CHEMISTRY

BOOKS - U-LIKE CHEMISTRY (HINGLISH)

CHEMICAL KINETICS

Ncert Intext Questions

1. For the reaction $R \rightarrow P$, the concentration of a reactant changes from 0.03 M to 0.02 M in 25 minutes. Calculate the average rate of reaction using units of time both in minutes and seconds.

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2. In a reaction, $2A \rightarrow$ Products, the concentration of A decreases from 0.5 mol L^{-1} to 0.4 mol L^{-1} in 10 minutes. Calculate the rate

during this interval .

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3. For a reaction, $A + B \rightarrow$ Product, the rate is given by, $r = k[A]^{1/2}[B]^2$. What is the order of the reaction?

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4. The conversion of the molecules X to Y follows second order kinetics. If the concentration X is increased to three times, how will it affect the rate of formation of Y?

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5. A first order reaction has a rate constant $1.15 \times 10^{-3} s^{-1}$. How long will 5 g of this reactant take to reduce to 3 g?

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6. Time required to decompose SO_2Cl_2 to half of its initial amount is 60 minutes. If the decomposition is a first order reaction, calculate the rate constant of the reaction.

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7. What will be the effect of temperature on rate constant?

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8. The rate of the chemical reaction doubles for an increase of 10 K in absolute temperature from 298 K. Calculate E_a.

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9. The activation energy for the reaction

$2HI(g) \rightarrow H_2(g) + I_2(g)$,

is 209.5 kJ mol^{-1} at 581 K. Calculate the fraction of molecules of reactants hving energy equal to or greater than activation energy.

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Ncert Textbook Exercises

1. From the rate expression for the following reactions, determine their order of reaction and the dimensions of the rate constants:

(i) $3NO(g) \rightarrow N_2O(g)$, $\mathrm{Rate} = k[NO]^2$

(ii)

$H_2O_2(aq) + 3I^-(aq) + 2H^+ \rightarrow 2H_2O(l) + I_3^-$, $\mathrm{Rate} = k[H_2O_2]\left[I^-\right]$

(iii) $CH_3CHO(g) \rightarrow CH_4(g) + CO(g)$, $\mathrm{Rate} = k[CH_3CHO]^{3/2}$

(iv) $C_2H_5Cl(g) \rightarrow C_2H_4(g) + HCl(g)$, $\mathrm{Rate} = k[C_2H_5Cl]$

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2. For the reaction : $2A + B \rightarrow A_2B$, the rate $= k[A][B]^2$ with $k = 2.0 \times 10^{-6} \text{mol}^{-2} L^2 s^{-1}$. Calculate the initial rate of the reaction when $[A] = 0.1 \text{mol L}^{-1}$ and $[B] = 0.2 \text{mol L}^{-1}$. Calculate the rate of reaction after [A] is reduced to 0.06 mol L^{-1}.

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3. The decomposition of NH_3 on platinum surface is zero order reaction. What are the rates of production of N_2 and H_2 if $k = 2.5 \times 10^{-4} \text{mol}^{-1} L s^{-1}$?

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4. The decomposition of dimethyl ether leads to the formation of CH_4, H_2 and CO and the reaction rate is given by

Rate $= k[CH_3OCH_3]^{3/2}$

The rate of reaction is followed by increase in pressure in a closed vessel, so the rate can also be expressed in terms of the partial pressure of dimethyl ether, i.e.,

Rate $= k(p_{CH_3OCH_3})^{3/2}$

If the pressure is measured in bar and time in minutes, then what are the units of rate and rate constants?

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5. A reaction is second order with respect to a reactant. How is the rate of reaction affected if the concentration of the reactant is

(i) doubled (ii) reduced to half?

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6. What is the effect of temperature on the rate constant of a reaction? How can this temperature effect on the rate constant be represented quantitatively?

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7. In a pseudo first order hydrolysis of an ester in water, and following results were obtained:

t/s	0	30	60	90
[Ester] mol L^{-1}	0.55	0.31	0.17	0.085

(i) Calculate the average rate of reaction between the time interval 30 to 60 seconds.

(ii) Calculate the pseudo first order rate constant for the hydrolysis of ester.

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8. A reaction is first order in A and second order in B.

(i) Write the differential rate equation.

(ii) How is the rte affected on increasing the concentration of B three times?

(iii) How is the rate affected when concentrations of both A and B are doubled?

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9. In a reaction, between A and B, the initial rate of reaction (r_0) was measured for different initial concentrations of A and B as given below :

A/mol L^{-1}	0.20	0.20	0.40
B/mol L^{-1}	0.30	0.10	0.05
r_0/mol L^{-1} s^{-1}	5.07×10^{-5}	5.07×10^{-5}	7.16×10^{-5}

What is the order of reaction with respect to A and B ?

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10. The following results have been obtained during the kinetic studies of the reaction:

$2A + B \rightarrow C + D$

Experiment	[A]/mol L^{-1}	[B]/mol L^{-1}	Initial rate of formation of D/mol L^{-1} min^{-1}
I	0.1	0.1	6.0×10^{-3}
II	0.3	0.2	7.2×10^{-2}
III	0.3	0.4	2.88×10^{-1}
IV	0.4	0.1	2.40×10^{-2}

Determine the rate law and the rate constant for the reaction.

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11. The reaction between A and B is first order with respect to A and zero order with respect to B. Fill in the blanks in the following table :

Experiment	[A]/mol L^{-1}	[B]/mol L^{-1}	Initial rate/mol L^{-1} min^{-1}
I	0.1	0.1	2.0×10^{-2}
II	—	0.2	4.0×10^{-2}
III	0.4	0.4	—
IV	—	0.2	2.0×10^{-2}

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12. Calculate the half-life of a first order reaction from their rate constants given below:

$(i) 200 s^{-1}$ $(ii) 2 \text{min}^{-1}$ $(iii) 4 \text{years}^{-1}$

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13. The half life for radioactive decay of ^{14}C is 5730 years. An archaeological artifact containing wood had only 80% of the ^{14}C found in living tree. Estimate the age of the sample.

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14. The experimental data for the decomposition of N_2O_5, $[2N_2O_5 \rightarrow 4NO_2 + O_2]$ in gas phase at 318 K are given below:

t/s	0	400	800	1200	1600	2000	2400	2800	3200
$10^2 \times [N_2O_5]$/mol L^{-1}	1.63	1.36	1.14	0.93	0.78	0.64	0.53	0.43	0.35

(i) Plot $[N_2O_5]$ against t.

(ii) Find the half-life period for the reaction.

(iii) Draw a graph between $\log[N_2O_5]$ and t.

(iv) What is the rate law?

(v) Calculate the rate constant.

(vi) Calculate the half-life period from k and compare it with (ii).

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15. The rate constant for a first order reaction is 60 s^{-1}. How much time will it take to reduce the initial concentration of the reactant to its 1/16th value ?

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16. During nuclear explosion, one of the products is ^{90}Sr with half-life of 28.1 years. If 1 μg of ^{90}Sr was absorbed in the bones of a newly born baby instead of calcium, how much of it will remain after 10 years and 60 years if it is not lost metabolically?

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17. For a first order reaction, show that time required for $99\,\%$ completion is twice the time required for the completion of $90\,\%$ of reaction.

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18. A first order reaction takes 40 min for 30% decomposition. Calculate $t_{1/2}$.

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19. For the decomposition of azoisopropane to hexane and nitrogen at 543K, the following data are obtained:

$SO_2Cl_2(g) \rightarrow SO_2(g) + Cl_2(g)$

Calculate the rate constant.

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20. The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at a constant volume.

Calculate the rate of reaction when total pressure is 0.65 atm.

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21. The rate constant for the decomposition of N_2O_5 at various temperatures is given below:

Draw a graph between in k and $1/T$ and calculate the values of A and E_a. Predict the rate constant at $30^\circ C$ and $50^\circ C$.

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22. The rate constant for the decomposition of hydrocarbons is $2.418 \times 10^{-5} s^{-1}$ at 546 K. If the energy of activation is 179.9 kJ/mol, what will be the value of pre-exponential factor?

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23. Consider a certain reaction $A \rightarrow$ Products with $k = 2.0 \times 10^{-2} s^{-1}$. Calculate the concentration of A remaining after 100 s if the initial concentration of A is 1.0 $molL^{-1}$.

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24. Sucrose decomposes in acid solution into glucose and fructose according to the first order rate law, with $t_{1/2} = 3.00$ hours. What fraction of the sample of sucrose remains after 8 hours?

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25. The decomposition of hydrocarbon follows the equation $k = \left(4.5 \times 10^{11} s^{-1}\right) e^{-28000K/T}$. Calculate E_a.

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26. The rate constant for the first order decomposition of H_2O_2 is given by the following equation :

$\log k = 14.34 - 1.25 \times 10^4 K/T$

Calculate E_a for this reaction and at what temperature will its half-period be 256 minutes?

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27. The decomposition of A into product has value of k as $4.5 \times 10^3 s^{-1}$ at 10 $^\circ C$ and energy of activation 60 kJ mol^{-1}. At what temperature would k be $1.5 \times 10^4 s^{-1}$?

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28. The time required for $10\,\%$ completion of a first order reaction at 298 K is equal to that required for its 25% completion at 308 K. If the value of A is $4 \times 10^{10} s^{-1}$ calculate k at 318 K and E_a.

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29. The rate of a reaction quadruples when the temperature changes from 293 K to 313 K. Calculate the energy of activation of the reaction, assuming that it does not change with temperature.

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Case Based Source Based Integrated Questions

1. Read the given passage and answer the questions:

Zero order reactions are relatively uncommon but they occur under special conditions. Some enzyme catalysed reactions and reactions which occurs on metal surfaces are a few examples of zero order reactions. The decompositions which occurs on metal surfaces are a few examples of zero order reactions. The decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high pressure.

$$2NH_3(g) \xrightarrow[\text{Pt catalyst}]{1130K} N_2(g) + 3H_2(g)$$

Rate $= k[NH_3]^0 = k$

In this reaction, Pt acts as a catalyst. At high pressure, the metal surface gets saturated with gas molecules. So a further change in reaction conditions is unable to alter the amount of ammonia on the surface of the catalyst making the rate of the reaction independent of its concentration.

Q. What are zero order reactions?

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2. Read the given passage and answer the questions:

Zero order reactions are relatively uncommon but they occur under special conditions. Some enzyme catalysed reactions and reactions which occurs on metal surfaces are a few examples of zero order reactions. The decompositions which occurs on metal surfaces are a few examples of zero order reactions. The decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high

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In this reaction, Pt acts as a catalyst. At high pressure, the metal surface gets saturated with gas molecules. So a further change in reaction conditions is unable to alter the amount of ammonia on the surface of the catalyst making the rate of the reaction independent of its concentration.

Q. If $[R]_0$ and [R] are the concentrations of the reactant initially and after time t, give the equation relating k.

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3. Read the given passage and answer the questions:

Zero order reactions are relatively uncommon but they occur under special conditions. Some enzyme catalysed reactions and reactions which occurs on metal surfaces are a few examples of zero order reactions. The decompositions which occurs on metal surfaces are a

few examples of zero order reactions. The decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high pressure.

$$2NH_3(g) \xrightarrow[\text{Pt catalyst}]{1130K} N_2(g) + 3H_2(g)$$

Rate $= k[NH_3]^0 = k$

In this reaction, Pt acts as a catalyst. At high pressure, the metal surface gets saturated with gas molecules. So a further change in reaction conditions is unable to alter the amount of ammonia on the surface of the catalyst making the rate of the reaction independent of its concentration.

Q. Why is the decomposition of NH_3 on Pt surface a zero order reaction?

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4. Read the given passage and answer the questions:

Zero order reactions are relatively uncommon but they occur under special conditions. Some enzyme catalysed reactions and reactions

which occurs on metal surfaces are a few examples of zero order reactions. The decompositions which occurs on metal surfaces are a few examples of zero order reactions. The decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high pressure.

$$2NH_3(g) \xrightarrow[\text{Pt catalyst}]{1130K} N_2(g) + 3H_2(g)$$

Rate $= k[NH_3]^0 = k$

In this reaction, Pt acts as a catalyst. At high pressure, the metal surface gets saturated with gas molecules. So a further change in reaction conditions is unable to alter the amount of ammonia on the surface of the catalyst making the rate of the reaction independent of its concentration.

Q. Give another example of a zero order reaction.

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5. Read the given passage and answer the questions:

Zero order reactions are relatively uncommon but they occur under

special conditions. Some enzyme catalysed reactions and reactions which occurs on metal surfaces are a few examples of zero order reactions. The decompositions which occurs on metal surfaces are a few examples of zero order reactions. The decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high pressure.

$$2NH_3(g) \xrightarrow[\text{Pt catalyst}]{1130K} N_2(g) + 3H_2(g)$$

Rate $= k[NH_3]^0 = k$

In this reaction, Pt acts as a catalyst. At high pressure, the metal surface gets saturated with gas molecules. So a further change in reaction conditions is unable to alter the amount of ammonia on the surface of the catalyst making the rate of the reaction independent of its concentration.

Q. Give the shape of the graph between concentration of reaction vs time in a zero order reaction.

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6. Read the given passage and answer the questions:

Most of the chemical reactions are accelerated by increase in temperature. For example, in decomposition of N_2O_5, the time taken for half of the original amount of material to decompose is 12 min at $50^\circ C$, 5 h at 25 $^\circ C$ and 10 days at 0 $^\circ C$. You also know that is a mixture of potassium permaganate and oxalic acid $H_2C_4O_4$, potassium permaganate $KMnO_4$ gets decolourised faster at a higher temperature than at a lower temperature. It has been found that for a chemical reaction with rise in temperature by 10 $^\circ C$, the rate constant is nearly doubled. The temperature dependence of the rate of a chemical reaction can be accurately explained by Arrhenius equation:

$k = Ae^{-E_a/RT}$

where A is the frequency factor, E_a is the activation energy measured in joules per mole.

Q. In the volumetric titration of oxalic acid against potassium permanganate $(KMnO_4)$, we heat the oxalic acid solution to about 40 $^\circ C$ before performing the titration. Why?

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7. Read the given passage and answer the questions:

Most of the chemical reactions are accelerated by increase in temperature. For example, in decomposition of N_2O_5, the time taken for half of the original amount of material to decompose is 12 min at 50$^\circ C$, 5 h at 25 $^\circ C$ and 10 days at 0 $^\circ C$. You also know that is a mixture of potassium permaganate and oxalic acid $H_2C_4O_4$, potassium permaganate $KMnO_4$ gets decolourised faster at a higher temperature than at a lower temperature. It has been found that for a chemical reaction with rise in temperature by 10 $^\circ C$, the rate constant is nearly doubled. The temperature dependence of the rate of a chemical reaction can be accurately explained by Arrhenius equation:

$k = Ae^{-E_a/RT}$

where A is the frequency factor, E_a is the activation energy measured in joules per mole.

Q. How does the time required for half change vary with the change in time?

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8. Read the given passage and answer the questions:

Most of the chemical reactions are accelerated by increase in temperature. For example, in decomposition of N_2O_5, the time taken for half of the original amount of material to decompose is 12 min at $50^\circ C$, 5 h at 25 $^\circ C$ and 10 days at 0 $^\circ C$. You also know that is a mixture of potassium permaganate and oxalic acid $H_2C_4O_4$, potassium permaganate $KMnO_4$ gets decolourised faster at a higher temperature than at a lower temperature. It has been found that for a chemical reaction with rise in temperature by 10 $^\circ C$, the rate constant is nearly doubled. The temperature dependence of the rate of a chemical reaction can be accurately explained by Arrhenius equation:

$k = Ae^{-E_a/RT}$

where A is the frequency factor, E_a is the activation energy measured in joules per mole.

Q. A reaction was carried out at $20^\circ C$ and than at $30^\circ C$. How do you expect the rate constant to change ?

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9. Read the given passage and answer the questions:

Most of the chemical reactions are accelerated by increase in temperature. For example, in decomposition of N_2O_5, the time taken for half of the original amount of material to decompose is 12 min at $50^\circ C$, 5 h at 25 $^\circ C$ and 10 days at 0 $^\circ C$. You also know that is a mixture of potassium permaganate and oxalic acid $H_2C_4O_4$, potassium permaganate $KMnO_4$ gets decolourised faster at a higher temperature than at a lower temperature. It has been found that for a chemical reaction with rise in temperature by 10 $^\circ C$, the rate constant is nearly doubled. The temperature dependence of the rate of a chemical reaction can be accurately explained by Arrhenius

equation:

$k = Ae^{-E_a/RT}$

where A is the frequency factor, E_a is the activation energy measured in joules per mole.

Q. Give the Arrhenius equation in the original form.

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10. Read the given passage and answer the questions:

Most of the chemical reactions are accelerated by increase in temperature. For example, in decomposition of N_2O_5, the time taken for half of the original amount of material to decompose is 12 min at $50^\circ C$, 5 h at 25 $^\circ C$ and 10 days at 0 $^\circ C$. You also know that is a mixture of potassium permaganate and oxalic acid $H_2C_4O_4$, potassium permaganate $KMnO_4$ gets decolourised faster at a higher temperature than at a lower temperature. It has been found that for a chemical reaction with rise in temperature by 10 $^\circ C$, the rate constant is nearly doubled. The temperature dependence of the rate

of a chemical reaction can be accurately explained by Arrhenius equation:

$k = Ae^{-E_a/RT}$

where A is the frequency factor, E_a is the activation energy measured in joules per mole.

Q. How will change this equation into natural logaritham form?

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11. Read the given passage and answer the questions:

According to Arrhenius equation, the lower the value of activation energy, faster will be the rate of reaction. A small amount of catalyst can catalyse a large amount of reagents. A catalyst does not alter Gibbs energy. ΔG of a reaction. It catalyses the spontaneous reactions but does not catalyse non-spontaneous reactions. It is also found that a catalyst does not change the equilibrium constant of a reaction rather, it helps in attaining the equilibrium faster, that is, it catalyses the forward as well as the backward reactions to the same

extent so that the equilibrium state remains same but it reached earlier.

Q. What is conveyed by Arrhenius equation?

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12. Read the given passage and answer the questions:

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Q. Can a catalyst bring about a change which is generally not probable?

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13. Read the given passage and answer the questions:

According to Arrhenius equation, the lower the value of activation energy, faster will be the rate of reaction. A small amount of catalyst can catalyse a large amount of reagents. A catalyst does not alter Gibbs energy. ΔG of a reaction. It catalyses the spontaneous reactions but does not catalyse non-spontaneous reactions. It is also found that a catalyst does not change the equilibrium constant of a reaction rather, it helps in attaining the equilibrium faster, that is, it catalyses the forward as well as the backward reactions to the same extent so that the equilibrium state remains same but it reached earlier.

Q. Write Arrhenius equation in the mathematical form.

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14. Read the given passage and answer the questions:

According to Arrhenius equation, the lower the value of activation energy, faster will be the rate of reaction. A small amount of catalyst can catalyse a large amount of reagents. A catalyst does not alter Gibbs energy. ΔG of a reaction. It catalyses the spontaneous reactions but does not catalyse non-spontaneous reactions. It is also found that a catalyst does not change the equilibrium constant of a reaction rather, it helps in attaining the equilibrium faster, that is, it catalyses the forward as well as the backward reactions to the same extent so that the equilibrium state remains same but it reached earlier.

Q. Out of Gibb's energy and equilibrium constant, which quantity is changed by the catalyst?

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15. Read the given passage and answer the questions:

According to Arrhenius equation, the lower the value of activation energy, faster will be the rate of reaction. A small amount of catalyst can catalyse a large amount of reagents. A catalyst does not alter Gibbs energy. ΔG of a reaction. It catalyses the spontaneous reactions but does not catalyse non-spontaneous reactions. It is also found that a catalyst does not change the equilibrium constant of a reaction rather, it helps in attaining the equilibrium faster, that is, it catalyses the forward as well as the backward reactions to the same extent so that the equilibrium state remains same but it reached earlier.

Q. What is the utility of a catalyst?

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Multiple Choice Questions

1. Units of rate constant for a second order reaction is

A. $\mathrm{mol\,L^{-1}}s^{-1}$

B. s^{-1}

C. $\mathrm{mol^{-1}\ \ L\,s^{-1}}$

D. $\mathrm{mol^{-2}L\,s^{-1}}$

Answer: C

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2. For the reaction $X + Y \rightarrow Z$, it is found that doubling the concentration of X doubles the rate and doubling the concentration of Y again doubles the reaction rate. What is the overall order of the reaction?

A. 1

B. 2

C. $\frac{3}{2}$

D. 0

Answer: B

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3. A first order reaction is 50% completed in $1.26 \times 10^{14} s$. How much time would it take for 100% completion?

A. $1.26 \times 10^{15} s$

B. $2.52 \times 10^{14} s$

C. $2.52 \times 10^{28} s$

D. Infinite

Answer: D

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

A. area under the curve must not change with increase in temperature

B. area under the curve increases with increase in temperature

C. area under the curve decreases with increase in temperature

D. with increase in temperature curve broadens and shifts to the right hand side

Answer: A::B

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5. Which of the following statements for the order of a reaction is incorrect?

A. Order can be determined only experimentally.

B. Order is not influenced by stoichiometric coefficient of the reactants.

C. Order of the reaction is the sum of powers to the concentration terms of reactants to express the rate of reaction.

D. Order of the reaction is always a whole number.

Answer: D

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6. Which of the following statements is incorrect about the collision theory of chemical reaction?

A. It considers reacting molecules or atoms to be hard spheres and ignores their structural features.

B. Number of effective collisions determines the rate of reaction.

C. Collision of atoms or molecules possessing sufficient threshold energy results into the product formation.

D. Molecules should collide with sufficient threshold energy and proper orientation for the collision to be effective.

Answer: C

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7. The rate of a reaction doubles for energy $10^{\circ} C$ rise of temperature. If the temperature is raised by $50^{\circ} C$, the rate of reaction increases by about

A. 10 times

B. 24 times

C. 32 times

D. 64 times

Answer: C

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8. Mark the incorrect statements:

A. Catalyst provides an alternative pathway to reaction mechanism.

B. Catalyst raises the activation energy.

C. Catalyst lowers the activation energy.

D. Catalyst alters enthalpy change of the reaction.

Answer: C::D

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9. Half-life period of a first order reaction is

A. directly proportional to initial concentration a.

B. inversely proportional to a.

C. independent of a.

D. independent of rate constant of the reaction.

Answer: C

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10. The chemical reactions in which reactants high amount of activation energy are generally

A. slow

B. fast

C. instantaneous

D. spontaneous

Answer: A

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11. Which of the following expressions is correct for the rate of reaction given below?

$$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

A. $\frac{\Delta[Br^-]}{\Delta t} = 5\frac{\Delta[H^+]}{\Delta t}$

B. $\frac{\Delta[Br^-]}{\Delta t} = \frac{6}{5}\frac{\Delta[H^+]}{\Delta t}$

C. $\frac{\Delta[Br^-]}{\Delta t} = \frac{5}{6}\frac{\Delta[H^+]}{\Delta t}$

D. $\frac{\Delta[Br^-]}{\Delta t} = 6\frac{\Delta[H^+]}{\Delta t}$

Answer: C

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12. Which of the following statements is correct?

A. The rate of a reaction decreases with passage of time as the concentration of reactants decreases.

B. The rate of a reaction is 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 concentration of reactant(s).

Answer: A

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13. Rate law for the reaction $A + 2B \rightarrow C$ is found to be

Rate $= k[A][B]$

Concentration of reactant 'B' is doubled, keeping the concentration of 'A' constant, the value of rate constant will be _____.

A. the same

B. doubled

C. quadrupled

D. halved

Answer: B

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14. For a first order reaction with rate constant k and initial concentration a, the half-life period is given by

A. In $3/k$

B. $1/ka$

C. $0.693/k$

D. $3/2ka^2$

Answer: C

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15. A catalyst increases rate of reaction by

A. decreasing enthalpy.

B. decreasing internal energy.

C. decreasing activation energy.

D. increasing activation energy.

Answer: C

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16. A large increase in rate constant with a small rise in temperature for a gaseous reactions is indicative of

A. large number of collisions at higher temperature.

B. high value of activation energy of the reaction.

C. high value of exponential factor.

D. increase in average energy of the molecules.

Answer: C

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17. A catalyst is used

A. only for increasing the velocity of reaction.

B. for altering the velocity of reaction.

C. only for decreasing the velocity of reaction.

D. for getting greater yield of the product.

Answer: B

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18. The rate law expression for a hypothetic reaction:

$2A + 3B \rightarrow 2C$ is

$$\frac{dx}{dt} = k[A][B]^2$$

The order of the reaction is

A. 1

B. 2

C. 3

D. 5

Answer: C

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19. A reaction involves two reactants. The rate of reaction is directly proportional to the concentration of one of them and inversely proportional to the concentration of the other. The overall order of the reaction will be

A. one

B. two

C. zero

D. None of these

Answer: C

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Assertion Reason Questions

1. Assertion (A) : The extent to which a reaction will proceed can be determined from chemical equilibrium.

Reason (R) : The word kinetics is derived from the Greek word kinesis.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: B

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2. Assertion (A) : Precipitation of silver chloride by mixing of silver nitrate and sodium chloride solutions is an instantaneous reaction.

Reason (R) : Hydrolysis of starch to give glucose occurs with the very slow speed.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: C

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3. Assertion (A) : The representation of rate of reaction I n terms of concentration of the reactants is known as rate law:

Reason (R) : Order of the reaction: $CHCl_3 + Cl_2 \rightarrow CCl_4 + HCl$ is $\frac{3}{2}$.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: B

View Text Solution

4. Assertion (A) : Unit of rate constant for a zero order reaction is $\text{mol}^{-1}Ls^{-1}$.

Reason (R) : Trimolecular reactions involve simultaneous collision between three reacting species.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: D

View Text Solution

5. Assertion (A) : Hydrolysis of ethyl acetate in acidic medium is a first order reaction.

Reaction (R) : For a complex reaction, order is given by the slowest step.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: A

View Text Solution

6. Assertion (A) : Rate of reaction normally increases by a factor of 2 to 3 for every 10° rise in temperature.

Reason (R) : Increase of temperature increases the number of collisions .

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: A

View Text Solution

7. Assertion (A) : Catalyst increases the rate of reaction.

Reason (R) : Catalyst lowers the threshold energy of the reaction.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: A

View Text Solution

8. Assertion (A) : Arrhenius equation explains the temperature dependence of rate of a chemical reaction.

Reason (R) : Plot of log k versus $1/T$ are linear and energy of activation is obtained from such graphs.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: B

View Text Solution

9. Assertion (A) : Hydrolysis of ethyl acetate in the presence of acid is a first order reaction whereas in the presence of alkali, it is a second order reaction.

Reason (R) : Acid only acts as catalyst whereas alkali acts as one of the reactants.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: A

View Text Solution

10. Assertion (A) : In a reversible endothermic reaction, E_{act} of forward reaction is more than that of backward reaction.

Reason (R) : The threshold energy of the forward reaction is more than that of the backward reaction.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: C

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Fill In The Blanks

1. Zero order reaction means that the rate of reaction is proportional to _____ of the concentration of reactants.

View Text Solution

2. All natural and artificial radioactive decay of unstable nuclei take place by _____ kinetics.

View Text Solution

3. _____ is the study of chemical reactions with respect to reaction rates, effects of various variables, etc.

View Text Solution

4. Rate law has to be determined _____ and cannot be predicted.

View Text Solution

5. Order of a reaction is the power of its concentration which appears in the _____ equation.

View Text Solution

6. Steric factor, P, refers to the orientation of molecules which collide and contributes to _____ collision.

View Text Solution

7. Order of a reaction can be 0, 1, 2, 3, or even a _____ .

View Text Solution

8. The presence of _____ lowers the activation energy and provides an alternative path for the reaction.

View Text Solution

9. A number of factors such as temperature, concentration of reactants, _____, affect the rate of reaction.

View Text Solution

10. A, arrhenius factor or pre-exponential factor corresponds to the _____ frequency.

View Text Solution

Very Short Answer Questions

1. For the reaction $A \rightarrow B$. The rate of reaction becomes three times when the concentration of A is increased by nine times. What is the order of the reaction?

View Text Solution

2. For the reaction $R \rightarrow P$, half-life $\left(t_{1/2}\right)$ is observed to be independent of initial concentrtion of the reactants. What is the order of the reaction?

View Text Solution

3. What is the effect of adding a catalyst on activation energy $\left(E_a\right)$?

View Text Solution

4. What is the effect of adding a catalyst on Gibb's energy (ΔG) of a reaction?

View Text Solution

5. How do you define chemical kinetics?

View Text Solution

6. Define the term order of a reaction.

View Text Solution

7. Define 'activation energy' of a reaction.

View Text Solution

8. Identify the reaction order from the following rate constant:

$k = 2.3 \times 10^{-5} \ \ \mathrm{L\,mol^{-1}} s^{-1}$

View Text Solution

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

View Text Solution

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

View Text Solution

11. Why does the rate of a reaction not remain constant throughout the reaction process?

View Text Solution

12. How does the catalyst act according to intermediate complex theory?

View Text Solution

13. The reaction between $H_2(g)$ and $O_2(g)$ 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.

View Text Solution

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

View Text Solution

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

View Text Solution

16. Define collision frequency.

View Text Solution

17. What is meant by order of a reaction being zero?

View Text Solution

18. Define the term order of reaction for chemical reactions.

View Text Solution

19. Express the rate of the following reaction in terms of disappearance of hydrogen in the reaction:

$3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$.

View Text Solution

20. A reaction is 50% complete in 2 hours and 75% complete in 4 hours. What the order of the reaction?

View Text Solution

21. For the reaction $Cl_2(g) + 2NO(g) \rightarrow 2NOCl(g)$, the rate law is expressed as : rate $= k[Cl_2][NO]^2$. What is the overall order of this reaction?

View Text Solution

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

View Text Solution

23. Give two examples of pseudo molecular reactions.

View Text Solution

24. Define activation energy of a reaction.

View Text Solution

25. Express the relation between the half-life period of a reactant and its initial concentration for a reaction of nth order.

View Text Solution

26. Give the plot of $\log \frac{[R]_0}{[R]}$ vs time for a first order reaction.

View Text Solution

27. The rate of reaction $X \rightarrow Y$ becomes 8 times when the concentration of the reactant X is doubled. Write the rate law of the reaction.

View Text Solution

28. The reaction $A + B \rightarrow C$ has zero order. What is the rate equation ?

View Text Solution

29. What is meant by elementary step in a reaction?

View Text Solution

30. Rate constant of a first order reaction at 298 K is $15.5s^{-1}$. What is the approximate rate constant for this reaction at 308 K?

View Text Solution

31. How does the value of rate constant vary with reactant concentration?

View Text Solution

32. A substance with initial concentration a follows zero order kinetics with rate constant k mol $L^{-1}s^{-1}$. In how much time will the reaction go to completion?

View Text Solution

33. In the arrhenius equation, what does the factor $e^{-E_a/RT}$ correspond to ?

View Text Solution

34. For a chemical reaction to take place, what should be the value of ΔG ?

View Text Solution

35. The number of reacting species taking part in an elementary reaction which must collide simultaneously in order to bring about a chemical reaction is called?

View Text Solution

36. Name the scientist who gave the relationbetween rate of a chemical reaction and temperature.

View Text Solution

37. Name a substance that accelerates a reaction but does not undergo a change in itself.

View Text Solution

38. What does 'A' represent in Arrhenius equation giving the change of reaction velocity with change of temperature?

View Text Solution

39. How do you represent energy of activation?

View Text Solution

40. The rate of a reaction at a particular temperature is r and at another temperature is 2r. What could be approximate difference

between the two temperatures?

View Text Solution

41. What is the name given to number of collisions per second per unit volume of the reaction mixture?

View Text Solution

42. What kind of reactions are not catalysed by the catalyst?

View Text Solution

43. In the equation : Rate $= PZ_{AB}e^{-Ea/RT}$, what does P represent ?

View Text Solution

44. Name the substance which when added reduces the rate of reaction.

View Text Solution

45. A substance on hydrolysis in the presence of acid gives a mixture of glucose and fructose. Name the substance.

View Text Solution

46. Thermal decomposition of gaseous ammonia is a zero order reaction. What is the catalyst in this case?

View Text Solution

47. Ethyl acetate is hydrolysed with water to acetic acid and ethyl alcohol. Which component has the order 1?

View Text Solution

Short Answer Questions

1. For the reaction:

$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$,

the rate of formation of $NO_2(g)$ is $2.8 \times 10^{-3} Ms^{-1}$. Calculate the rate of disappearance of $N_2O_5(g)$.

View Text Solution

2. For the reaction : $2NH_3(g) \xrightarrow[\text{Rate}=k]{Pt} N_2(g) + 3H_2(g)$

(i) Write the order and molecularity of the reaction.

(ii) Write the unit of k.

View Text Solution

3. For a reaction : $H_2 + Cl_2 \xrightarrow[\text{Rate}=k]{h\nu} 2HCl$

(i) Write the order and molecularity of this reaction.

(ii) Write the unit of k.

View Text Solution

4. Show that in the first order reaction, time required for completion of 99.9% is 10 times that of half-life $\left(t_{1/2}\right)$ of the reaction.

View Text Solution

5. Derive integrated rate equation for rate constant for a first order reaction.

View Text Solution

6. Write two differences between order of a reaction and molecularity of a reaction.

View Text Solution

7. Define rate of a reaction. Write two factors that affect the rate of a reaction.

View Text Solution

8. A first order gas reaction $A_2B_2(g) \rightarrow 2A(g) + 2B(g)$ at the temperature $400^\circ C$ has the rate constant $k = 2.0 \times 10^{-4} s^{-1}$. What percentage of A_2B_2 is decomposed on heating for 900 seconds?

View Text Solution

9. Rate constant k for first order reaction has been found to be $2.54 \times 10^{-3} s^{-1}$. Calculate its three-fourth time.

View Text Solution

10. A reaction is of second order with respect to a reactant. How is its rate affected if the concentration of the reactant is (i) doubled (ii) reduced to half?

View Text Solution

11. The thermal decomposition of HCO_2H is a first order reaction with a rate constant of $2.4 \times 10^{-3} s^{-1}$ at a certain temmperature. Calculate how long will it take for three-fourths of initial quantity of HCO_2H to decompose. $[\log 0.25 = -0.6021]$

View Text Solution

12. What do you understand by the rate law and rate constant of a reaction? Identity the order of a reaction if the units of its rate constant are:

$(i) L^{-1}\text{mol s}^{-1}$ $(ii) \text{L mol}^{-1} s^{-1}$

View Text Solution

13. In a first order reaction, the concentration of the reactant is reduced from 0.6 mol L^{-1} to 0.2 mol L^{-1} in 5 minutes. Calculate the rate constant of the reaction.

View Text Solution

14. Identify giving reasons, the reaction order from each of the following rate constants:

$(i) k = 2.3 \times 10^{-5} \text{L mol}^{-1} s^{-1}$ $(ii) k = 3 \times 10^{-4} s^{-1}$

View Text Solution

15. A reaction is of first order in reactant A and of second order in reactant B. How is the rate of this reaction affected when (i) the concentration of B alone is increased to three times. (ii) the concentrations of A as well as B are doubled?

View Text Solution

16. For the reaction at 500 K

$$NO_2(g) + CO(g) \rightarrow CO_2(g) + NO(g)$$

The proposed mechanism is as follows:

(i) $NO_2 + NO_2 \rightarrow NO + NO_3$ (slow) (ii)

$NO_3 + CO \rightarrow CO_2 + NO_2$ (fast)

What is the rate law for the reaction?

View Text Solution

17. For a chemical reaction variation in concentration, In [R] vs time (min) plot is shown below:

(i) What is the order of the reaction?

(ii) What are units of rate rate constant, k for the reaction?

(iii) If initial concentration of the reactant is half of the original concentration how will $t_{1/2}$ change?

(iv) Draw the plot of $\log[R]_0 / [R]$ vs time (s).

View Text Solution

18. The rate constants of a reaction at 500K and 700K are $0.02s^{-1}$ and $0.07s^{-1}$, respectively. Calculate value of activation energy for the reaction. [Given $R = 8.314JK^{-1}MI^{-1}$].

View Text Solution

19. What is known as activation energy? How is activation energy affected by

(i) the use of a catalyst ? (ii) a rise in temperature ?

View Text Solution

20. Consider the reaction $A \xrightarrow{k} P$. The change in the concentration of A with time is shown in the following plot :

Predict the order of the reaction.

(ii) Derive the expression for the time required for the completion of the reaction.

View Text Solution

21. Consider the decomposition of hydrogen peroxide in alkaline medium which is catalysed by iodide ions.

$2H_2O_2 \xrightarrow{OH^-} 2H_2O + O_2$

The This reaction takes place in two steps as given below:

Step I $H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow)

Step II $H_2O_2 + IO^- \rightarrow H_2O + I^- + O_2$ (fast)

(a) Write the rate expression and determine the order of reaction wrt H_2O_2.

(b) What is the molecularity of each individual step?

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22. The rate of a reaction increases to four times when the prevailing temperature is raised from 300 K to 320 K. Calculate the energy of activation of this reaction assuming that it does not change with temperature. $\left[R = 8.314 \text{J mol}^{-1} K^{-1}\right]$

View Text Solution

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

View Text Solution

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

View Text Solution

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

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

View Text Solution

26. Calculate the rate of reaction from the following rate law:

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

when the concentrations of A and B are 0.01 M and 0.02 M respectively and $k = 5.1 \times 10^{-3} L^2 \text{mol}^{-2} s^{-1}$.

View Text Solution

27. For a general reaction $A \rightarrow B$, plot of concentration of A vs time is given in the figure below. Answer the following questions on the basis of 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 ?

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

View Text Solution

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

View Text Solution

30. Why does the rate of a reaction generally decrease during the course of reaction?

View Text Solution

31. Why can't the molecularity of a reaction be equal to zero?

View Text Solution

32. The rate of reaction $2NO + Cl_2 \rightarrow 2NOCl$ is doubled when concentration of Cl_2 is doubled and it becomes eight times when concentration of both NO and Cl_2 are doubled. Deduce the order of the reaction.

View Text Solution

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

View Text Solution

34. Thermodynamic feasibility of a reaction alone cannot decide the rate of the reaction. Explain with the help of an example.

View Text Solution

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

View Text Solution

36. The following experimental data were collected for the reaction:

$Cl_2(g) + 2NO(g) \rightarrow 2NOCl(g)$

Construct the rate equation for the reaction.

View Text Solution

37. The reaction $SO_2Cl_2 \rightarrow SO_2 + Cl_2$ is a first order reaction with half-life $3.15 \times 10^4 s$ at $320^\circ C$. What percentage of SO_2Cl_2 would be decomposed on heating at $320^\circ C$ for 90 minutes?

View Text Solution

38. The possible mechanism for the reaction

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ is

(i) $NO + O_2 \xrightarrow{k} NO_3$ (fast)

(ii) $NO_3 + NO \xrightarrow{k_2} NO_2 + NO_2(g)$ (slow)

Write the rate law and order for the reaction.

View Text Solution

39. What will be the initial rate of reaction if its rate constant is $10^{-3}s^{-1}$ and the concentration of the reactant is 0.2 mol L^{-1}? What fraction of the reactant will be converted into the products in 200 seconds ?

View Text Solution

40. Rate constant k for a reaction varies with temperature according to the equation

$$\log k = \text{constant} - \frac{E_a}{2.303R} \cdot \frac{1}{T}$$

where E_a is the energy of activation for the reaction. When a graph is plotted for log k vs $1/T$, a straight line with a slope of -6670 K is obtained. Calculate energy of activation for this reaction. State the units. $\left[R = 8.314 JK^{-1}\text{mol}^{-1}\right]$

View Text Solution

41. After 24 hrs, only 0.125 g out of the initial quantity of 1 g of a radioactive isotope remains behind. What is its half-life period?

View Text Solution

Long Answer Questions I

1. A first order reaction is 50% completed in 40 minutes at 300 K and in 20 minutes at 320 K. Calculate the activation energy of the reaction.

[Given : $\log 2 = 0.3010, \log 4 = 0.6021, R = 8.314 JK^{-1}\text{mol}^{-1}$]

View Text Solution

2. A first order reaction takes 40 minutes for $30\,\%$ decomposition. Calculate $t_{1/2}$.

View Text Solution

3. Following data are obtained for the reaction :

$$N_2O_5 \rightarrow 2NO_2 + \frac{1}{2}O_2$$

(a) Show that it follows first order reaction.

(b) Calculate the half-life [Given : log2 = 0.3010, log 4 = 0.6021]

View Text Solution

4. A first order reaction takes 20 minutes for 25% decomposition. Calculate the time when 75% of the reaction will be completed. [Given : log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021]

View Text Solution

5. The rate constant for the first order decomposition of H_2O_2 is given by the following equation :

$$\log k = 14.2 - \frac{1.0 \times 10^4}{T}$$

Calculate E_a for this reaction and rate constant k if its half-life period be 200 minutes.

[Given : $R = 8.314 JK^{-1}\text{mol}^{-1}$]

View Text Solution

6. For the first order thermal decomposition reaction, the following data were obtained:

$$C_2H_5Cl(g) \rightarrow C_2H_4(g) + HCl(g)$$

Time/second	$\text{Total pressure/atm}$
0	0.30
300	0.50

Calculate the rate constant. [Given : log 2 = 0.301, log 3 = 0.4771, log 4 = 0.6021]

View Text Solution

7. The rate constant of a first order reaction increases from 2×10^{-2} to 8×10^{-2} when the temperature changes from 300 K to 320 K. Calculate the energy of activation.

View Text Solution

8. Half-life of a first order reaction is 5×10^4s. What percentage of the initial reactant will react in 2 hours? Calculate.

View Text Solution

9. For a chemical reaction, variation in rate with concentration is shown in figure:

(i) What is the order of the reaction?

(ii) What are the units of rate constant k for the reaction?

View Text Solution

10. Nitrogen pentoxide decomposes according to equation:

$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

This first order reaction was allowed to proceed at $40^\circ C$ and the data below were collected:

(i) Calculate the rate constant. Include units with your answer.

(ii) What will be the concentration of N_2O_5 after 100 minutes?

(iii) Calculate the initial rate of reaction?

View Text Solution

11. The rate of a reaction becomes four times when the temperature changes from 293 K to 313 K. Calculate the energy of activation (E_a) of the reaction assuming that it does not change with temperature.

$$\left[R = 8.314 JK^{-1}\text{mol}^{-1}, \log 4 = 0.6021\right]$$

View Text Solution

12. For a certain chemical reaction, variation in concentration In [R] vs time [s] plot is given in figure:

(i) What is the order of the reaction?

(ii) Give the relationship between k and $t_{1/2}$ (half-life period).

(iii) Draw the plot of log $[R]_0 / [R]$ vs time t(s).

View Text Solution

13. Half-life of a first order reaction is 5×10^4s. What percentage of the initial reactant will react in 2 hours? Calculate.

View Text Solution

14. For a decomposition reaction, the values of rate constant k at two different temmperature are given below:

$k_1 = 2.15 \times 10^{-8} \mathrm{L\ mol^{-1} s^{-1}}$ at 650 K

$k_2 = 2.39 \times 10^{-7} \mathrm{L\ mol^{-1} s^{-1}}$ at 700 K

Calculate the value of activation energy for this reaction. $\left[R = 8.314 JK^{-1} \mathrm{mol}^{-1}\right]$

View Text Solution

15. The decomposition of $N_2O_5(g)$ is a first order reaction with a rate constant of $5 \times 10^{-4} s^{-1}$ at $45^\circ C$. i.e., $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$. If initial concentration of N_2O_5 is 0.25M, calculate its concentration after 2 min. Also calculate half-life for decomposition of N_2O_5 (g).

View Text Solution

16. For an elementary reaction

$2A + B \rightarrow 3C$

the rate of appearance of C at time 't' is $1.3 \times 10^{-4} \text{mol L}^{-1} s^{-1}$.

Calculate at this time

(i) rate of the reaction.

(ii) rate of disappearance of A.

View Text Solution

17. For an elementary reaction

$2A + B \rightarrow 3C$

the rate of disappearance of C at time t is $1.3 \times 10^{-4} \text{mol L}^{-1} s^{-1}$.

Calculate at this time

(i) rate of the reaction.

(ii) rate of disappearance of A.

View Text Solution

18. The decomposition of $N_2O_5(g)$ is a first order reaction with a rate constant of $5 \times 10^{-4} s^{-1}$ at $45^\circ C$. i.e.,

$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$.

If initial concentration of N_2O_5 is 0.25M, calculate its concentration after 2 minutes. Also calculate the half-life for decomposition of $N_2O_5(g)$.

View Text Solution

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

View Text Solution

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

View Text Solution

21. The decomposition of NH_3 on platinum surface is zero order reaction. What would be the rates of production of N_2 and H_2 if $k = 2.5 \times 10^{-4} \text{mol L}^{-1} s^{-1}$?

View Text Solution

22. Answer the following questions on the basis of the given curve for a first order reaction $A \rightarrow P$:

(a) What is the relation between slope of this line and rate constant?

(b) Calculate the rate constant of the above reaction if the slope is $2 \times 10^{-4} s^{-1}$.

(c) Derive the relationship between half-life of a first order reaction and its rate constant.

View Text Solution

23. The half life for radioactive ^{14}C is 5730 years. An archeological artefact containing wood had only 80% of ^{14}C activity as found in a living tree. Calculate the age of the artefact.

View Text Solution

24. The activation energy of a reaction is 75.24 kJ mol^{-1} in the absence of a catalyst and $50.14\mathrm{kJ\ mol}^{-1}$ with a catalyst. How many times will the rate of reaction grow in the presence of a catalyst if the reaction proceeds at $25^{\circ}C$?

View Text Solution

25. The rate constant for a first order reaction is 60 s^{-1}. How much time will it take to reduce 1 g of the reactant to 0.0625 g?

View Text Solution

26. Observe the graph in the diagram and answer the f ollowing questions:

(i) If slope is equal to $-2.0 \times 10^{-6} s^{-1}$, what will be the value of rate constant?

(ii) How does the half-life of zero order reaction relate to its rate

constant?

View Text Solution

Long Answer Questions Ii

1. The following data were obtained for the reaction:

$2NO + O_2 \rightarrow 2NO_2$

(a) Find the order of reaction with respect to NO and O_2.

(b) Write the rate law and overall order of reaction.

(c) Calculate the rate constant (k).

View Text Solution

2. For the hydrolysis of methyl acetate in aqueous solution, the following results were obtained:

(i) Show that it follows pseudo first order reaction, as the concentration of water remains constant.

(ii) Calculate the average rate of reaction between the time interval 30 to 60 seconds.

[Given log 2 = 0.3010, log 4 = 0.6021]

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3. Define the following terms:

(i) Activation energy (ii) Rate constant

View Text Solution

4. A first order reaction takes 10 minutes for $25\,\%$ decomposition. Calculate $t_{1/2}$ for the reaction.

[Given : log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021]

View Text Solution

View Text Solution

5. For a first order reaction, show that time required for $99\,\%$ completion is twice the time required for the completion of $90\,\%$ of reaction.

View Text Solution

6. Rate constant 'k' of a reaction varies with temperature 'T' according to the equation:

$$\log k = \log A - \frac{E_a}{2.303R}\left(\frac{1}{T}\right)$$

where E_a is the activation energy. When a graph is plotted for log k vs $\frac{1}{T}$, a straight line with a slope of -4250 K is obtained. Calculate $'E_a'$ for the reaction. $\left[R = 8.314 JK^{-1}\text{mol}^{-1}\right]$

View Text Solution

7. For the reaction:

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$$

write:

(i) rate of reaction expression.

(ii) rate law equation.

(iii) molecularity.

(iv) order of reaction.

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8. The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at a constant volume.

$$SO_2Cl_2(g) \rightarrow SO_2(g) + Cl_2(g)$$

Calculate the rate of reaction when total pressure is 0.65 atm.

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9. Explain the following terms:

(i) Rate of a reaction (ii) Activation energy of a reaction

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10. The decomposition of phosphine, PH_3, proceeds according to the following equation:

$4PH_3(g) \rightarrow P_4(g) + 6H_2(g)$

It is found that the reaction follows the following rate equation:

Rate $= k[PH_3]$.

The half-life of PH_3 is 37.9s at $120^\circ C$.

(i) How much time is required for $3/4th$ of PH_3 to decompose?

(ii) What fraction of the original sample of PH_3 remains behind after 1 minute?

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11. For a certain chemical reaction

$A + 2B \rightarrow 2C + D$

The experimentally obtained information is tabulated below:

For this reaction

(i) derive the order of the reaction of the reaction w.r.t. both the reactants A and B.

(ii) write the rate law.

(iii) calculate the value of rate constant k.

(iv) write the expression for the rate of reaction in terms of A and C.

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12. (a) Illustrate graphically the effect of catalyst on activation energy.

(b) Catalysts have no effect on the equilibrium constant. Why?

(c) The decomposition of A into product has value of k as

$4.5 \times 10^3 s^{-1}$ at $10^\circ C$ and activation energy is 60 kJ mol^{-1}. Calculate the temperature at which the value of kW(J) be $1.5 \times 10^4 s^{-1}$.

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13. (a) A first reaction is 75% completed in 40 minutes. Calculate its $t_{1/2}$.

(b) Predict the order of the reaction in the given plots:

where $[R]_0$ is the initial concentration of reactant. [Given : log 2 = 0.3010, log 4 = 0.6021]

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Self Assessment Test Section A Multiple Choice Questions

1. Units of rate constant for a second order reaction is

A. $\text{mol L}^{-1}s^{-1}$

B. $\text{mol}^{-1}Ls^{-1}$

C. $\text{mol}^{-1}L^{-1}s^{-1}$

D. $\text{mol}^{-1}L^{-2}s^{-1}$

Answer: B

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2. The rate constant of a first order reaction is given by

A. $k = \frac{2.303}{t/2}\log\frac{[R]_0}{[R]}$

B. $k = \frac{2.303}{t/2}\log\frac{[R]}{[R]_0}$

C. $k = \frac{2.303}{t}\log\frac{[R]_0}{[R]}$

D. $k = \frac{2.303}{t}\log\frac{[R]}{[R]_0}$

Answer: C

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3. For a reaction $t_{1/2} = [R]_0 2k$, reaction is of the

A. first order.

B. second order.

C. third order.

D. zero order.

Answer: D

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4. The reaction $CH_3COOC_2H_5 + H_2O + H_2O \xrightarrow{H^+} CH_3COOH + C_2H_5OH$ is of

A. first order.

B. pseudo first order.

C. zero order.

D. second order.

Answer: B

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5. The relation between rate constant and temperature of a reaction was given by

A. Arrhenius

B. Charles

C. Boyle

D. Avogadro

Answer: A

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6. Assertion (A) : Reactions taking place in one step are called elementary reactions.

Reason (R) : When a sequence of elementary reactions gives us the products, the reactions are called complex reactions.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: B

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7. Assertion (A) : For a reaction, with rise in temperature by $10^{\circ} C$, the rate constant is nearly doubled.

Reason (R) : A catalyst changes the equilibrium point of the reaction.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: C

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Self Assessment Test Section C

1. A first order reaction is 50% completed in 40 minutes at 300 K and in 20 minutes at 320 K. Calculate the activation energy of the reaction.

[Given : $\log 2 = 0.3010, \log 4 = 0.6021, R = 8.314 JK^{-1}\text{mol}^{-1}$]

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Self Assessment Test Section D

1. (a) Explain the following terms:

(i) Rate of a reaction. (ii) Activation energy of a reaction.

(b)The decomposition of phosphine, PH_3 proceeds according to the following equation:

Rate $= k[PH_3]$

The half-life of PH_3 is 37.9 s at $120^\circ C$.

(i) How much time is required for $3/4th$ of PH_3 to decompose?

(ii) What fraction of the original sample of PH_3 remains behind after 1 minute?

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