq)}+3H_2O_{(l)}$$

Rate of reaction $=-\frac{1}{5}\frac{\Delta[Br^-]}{\Delta t}=-\frac{\Delta[BrO_3^-]}{\Delta t}$

Or, $\frac{1}{5}\times 0.05\ mol\ L^{-1}\ min^{-1}=-\frac{\Delta[BrO_3^-]}{\Delta t}$

Or, $-\frac{\Delta[BrO_3^-]}{\Delta t}=0.01\ mol\ L^{-1}\ min^{-1}$

Q.7. **Assertion:** The rate law of a reaction cannot be predicted from its balanced chemical equation, but must be determined experimentally only.

Reason: The order of a reaction is always an integer like $0,\ 1,\ 2$ and 3.

[TS EAMCET (med.) 2015]

A) Assertion and Reason are true. Reason is the correct explanation of Assertion.

B) Assertion and Reason are true. Reason is not the correct explanation of the Assertion.

C) Assertion is true, Reason is false.

D) Assertion is false, Reason is true.

Answer: Assertion is true, Reason is false.

Solution: The order of the reaction is an experimental quantity, and as per the rate law, $\Rightarrow \mathrm{rate} = \mathrm{K}\,[\mathrm{reactant}]^{\mathrm{order}}$

Thus, the rate law of any reaction can't be defined by knowing the reaction, rather by the experiment.

The order of any reaction can be positive, negative or even a fraction.

Hence, the Assertion is true, the Reason is false

Q.8. Which one of the following statement is not correct for the order of the reaction?

[IIT JEE 2005; CBSE PMT (Prelims) 2011]

A) The order can be determined experimentally.

B) The order of the reaction is equal to the sum of the powers of the concentration terms in the differential rate law.

C) It is not affected with the stoichiometric coefficient of the reactants.

D) The order can't be fractional.

Answer: The order can't be fractional.

Solution: According to the rate law, $\Rightarrow \quad \mathrm{rate} = \mathrm{K}\ [\mathrm{reactant}]^{\mathrm{order}}$

The order of any reaction can be calculated by the experimental method.

The value of the order can be positive, negative, zero or even a fraction.

For a reaction, having more than one reactant order of reaction $=$Sum of the order with respect to each reactant.

The order of a reaction is not the same as the stoichiometric coefficient of the reactants.

Q.9. A catalyst increases the rate of reaction by:

A) Decreasing enthalpy

B) Decreasing internal energy

C) Decreasing activation energy

D) Increasing activation energy

Answer: Decreasing activation energy

Solution: A catalyst can lower the activation energy for a reaction by providing a different mechanism for the reaction. A reaction with lower activation energy proceeds with a faster rate. However, it does not take part in the reaction and there is no change in the chemical composition of the reactant and the product. So, there will be no change in the state parameters like enthalpy and internal energy.

Q.10. The rate of a reaction is expressed in different ways as follows:
$+1/2(\mathrm{d}[\mathrm{C}]/\mathrm{dt}) = -1/3(\mathrm{d}[\mathrm{D}]/\mathrm{dt}) = +1/4(\mathrm{d}[\mathrm{A}]/\mathrm{dt}) = -(\mathrm{d}[\mathrm{B}]/\mathrm{dt})$

The reaction is:

A) $4\mathrm{A} + \mathrm{B} \longrightarrow 2\mathrm{C} + 3\mathrm{D}$

B) $\mathrm{B+3D\longrightarrow 4A+2C}$

C) $\mathrm{4A+2B\longrightarrow 2C+3D}$

D) $\mathrm{B+(1/2)D\longrightarrow 4A+3}$

Answer: $\mathrm{B+3D\longrightarrow 4A+2C}$

Solution: Rate of a reaction can be determined by the time derivative of the concentration of any reactant or product in a balanced chemical equation.

In general,

$\mathrm{p\,B\ +\ q\,D\ \rightarrow r\,A\ +\ s\,C}$

Rate$= -\frac{1}{p}\frac{d[B]}{dt} = -\frac{1}{q}\frac{d[D]}{dt} = \frac{1}{r}\frac{d[A]}{dt} = \frac{1}{s}\frac{d[C]}{dt}$ ....(1)

Here, $-$ sign represents the reactants since they disappear with respect to time.

The given equation after rearrangement is:

$-\frac{d[B]}{dt} = -\frac{1}{3}\frac{d[D]}{dt} = \frac{1}{4}\frac{d[A]}{dt} = \frac{1}{2}\frac{d[C]}{dt}$ ....(2)

From the comparison of equation (1) and equation (2),

$\mathrm{p=1,\ q=3,\ r=4\ \&\ s=\ 2.}$

So, the balanced equation will be

$\mathrm{B+3D\longrightarrow 4A+2C.}$

Q.11. $\mathrm{aA+bB\longrightarrow}$ Product, $\mathrm{dx/dt=k[A]^{a}[B]^{b}}$. If the concentration of A is doubled, the rate is four times. If the concentration of B is made four times, the rate is doubled. What is the relation between the rate of disappearance of A and that of B?

A) $-\{d[A]/dt\} = -\{d[B]/dt\}$

B) $-\{d[A]/dt\} = -\{4d[B]/dt\}$

C) $-\{4d[A]/dt\} = -\{d[B]/dt\}$

D) None of these

Answer: $-\{d[A]/dt\} = -\{4d[B]/dt\}$

Solution: For the given equation

$\mathrm{aA + bB \longrightarrow Products,}$

the rate law is given

$\frac{dx}{dt} = k\left[A\right]^a\left[B\right]^b$ ....(1)

(i) As on doubling the concentration of A, the rate becomes four times

$4\frac{dx}{dt} = k\left[2A\right]^a\left[B\right]^b$ .....(2)

From equations (1) and (2),

$4 = (2)^a$; so $a = 2$.

(ii) On increasing by four times the concentration of B, the rate becomes double

$2\frac{dx}{dt} = k\left[A\right]^a\left[4B\right]^b$ ....(3)

From equations (1) and (3),

$2 = (4)^b$; so $b = \frac{1}{2}$.

Now, the given equation will be

$2\ A + \frac{1}{2}\ B \longrightarrow \mathrm{Products.}$

Rate $= -\frac{1}{2}\frac{d[A]}{dt} = -2\frac{d[B]}{dt}$

Or $-\frac{d[A]}{dt} = -4\frac{d[B]}{dt}$.

Q.12. For a reaction $pA + qB \rightarrow$ products, the rate law expression is: $r = k\left[A\right]^1\left[\ B\right]^m$, then

A) $(p+1) < (1+m)$

B) $(p+q) > (1+m)$

C) $(p+q)$ may or may not be equal to $(1+m)$

D) $(p+q) = (1+m)$

Answer: $(p+q)$ may or may not be equal to $(1+m)$

Solution: Rate law of any chemical reaction is always determined experimentally. The order of the reaction with respect to any reactant may or may not be equal to its stoichiometric coefficient.

In general, for the reaction

$\mathrm{a\ A\ +\ b\ B\ +\ c\ C\ \rightarrow Products,}$

the experimental rate law is:

$\mathrm{rate} = [A]^{\alpha}[B]^{\beta}[C]^{\gamma}.$

The order $\alpha,\ \beta\ \&\ \gamma$ may or may not be equal to a, b & c.

Order, with respect to any reactant, has no relation with stoichiometric coefficient.

Q.13. The rate constant of reaction $2A + B \longrightarrow C$ is $2.57 \times 10^{-5}\ \mathrm{L\ mole^{-1} sec^{-1}}$ after 10 seconds, $2.57 \times 10^{-5}\ \mathrm{L\ mole^{-1} sec^{-1}}$ after 20 seconds, and $2.57 \times 10^{-5}\ \mathrm{L\ mole^{-1}\ sec^{-1}}$ after 30 seconds. The order of the reaction is:

A) 0

B) 1

C) 2

D) 3

Answer: 2

Solution: For the reaction:

$2A + B \longrightarrow C,$

the order of the reaction can be determined by the unit of rate constant.

In general, the unit of rate constant is $\left(\frac{L}{mol}\right)^{n-1} s^{-1}$, where the order of the reaction is n.

The given unit of rate constant is $L\ mol^{-1} s^{-1}$, so, by comparison, $n - 1 = 1$ and $n = 2$.

So, the reaction will be of second order.

Q.14. $A + B \longrightarrow$ Product, $\frac{dx}{dt} = k[A]^a[B]^b$. If $\left(\frac{dx}{dt}\right) = k$, then order is ______.

A) 4

B) 2

C) 1

D) 0

Answer: 0

Solution: For the given reaction

$A + B \longrightarrow$Products

Given:

$\frac{dx}{dt} = k[A]^a[B]^b$; x is the number of moles consumed.

Where a $\&$ b are the order of reaction with respect to A $\&$ B.

Now, if $\frac{dx}{dt} = k$ that is the rate of reaction is constant.

Then, $a + b = 0$; so, the reaction is of zero order.

Q.15. In a zero-order reaction, if the initial concentration of the reactant is doubled, the time required for half the reactant to be consumed:

A) increases two-fold

B) increases four-fold

C) decreases by half

D) does not change

Answer: increases two-fold

Solution: For a zero order reaction, the half-life time is given by,

$t_{1/2} = \frac{\text{initial concentration}}{2k}$.

Therefore, on doubling the initial concentration, the half-life time also gets doubled.

Q.16. A zero-order reaction, $\mathrm{A} \rightarrow$ Product, with an initial concentration $[\mathrm{A}]_0$ has a half-life of $0.2\ \mathrm{s}$. If one starts with the concentration $2[\mathrm{A}]_0$, then the half-life is :

A) $0.1\ \mathrm{s}$

B) $0.4\ \mathrm{s}$

C) $0.2\ \mathrm{s}$

D) $0.8\ \mathrm{s}$

Answer: $0.4\ \mathrm{s}$

Solution: For a zero order reaction, the half-life time is given by,

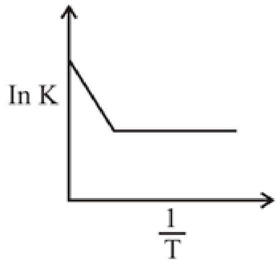
$\mathrm{t}_{1/2} = \frac{\text{initial concentration}}{2\mathrm{k}}$.

Therefore, on doubling the initial concentration the half-life time also gets doubled.

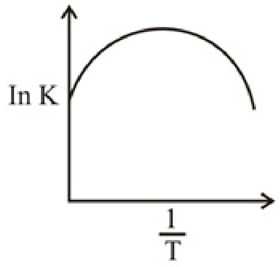
New half-life $= 0.4\ \mathrm{s}$

Q.17. Among the following graphs showing variation of rate (k) with temperature (T) for a reaction, the one that exhibits Arrhenius behavior over the entire temperature range is:

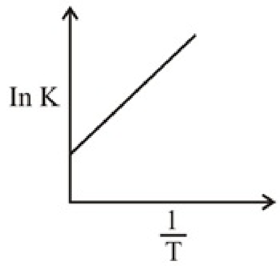
A)



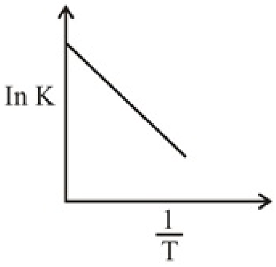
B)



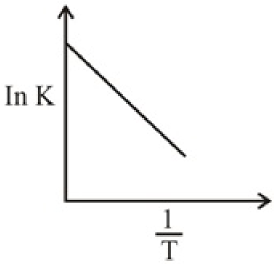
C)



D)



Answer:



Solution: According to arrhenius equation, the rate constant is given as,

$k = Ae^{-\left(\frac{E_a}{RT}\right)}$
$\text{where } A = \text{arrhenius equation}, E_a = \text{Activation energy}, T = \text{temperature}$

Taking log we get,

$\ln\left(k\right) = \ln\left(A\right) - \frac{E_a}{R}\left(\frac{1}{T}\right)$

The equation is linear with a negative slope.

Q.18. The time taken for the concentration of the reactant in a first-order reaction to be halved is: (decay constant is $10^{-3}/\text{minutes}$).

A) 2303 minutes.

B) 1000 minutes.

C) 500 minutes.

D) 693 minutes.

Answer: 693 minutes.

Solution: The time required for the initial concentration of the reactant to become half, is called half-life of the reaction.

We know that, decay constant $(\lambda) = \frac{0.693}{t_{1/2}}$

$t_{1/2} = \frac{0.693}{10^{-3}} = 693 \text{ minutes}$

Q.19. For the formation of ammonia in the following reaction, it is given that $N_2\,(g) + 3H_2\,(g) \rightarrow 2\,NH_3\,(g),\ E_a-$ activation energy $\frac{1}{2}N_2\left(g\right) + \frac{3}{2}H_2\left(g\right) \rightarrow NH_3\left(g\right),\ Ea_1-$ activation energy.

A) $E_a > E_{a_1}$

B) $E_a < E_{a_1}$

C) $E_{a_1} = \frac{1}{2} E_a$

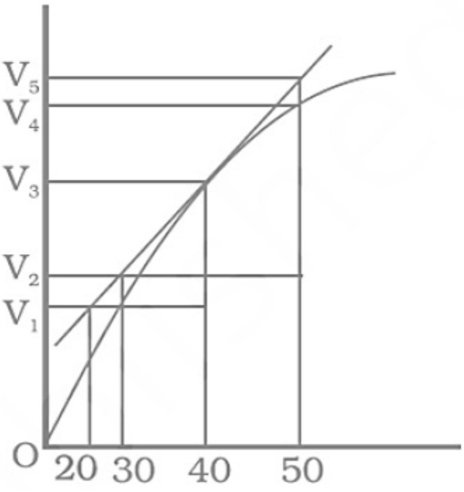
D) $E_a = E_{a_1}$

Answer: $E_a = E_{a_1}$

Solution: Activation energy: the minimum amount of extra energy required by a reacting molecule to get converted into product.

Activation energy is independent of stoichiometry of the reaction.

Q.20. A graph of volume of hydrogen released vs time for the reaction between zinc and dil. HCl is given in Figure. On the basis of this mark the correct option.



A) Average rate upto 40 seconds is $\frac{V_3 - V_2}{40}$

B) Average rate upto 40 seconds is $\frac{V_3 - V_2}{40 - 30}$

C) Average rate upto 40 seconds is $\frac{V_3}{40}$

D) Average rate upto 40 seconds is $\frac{V_3 - V_1}{40 - 20}$

Answer: Average rate upto 40 seconds is $\frac{V_3}{40}$

Solution: Average rate for the reaction $= \frac{\text{Change in concentration of } H_2}{\text{Change in time}}$

$= \frac{V_3 - 0}{40 - 0} = \frac{V_3}{40}$

Q.21. Which of the following statements is not correct about order of a reaction?

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

D) The order of a reaction is the sum of the powers of molar concentration of the reactants in the rate law expression.

Answer: The order of a reaction is always equal to the sum of the stoichiometric coefficients of reactants in the balanced chemical equation for a reaction.

Solution: The sum of powers of the concentration of the reactants in the rate law expression is called the order of that chemical reaction. Rate law is the expression in which reaction rate is given in terms of molar concentration of reactants with each term raised to some power, which may or may not be same as the stoichiometric coefficient of the reacting species in a balanced chemical equation.

Q.22. A first order reaction is 50% completed in 1.26×10^{14} s. How much time would it take for 100% completion?

A) 1.26×10^{15} s

B) 2.52×10^{14} s

C) 2.52×10^{28} s

D) infinite

Answer: infinite

Solution: It is impossible to perform 100% of the reaction, whole of the substance never react. Hence, time taken for 100% completion of a reaction is infinite.

$$t = \frac{1}{k}\ln\left(\frac{N_0}{(N_0 - x)}\right),$$

$$N_0 - x = 0,$$

$$t = \frac{1}{k} \times \text{Infinity}$$

So, time taken is infinite to complete the reaction.

Q.23. Under the same reaction conditions, the initial concentration of $1.386\ \text{mol}\ \text{dm}^{-3}$ of a substance becomes half in 40 s and 20 s through first-order and zero-order kinetics, respectively. What will be the ratio of the rate constants $\left(\frac{k_1}{k_0}\right)$, for the first-order (k_1) and zero-order (k_0) of the reaction?

A) $0.5\ \text{mol}^{-1}\text{dm}^3$

B) $1.0\ \text{mol}\ \text{dm}^{-3}$

C) $1.5\ \text{mol}\ \text{dm}^{-3}$

D) $2.0\ \text{mol}^{-1}\text{dm}^3$

Answer: $0.5\ \text{mol}^{-1}\text{dm}^3$

Solution: The half-life of a zero-order reaction is directly proportional to the initial concentration of the reactant.

$$k_0 = \frac{[A]_0}{2t_{1/2}} = \frac{1.386}{2 \times 20} = 0.03465\ \text{mol}\ \text{dm}^{-3}\ \text{s}^{-1}$$

The half-life of a first-order reaction is independent of the initial concentration of the reactant.

$$k_1 = \frac{0.693}{t_{1/2}} = \frac{0.693}{40} = 0.017325\ \text{s}^{-1}$$

Where k_0 and k_1 are the rate constants for zero and first-order reactions.

So, according to the question,

$$\frac{k_1}{k_0} = \frac{0.017325\ \text{s}^{-1}}{0.03465\ \text{mol}\ \text{dm}^{-3}\ \text{s}^{-1}} = 0.5\ \text{mol}^{-1}\ \text{dm}^3$$

Q.24. What is $t_{3/4}$ for a first-order reaction?

A) $0.693/\mathrm{k}$

B) $1.386/\mathrm{k}$

C) $0.75/\mathrm{k}$

D) $0.63/\mathrm{k}$

Answer: $1.386/\mathrm{k}$

Solution: $\mathrm{t}_{3/4}$ is the time required for 75% completion of the reaction.

For a first-order reaction,

$$\mathrm{k}=\frac{2.303}{\mathrm{t}}\log\frac{[\mathrm{A}]_0}{[\mathrm{A}]}\ldots\ldots\ldots(\mathrm{i})$$

So, at $\mathrm{t}_{3/4}$, $[\mathrm{A}]=0.25[\mathrm{A}]_{\mathrm{o}}$

Now, from equation (i) :

$$\mathrm{t}_{3/4}=\frac{2.303}{\mathrm{k}}\log\frac{[\mathrm{A}]_0}{[\mathrm{A}]_0}\times 4$$
$$=\frac{2.303}{\mathrm{k}}\log\ 4$$
$$=\frac{1.386}{\mathrm{k}}$$

Q.25. The time taken for the initial concentration of a reactant to reduce to half is 4 hours, following first-order kinetics. The fraction of the initial reactant left after 32 hours is:

A) $\frac{1}{16}$

B) $\frac{1}{32}$

C) $\frac{1}{64}$

D) $\frac{1}{256}$

Answer: $\frac{1}{256}$

Solution: The initial concentration of reactant is $[\mathrm{A}]_{\circ}$ and the half-life is given as 4 hours.

After 32 hours, the number of half-lives $(\mathrm{n})=\frac{32}{4}=8$.

So, the amount of reactant left after 8 half-lives $=\frac{[\mathrm{A}]_0}{2^8}=\frac{[\mathrm{A}]_0}{256}$.

The fraction of the initial reactant left after the 32 hours is $\frac{1}{256}$.

Practice more on Chemical Kinetics