CHEMISTRY

BOOKS - R SHARMA CHEMISTRY (HINGLISH)

CHEMICAL KINETICS

Example

1. Relating the different ways of expressing reaction rates: Ethanol (CH_3CH_2OH), the avtive ingredient in alcoholic beverges and an octane booster in gasoline, is yielded by fermentation of glucose. The balance chemical equation is $C_6H_{12}O_6(aq.) \xrightarrow{\text{zymase}} 2CH_3CH_2OH(aq.)+2CO_2(g)$ How is the rate of formation of ethanol related to the rate of consumption of glucose ?

Strategy : The rate of disappearance of a reactant X is $-\Delta[X]/\Delta t$

while the rate of appearance of a product Y is $\Delta[Y]/\Delta t$. We can express the rate of the reaction in terms of either rate expressoin. To find the relative rates, look at the coefficients in the balanced chemical equation. These rate expressions can be equated , if we first divide each by the coefficient of the corresponding substance in the chemical equation.

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2. Calculating the average reaction rate : Calculate the average rate of decomposition of N_2O_5 by the reaction

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

during the time interval from $t = 600s$ $t = 1200s$, using the following data:

Time , $[N_2O_5]$

$600s$, $1.24 \times 10^{-2}M$

$1200s$, $0.93 \times 10^{-2}M$

Strategy : Calculater a Δ quantity in concentration, $[N_2O_5]$, by taking the final value minus the value. Then, divide it by the time interval, Δt.

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3. Average rate of reaction : From the concentrations of R at different times given below, calculate the average rate of the reaction :

$R \to P$

During different intervals of time

t/s	0	5	10	20	30
$10^3 \times [R]/molL^{-1}$	160	80	40	10	2.5

Strategy : Determine the difference in concentration, $\Delta[R]$ over different intervals of time. Divide $\Delta[R]$ by Δt to determine the average reaction rate.

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4. Reaction rate : At some time, we observe that the reaction

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

is forming NO_2 at the rate of $0.0072 mol L^{-1} s^{-1}$.

(i) What is the rate of reaction at this time ?

(ii) What is the rate of formation of O_2 at this time ?

(iii) What is the rate of consumption of N_2O_5 at this time ?

Strategy : For expressing the rate of such reaction where stoichiometric coefficents of reactants or products are not equal to one, rate of any of the products is divided by their respective stoichiometric coefficients. Use the mole ratios from the balanced equation to determine the rates of change of other products and reactants.

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5. The decompoistion of N_2O_5 in CCI_4 solution at $318K$ has been studied by monitoring the concentration of N_2O_5 in the solution.

Initially, the concentration of N_2O is $2.33M$ and after $184 \min$, it is reduced to $2.08M$. The reaction takes place according to the equation:

$2N_2O_5 \rightarrow 4NO_2 + O_2$

Calculate the average rate of this reaction in terms of hours, minutes, and seconds. What is the rate of Production of NO_2 during this period?

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6. For the reaction :

$2A + B \rightarrow A_2B$

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

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7. Determining the order of reaction from the rate law: Bromide ion is oxidized by bromate ion in acidic solution.

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

The expermentally determined rate law is

$$\text{Rate} = k[Br^-][BrO_3^-][H^+]^2$$

What is the order of reaction with respect to each of the reactants and what is teh overall reaction order ?

Strategy : To find the reaction order with respect to each reactant, look at the exponents in the rate law, not the coefficients in the balanced chemical equation, and then sum the exponents to obtain the overall reaction order.

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8. Interpration of the rate law: For a hydrothertical reaction

$X + Y + Zrazrr$ products

the rate law is determined to be

$\text{Rate} = k[X][Y]^2$

What happens to the reaction rate when we make each of the following concentration changes ?

(a) We dobule the concentration of X without changing the concentration of Y or Z.

(b) We double the concentration of Y without changing the concentration of X or Z.

(c) We double the concentrations of Z without changing the concentration of X or Y.

(d) We double all three concentrations simultaneously.

Strategy: Interpret the law to predict the changes in reaction rate. Remember that changing concentrations does not change the value of k.

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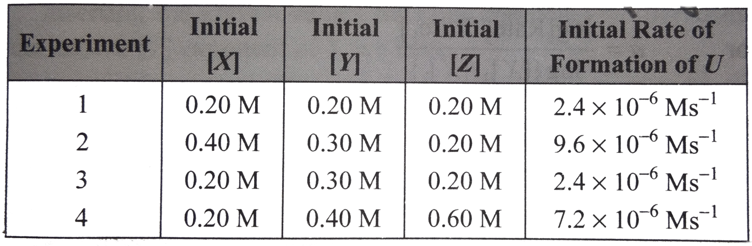
9. Method of intial rates: Given the following data, determine the rate law expression and the value of the rate constant for the reaction.

$2X + Y + Z \rightarrow U + V$



Experiment	Initial $[X]$	Initial $[Y]$	Initial $[Z]$	Initial Rate of Formation of U
1	0.20 M	0.20 M	0.20 M	2.4×10^{-6} $\mathrm{Ms^{-1}}$
2	0.40 M	0.30 M	0.20 M	9.6×10^{-6} $\mathrm{Ms^{-1}}$
3	0.20 M	0.30 M	0.20 M	2.4×10^{-6} $\mathrm{Ms^{-1}}$
4	0.20 M	0.40 M	0.60 M	7.2×10^{-6} $\mathrm{Ms^{-1}}$

Strategy: The rate law is of the from

$$\text{Rate} = k[X]^a[Y]^b[Z]^c$$

We must evaluate a,b,c, and k by using the reasoning outlined earlier. Thus, to determine order with respect to X, we must select those experiments in which concentration of X changes but the concentrations of Y and Z are kept onstant and so on. Note that the coefficient of U in the balenced equation is 1, so the rate of reaction is equal to the rate of formation of U.

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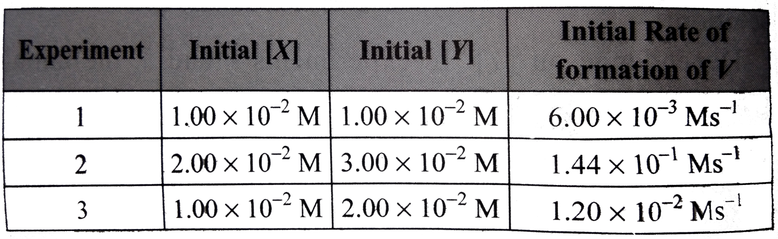
10. Intitial rate method: Use the following initial rate data determine the form of the rate law expressoin for the reaction

$3X + 2Y \rightarrow 2U + V$



Experiment	Initial [X]	Initial [Y]	Initial Rate of formation of V
1	1.00×10^{-2} M	1.00×10^{-2} M	6.00×10^{-3} Ms^{-1}
2	2.00×10^{-2} M	3.00×10^{-2} M	1.44×10^{-1} Ms^{-1}
3	1.00×10^{-2} M	2.00×10^{-2} M	1.20×10^{-2} Ms^{-1}

Strategy: The rate law is of the form

$$Rate = k[X]^a[Y]^b$$

No two experiments have the same in initial [Y], thus, use the alternative method discussed earlier to evalaute a and b.

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11. Writing the overall chemical equation from a mechanism: Carbon tetrachloride, CCI_4, is obtained by chlorinating methane or an incompletely chlorinated methane such as chloroform, $CHCI_3$. The mechanism for the gas phase chlorination of $CHCI_3$ is

$CI_2 \Leftrightarrow 2\dot{C}I$, Elementary reaction

$\dot{C}I + CHCI_3 \rightarrow HCI + \dot{C}CI_3$, Elementary reaction

$\dot{C}I + \dot{C}CI_3 \rightarrow CCI_4$, Elementary reaction

Obtain the net, or overall, chemical equation from this mechanism

Straregy : The overall chemical equation, which represents the net result of the elementary reaction in the mechanism, is obtined by adding the steps together and cancelling species that occur on borth sides.

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12. Determining the overall reaction and the molecularity of an elementary reaction : The following two - step mechanism hqas proposed for the gas-phase decomposition of nitrous oxide (N_2O) :

Step 1: $N_2O(g) \rightarrow N_2(g) + O(g)$

Step 2: $N_2O(g) + O(g) \rightarrow N_2(g) + O_2(g)$

(i) Write the chemical equation for the overall reaction

(ii) Identify any reaction intermediates

(iii) What is the molecularity of each of the elementary reactions ?

(iv) What is the molecularity of the overvall reaction

Strategy : The step-by -step pathway by which a reaction occurs is called its mechanism. Some reactions takes place in a single step, but most reactions occur in a series of elementary steps. To identify intermediates and molecularity, look at the indicidual steps

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13. Determining the rate law from a mechanism with an initial slow step: Ozone reacts with nitrogen dioxide to produce oxygen and dinitrogen pentoxide

$$O_3(g) + 2NO_2(g) \rightarrow O_2(g) + N_2O_5(g)$$

The proposed mechanism is

$$O_3(g) + NO_2(g) \xrightarrow{slow} NO_3(g) + O_2(g)$$

$$NO_3(g) + NO_2(g) \xrightarrow{\text{fast}} N_2O_5(g)$$

What is the rate law predicted by this mechanism ?

Strategy : The designations "slow" and "fast" indicate the relative rates of the steps. The rate is determined completely by the slow step, or rate-determining sterp.

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14. Prediction of reaction mechanism: The following reaction has a second - order rate law : $H_2(g) + 2ICI(g) \rightarrow I_2(g) + 2HCI(g)$

$Rate = k[H_2][ICI]$

Devise a possible reaction mechanism

Strategy: The reaction doesn't occur in a single elementary step because, if did, the rate law would be third order: Rate $= k[H_2][ICI]^2$. The observed rate law would be obtained if the rate determining step involves the bimolecular reaction of H_2 and ICI.

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15. Determining the law from a mechanism with an initial fast, equilibrium step: The oxidation of iodide ion by hydrochlorite ion : $CIO^-(aq.) + I^-(aq.) \rightarrow CI^-(aq.) + IO^-(aq.)$ has been postulated to occur by the two step mechanism :

1. $CIO^{-}(aq.)+H_2O(l)\Leftrightarrow HCIO(aq.)+OH^{-}(aq.)$ fast, equilibrium

2. $I^{-}(aq.)+HCI(aq.)\xrightarrow{k_2}(HIO(aq.)+CI^{-}(aq.)$ slow

What rate law is predicted by this mechanism ?

Strategy : Write the rate equation for the rate determining (slow) step. However, in this case the equation contains a species that does not appear in the overall eqwuation for the reaction. We need to eliminate it from the final from of the rate law. For this purpose we use the fast and equilibrium step.

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16. Using the concentration time equation for a first order reaction : The decomposition of N_2O_5 to NO_2 and O_2 is first order, with a rate constant of $4.80\times10^{-4}/sa$45$^{\circ}C$

$$N_2O_5(g)\to 2NO_2(g)+\frac{1}{2}O_2(g)$$

(a) If the initial concentration of $N_2O_5 is 1.65\times10^{-2}mol/L$, what is its concentration after 825 s ?

(b) How long would it take for the concentration of N_2O_5 to decrease to $100 \times 10^{-2} mol L^{-1}$ from its initiqal value, given in (a) ?

Strategy : Since this reaction has a first order rate law, $d[N_2O_5]/dt = k[N_2O_5]$, we can use the corresaponding concentration time equation for a first order reaction :

$$k = \frac{2.303}{t} \frac{\log([N_2O_5]_0)}{[N_2O_5]_t}$$

In each part, we substitute the know quantities into this equation and solve for the unkbnown.

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17. The initial concentration of N_2O_5 in the following first order reaction:

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

was $1.24 \times 10^{-2} mol L^{-1}$ at $318K$. The concentration of N_2O_5 after $60 \min$ was $0.20 \times 10^{-2} mol L^{-1}$. Calculate the rate constant of the reaction at $318K$.

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18. Calculating fraction : The rate constant of a first order reaction is $0.0231 \min^{-1}$. What fraction of the reactant remains after 70 minuts ?

Strategy : If 'f' is the reaction of the reactant reacting after 70 minutes, then the fraction of the reactant remaining after 70 minutes will be 1 - f.

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19. Calculating time requireed to complete a definite fraction of first order reaction : A first order reaction is 20% complete in 10 minutes. Calculate the time taken for the reaction to go to 75% completion.

Stratagy : First calculate the rate constant (k) using frist data and then calculate the required time to complete 75% of the reaction by using the value of rate constant :

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20. The following data were obtained during the first thermal decompoistion of $N_2O_5(g)$ at constant volume.

$$2N_2O_5(g) \rightarrow 2N_2O_4(g) + O_2(g)$$

S.No.	Time (s)	Total pressure (atm)
$i.$	0	0.5
$ii.$	100	0.512

Calculate the rate constant.

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21. 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 a living tree. Estimat the age of the sample.

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22. Findingf concentration and time : The rate constant for the decomposition of gasous $N_2O_5at55^\circ Cis1.7\times10^{-3}s^{-1}$. If the initial concentration of N_2O_5 after five half-lives ? How long will it take for the N_2O_5 concentration to fall to 12.5% of its initial values ?

Strategy : Because the unit of rate constant is $time^{-1}$, the decomposition of N_2O_5 is a first order reaqction. To find $[N_2O_5]$ after n half lives, multiply its initial concentration by $(1/2)^n$ since $[N_2O_5]$ drops by a factor of 2 during each successive haslf-life.

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23. The hydrolyiss of methyl acetate in aqueous solution is has been studied by titrating the liberated acetic acid against $NaOH$. The concentration of ester at different times is given below:

t (min)	0	30	60	90
$C(MolL^{-1})$	0.8500	0.8004	0.7538	0.7096

Show that it follows a pseudo first order reaction, as the concentration of water remains nearly constant $(55 mol L^{-1})$ during the course of the reaction . What is the value of k' in the equation ?

Rate $= k'[CH_3COOCH_3][H_2O]$

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24. Pseudo approach : At $25^{\circ}C$ and at a constant pH of 5, the hydrolysis of reactant, A, proceeds with a constant half-life of 500 min. At this temperature, but at a pH of 4, the half life ios constant at 50 min. Find the rate law.

Strategy : $C_{H^{+}}=10^{-pH}mol/L,$ since half life $(t_{1/2}\propto 1/ratecons\tan t)$ changes with change of pH, it impiles that reaction rate also depends upon $[H^{+}]$. Thus, the rate law should of the following type

$Rate=K[A]^{x}[H^{+}]^{y}$

To find this rate law, we need to determine two unknowns : x and y. We can simplify the situation by pseudo approach which allows us to find x and y stepwise.

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25. Using the Arrhenius equation : The rate constant fot the formation of hydrogen iodide from the elemewnts

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

is $2.7 \times 10^{-4} L/(mol. s)at600k$ and $3.5 \times 10^{-3} L/(mol. s)at650k$.

(a) Find the activation energy E_a . (b) Calculate the rate constant at 700 k .

Strategy : (a) Substitute the data given in the problem statement into the Equation (4.37) noted just before this example, then solve for E_a . , (b) Use the same equation, but substitute for k_1, T_1, T_2 and E_a obtained in (a) and solve for k_2 .

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Follow Up 1

1. Chemical thermodynamics does not answer about the

A. feasibility of a reaction

B. extent of a reaction

C. speed of a reaction

D. Both '1' and '2'

Answer: C

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2. The branch of science called chemical kinetics does not deal with the

A. rate of reaction

B. factors that influence rate of a reaction

C. reaction mechanism

D. extent of reaction

Answer: D

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3. when ammonia is treated with O_2 at elevated temperature the rate of disappearance of ammonia is found to be 3.5×10^{-2} mol $L^{-1} \sec(-1)$ during a measured time interval. The rate of appearance of water will be

A. $3.5 \times 10^{-2} molL^{-1} \sec^{-1}$

B. $5.3 \times 10^{-2} molL^{-1} s^{-1}$

C. $2.1 \times 10^{1} molL^{-1} \sec^{-1}$

D. $1.4 \times 10^{-1} molL^{-1} s^{-1}$

Answer: B

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4. To know the numerical value of a rate expression, we muyst know the concentration or the pressure of a substance at two different times during the course of a reaction. This information can be obtained experimentally, if we have a method of

A. measuring time

B. concentration or pressure

C. keeping the conditions, especially the temperature constant

D. all of these

Answer: D

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5. At high temperatures, N_2O decompose to N_2 and O_2. If the change in totqal pressure with time is measured, the following data are obtained from an initial pressure of N_2O of 0.29 atm at $970K$

$P_T(atm)$	0.29	0.33	0.36	0.39	0.41
$t(\sec)$	0	300	900	2000	4000

The rate of disapperance of N_2O for the first 300 sec will be

A. $2.7 \times 10^{-4} atm \sec^{-1}$

B. $1.4 \times 10^{-4} atm \sec^{-1}$

C. $2.0 \times 10^{-5} atm \sec^{-1}$

D. $1.0 \times 10^{-5} atm \sec^{-1}$

Answer: A

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6. In reference to Q.5, the rate of appearance of O_2 for the last 2000 sec is

A. $2.0 \times 10^{-5} atms^{-1}$

B. $3.0 \times 10^{-5} atm \sec^{-1}$

C. $4.0 \times 10^{-5} atms^{-1}$

D. $1.0 \times 10^{-5} atm \sec^{-1}$

Answer: D

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7. Which of the following is not a correct statement ?

A. Most chemical reactions become slower as they proceed

B. The rate during a measured time interval is called the average rate

C. The rate at any one istant during the interval is called instantanteous rate

D. The average rateand the instantantaneous rate are never equal

Answer: D

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8. Conisder the chemical reaction

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

The rate of this reaction can be expressed in terms of time derivatives of the concentration of $N_2(g)$, $H_2(g)$, or $NH_3(g)$. Identify the correct relationship among the rate expresisons.

A. $Rate = \frac{d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = \frac{1}{2}\frac{d[NH_3]}{dt}$

B. $Rate = -\frac{d[N_2]}{dt} = -3\frac{d[H_2]}{dt} = 2\frac{d[NH_3]}{dt}$

C. $Rate = \frac{d[N_2]}{dt} = \frac{1}{3}\frac{d[H_2]}{dt} = -\frac{1}{2}\frac{d[NH_3]}{dt}$

D. $Rate = -\frac{d[N_2]}{dt} = -\frac{d[H_2]}{dt} = \frac{d[NH_3]}{dt}$

Answer: A

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Follow Up 2

1. Which of the following is not a correct statement ?

A. Reactions where the reactants are not uniformly dispersed are known as heterogeneous reaction

B. Two reactants will react faster when the same reaction is allowed to proceed in a homogeneous manner

C. The rate of a heterogeneous reattion can be increased by agitatining the reaction mixture.

D. None of these

Answer: D

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2. Which of the following illustrates the influence of surface area of a solid reactant on reaction rate ?

A. Powered sugar dissolves faster than crystallune sugar

B. Finely powdered potassium permanganate reacts violently with glycerol than crystalline potassium permanganate

C. Explosion occurs when an inflammable substance is finely dispersed in a room

D. All of these

Answer: D

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3. Which of the following is a very fast reaction ?

A. $Fe(s) \xrightarrow{O_2 / H_2O} Fe_2O_3 . XH_2O$

B. $Na_2SO_4(aq.) + BaCI_2(aq.) \rightarrow BaSP_4(S) + 2NaCI(aq.)$

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

D. $NH_4NO_2 \xrightarrow{\Delta} 2H_2O + N_2$

Answer: B

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4. Rate law is an expression relating the rate of a reaction to the

A. temperature of the reaction

B. rate constant of the reactants

C. the concentration of the reactants

D. both (2) and (3)

Answer: D

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5. The specific reaction rate (or rate constant) of a reaction depends upon

(i) temperature of reaction

(ii) concentration of reactants and products

(iii) activation energy of reaction

(iv) presence of absence of a catalyst

A. (i), (iii), (iv)

B. (i), (ii), (iii), (iv)

C. (i), (iii)

D. (i), (ii)

Answer: A

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6. The units of rate constant and rate of a reaction are idential for:

A. third - order reaction

B. second - order rection

C. first - order reaction

D. zero - order reaction

Answer: D

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7. Which of the following is not a correct statement ?

A. Rate law can be deduced from the stoichiomatry of the reaction

B. The order of a reqaction with respect to a reactant is the power (exponent) of the concentration of the reactant to which the rate of the reaction is directly proportional.

C. The overall order of the reaction is the sum of the power (exponents) of the concentration of all the reactants in the rate law expression

D. The overall order of the reaction may be zero or even a faction, say, 0.5.

Answer: A

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8. The rate constant is unmerically the same for three reactions of first, second and third order respectively, the unit of concentration being in moles per litre. If $R_1, R_2 \text{ and } R_3$ are the rates of three reactions of first, second and third order respectively aqnd K is the rate constant, which of the following relationships is valid for the three reactions.

A. $R_1 = R_2 = R_3$

B. $R_1 < T_2 < R_3$

C. $R_3 < R_2 < R_1$

D. All of these

Answer: D

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9. $2N_2O_5 \rightarrow 4NO_2 + O_2$

If $\frac{-d[N_2O_5]}{dt} = k_1[N_2O_5]$

$\frac{d[NO_2]}{dt} = k_2[N_2O_5]$

$\frac{d[O_2]}{dt} = k_3[N_2O_5]$

What is the relation between k_1, k_2, and k_3?

A. $k_1 = k_2 = k_3$

B. $k_1 = 2k_2 = 4k_3$

C. $2k_1 = k_2 = 4k_3$

D. $4k_1 = k_2 = 2k_3$

Answer: C

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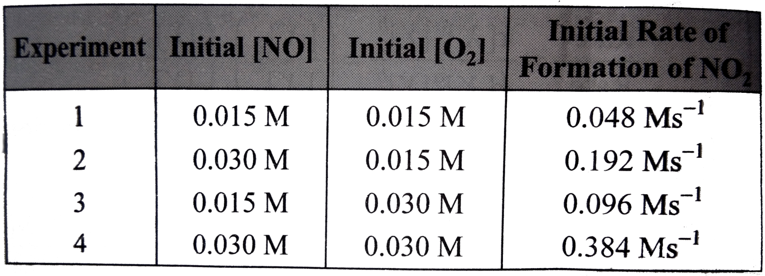
10. The air oxidation of nitric oxide is one of the reactions that contributes to the formation of acid rain:

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

Some initial rate data are collected



Experiment	Initial [NO]	Initial [O_2]	Initial Rate of Formation of NO_2
1	0.015 M	0.015 M	0.048 Ms^{-1}
2	0.030 M	0.015 M	0.192 Ms^{-1}
3	0.015 M	0.030 M	0.096 Ms^{-1}
4	0.030 M	0.030 M	0.384 Ms^{-1}

Two overall order of the reaction is

A. two

B. three

C. one

D. zero

Answer: B

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Follow Up 3

1. The number of molecules that react with each in an elementary step gives a measure of the

A. order of the reaction

B. molecularity of the reaction

C. stoichiometry of the reaction

D. activation energy of the reaction

Answer: B

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2. Which of the following elementary reactions is unimolecular ?

A. $A \rightarrow$ Products

B. $2A \rightarrow$ Products

C. $A+B+C \rightarrow$ Products

D. $A+B \rightarrow$ Products

Answer: A

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3. Trimolecular reactions are uncommon because

A. the probability of many molecules colliding at an instant is high.

B. the probability of three molecules colliding at an instant is low.

C. the probability of three molecules colliding at an instant is almost zero.

D. the probability of three molecules colliding at an instant is high.

Answer: C

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4. Which of the following os true for an elementary reaction ?

A. Equilibrium constant is not related to the forward and backward reactions

B. The trimolecular reactions are very common

C. The orders in the rate law are not determined by the reaction stoichiometry.

D. The orders in the rate law are determined by the reaction stoichiometry

Answer: D

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5. For the reaction

$A + 2B \rightarrow 2C$

the rate law for the formation of C is

A. $rate = k[A][B]^2$

B. $rate = k[A]^2[B]^2$

C. $rate = k[A][B]/[C]^2$

D. impossible to state from the stoichiometry of the reaction

Answer: D

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6. Which of the following statementsw about the order of a reaction is correct ?

A. A second order reaction is also bimolecular

B. The order of a reaction can only be determined by experiment

C. We can determine the order of a reaction from the correctly balnced net ionicv equation for the reaction

D. The order of a reaction must be a positive integer

Answer: B

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7. Which of the following is an example of a second order reaction ?

A. A radioactive decay process

B. Decomposition of hydrtogen peroxide

C. Decomposition of nitrogen pentoxide

D. Alkaline hydrolysis of rthyl acetate

Answer: D

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8. A reaction involiving two different reactants can never be:

A. bimolecular reaction

B. second order reaction

C. first order reaction

D. unimolecular reaction

Answer: D

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9. The following mechanism has been proposed for the reaction of NO with Br_2 to from NOBr.

$NO(g) + Br_2 \Leftrightarrow NOBr_2(g)$

$NOBr_2(g) + NO(g) \rightarrow 2NOBr(g)$

If the second step is the rate determining step, the order of the reaction with respect to NO(g) is

A. 2

B. 0

C. 0.5

D. 1

Answer: A

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10. Consider the reaction,

$Cl_2(aq) + H_2S(aq) \to S(s) + 2H^+(aq) + 2Cl^-(aq)$

The rate equation for this reaction is,

Rate $= k[Cl_2][H_2S]$

Which of these mechanisms is / are consistent with this rate equation

?

(I) $Cl_2 + H_2S \to H^+ + Cl^- + Cl^+ + HS^-$ (slow)

$Cl^+ + HS^- \to H^+ + Cl^- + S$ (fast)

(II) $H_2S \Leftrightarrow H^+ + HS^-$ (fast equilibrium)

$Cl^+ + HS^- \to 2Cl^- + H^+ + S$ (slow)

A. B only

B. Both A and B

C. Neither A nor B

D. A only

Answer: D

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Follow Up 4

1. For a zero order reaction of the type $A \rightarrow$ products, the integrated rate equation may be expressed as

A. $k = \frac{[A]_0 - [A]}{2}.t$

B. $k = \frac{[A]_0 - [A]}{2t}$

C. $k = \frac{[A] - [A]_0}{t}$

D. $k = \frac{[A]_0 - [A]}{t}$

Answer: D

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2. Reactant 'A' (initial concentration, a) reacts according to zero order kinetics, the time takews for the completion of the reaction is

A. a/k

B. $2a/k$

C. $k/2a$

D. a^2/k

Answer: A

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3. The reaction $A(g) \rightarrow B(g)$ is found to be zero order with respect to A(g) Which of the following is correct ?

A. Graph between [A] and time t is a straight line with $-ve$ slope and zero intercept

B. Graph between [A] and time t is a straight line with $+ve$ slope and nonzero intercept

C. Graph between [A] and time t is a straight T line with $-ve$ slope nonzero intercept

D. Graph between [A] and time t is a straight line with zero slope and nonzero intercept

Answer: C

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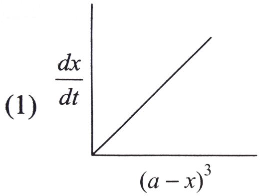
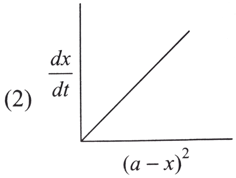
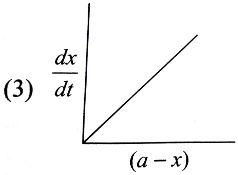
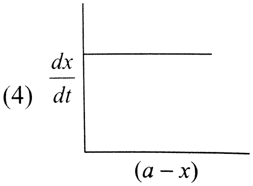
4. Which of the following graphs is the characteristic of a zero order reaction ?

A. 

B. 

C. 

D. 

Answer: D

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5. How many half-lives are needed to complete the zeroth order reaction ?

A. Two

B. Four

C. Infinite

D. Eight

Answer: A

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6. In a certain reaction, 10% of the reactant decomposes in one hour, 20% in two hours, 30% in theee hours, and so on. The dimenison of the velocity constant (rate constant) are

A. h^{-1}

B. $molL^{-1}h^{-1}$

C. $Lmol^{-1}h^{-1}$

D. $L^2mol^{-2}h^{-1}$

Answer: C

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7. For a first order reaction. When the initial concentration, a is not know, the integrated rate expression becomes

A. $k=\frac{2.303}{t_2-t_1}\log\left(\frac{a-x_1}{a-x_2}\right)$

B. $k=n\frac{2.303}{t.\ a}\log\left(\frac{a}{a-x}\right)$

C. $k=\frac{2.303}{t_2-t_1}\log\left(\frac{a}{a-x}\right)$

D. $k=\frac{2.303}{t}\frac{\log(a)}{a-x}$

Answer: A

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8. The reaction

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

is found to be firt order with respect to $N_2O_5(g)$. Which of the following is correct ?

A. Graph between log $P_{N_2O_5}$ and time t is a straight line with zero slope and zero intercept

B. Graph between lig $P_{N_2O_5}$ and time t is a straight line with $-ve$ slope and non zero intercept

C. Graph between log $P_{N_2O_5}$ and time t is a straight line with $+ve$ slope and nonzero intercept

D. Graph between loh $P_{N_2O_5}$ and time t is a straight line with $-ve$ slope and zero intercept

Answer: B

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9. The concept of half life is useful for the reactions of

A. second order

B. zero order

C. first order

D. all order

Answer: C

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10. The integrated rate expression for a first order reaction can be written as

A. (a-x)=a exp $(-k_1t)$

B. x=a exp $(-k_1t)$

C. (a-x)=t exp $(-k_1t)$

D. (a-x)=a exp $(-k_1/t)$

Answer: A

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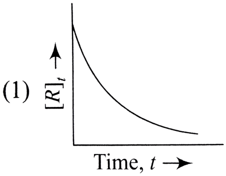
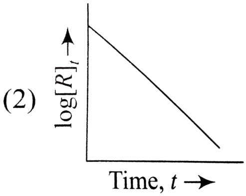
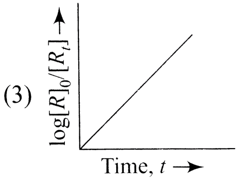
11. Which of the following curves represents a first order reaction.

A. 

B. 

C. 

D. All of these

Answer: D

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12. For a first order reaction

A. $t_{0.75} = 4t_{0.5}$

B. $t_{0.75} = 2t_{0.5}$

C. $t_{0.75} = 3t_{0.5}$

D. $t_{0.75} = 1.5t_{0.5}$

Answer: B

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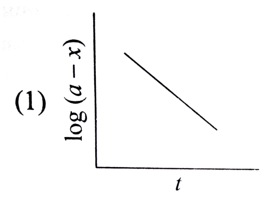
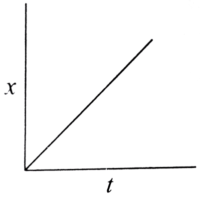
13. Which of the following curves represents a second order reaction ?

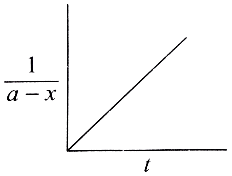
[x = product oncentration $(a - x)$ = reactant concentration)

A. 

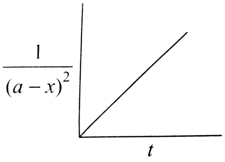
B. (2)



C. (3)



D. (4)



Answer: C

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14. A gaseous substance (AB_3) decomposes according to the overall equation : $AB_3 \rightarrow \frac{1}{2}A_2 + \frac{3}{2}B_2$

The variation of the partial pressure of AB_3 with time (starting with pure AB_3) is given below at $200^\circ C$:

$Time/h$	0	5.0	15.0	35.0
$P_{AB_3}/mmHg$	660	330	165	82.5

The order of the reqaction is

A. zero

B. three

C. one

D. two

Answer: D

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15. The time required for the decompoistion of 99.9% fraction of a first order reaction is.............to that of its half-life time.

A. 5

B. 10

C. 15

D. 20

Answer: B

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16. At 373 k, the following reaction $A(g) \rightarrow 2B(g) + C(g)$ is found to be of first order. Starting with pure A, the total pressure at the end of 10 minutes was 176 mm Hg and after a long time when A was completely dissociated, it was 270 mm Hf. The pressure of A at the end of 10 minutes was

A. 47 mm Hg

B. 43 mm Hg

C. 90 mm Hg

D. 86 mm Hg

Answer: A

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17. The rate law of the reaction $A + 2B \rightarrow$ Product is given by $\frac{d(\text{Product})}{dt} = k[A]^2[B]$. A is taken in large excess, the order of the reqaction will be

A. 3

B. 1

C. 2

D. 0

Answer: A

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18. Which of the following is an example of a pseudop first order reaction ?

A. $H_2 + CI_2 \rightarrow 2HCI$

B. $NO_2 + NO_3 \rightarrow NO + O + NO_2$

C. $CH_3COCH_3 + I_2 \rightarrow CH_2ICOOH_3 + HI$

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

Answer: D

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19. Rate for a zero order reaction is $2 \times 10^{-2} mol L^{-1} s^{-1}$. If the concentration of the reactant after 25s is $0.5M$, the initial concentration must have been

A. $12.5M$

B. $0.5M$

C. $1.0M$

D. $1.25M$

Answer: C

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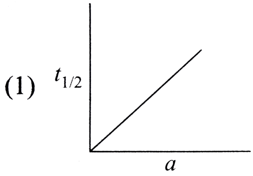
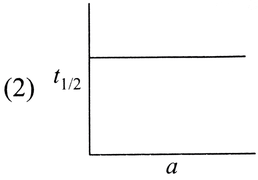
20. Which of the following curves represents a third order reaction ?

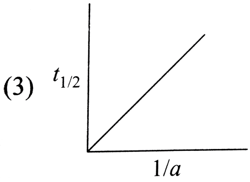
A.



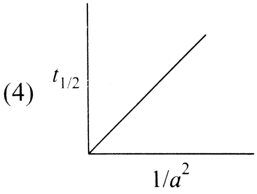
B.



C.



D.



Answer: D

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Follow Up 5

1. Collision theory is applicable to

A. first order reaction

B. second order reaction

C. any order reaction

D. bimolecular reaction

Answer: D

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2. The energy that the reactants must acquire through collisions to reach the activatred state is the

A. activastion energy for the reverse reaction

B. activation energy for the forward reaction

C. activation energy for the forward or the reverse reaction

D. entropy of activation

Answer: C

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3. In a reaction, the threshold energy is equal to

A. activation energy + entropy of the reaction

B. half of activation energy

C. activation energy - potential energy of the reactants

D. activation energy + potential energy of the reactants

Answer: D

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4. Which of the following statements is correct ?

A. An activated complex is formed before a reaction

B. An activation complex is formed after a reaction

C. An activated complex has longer life

D. An activated complex has infinite life

Answer: A

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5. In chemical kinetics, only a small fraction of colliisons lead to reactions. This is because

A. may not be properly oriented to one another and the collosions are very energetic

B. are properly oriented to one another and the collisions are not highly energetic

C. may not be properly oriented to one another and the collisions are not energetic

D. arer properly oriented to one another and the collosions are highly energetic

Answer: C

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6. In an exothermic reqaction,

A. the difference of the potential energy of the reactants and products is equal to the energy of the activated complex

B. the total potential energy of the reactants is higher than the total potential energy of the products

C. the sum of the potential energies of the reactants and products is equal to the energy of the activated complex

D. the total potential energy of the reactants is lower than the total energy of the products.

Answer: B

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7. Which of the following expression represents Arrhenius equation ?

A. $k = A\exp\left(\frac{-E_a}{RT^2}\right)$

B. $k = A\exp\left(\frac{E_a}{RT}\right)$

C. $k = A\exp\left(-\frac{E_a^2}{RT}\right)$

D. $k = A\exp\left(-\frac{E_a}{RT}\right)$

Answer: D

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8. For a first order reaction the units of A in Arrhenius equation will be

A. s^{-1}

B. $molL^{-1}s^{-1}$

C. $Jk^{-1}s^{-1}$

D. $Jk^{-1}L^{-1}s^{-1}$

Answer: A

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9. The logarithmic from of Arrhenius equation is represented by

A. $Ink = \frac{E_a}{RT} - InA$

B. $Ink = InA - \frac{E_a}{2.303RT}$

C. $Ink = InA - \frac{E_a}{RT}$

D. $Ink = InA + \frac{E_a}{RT}$

Answer: C

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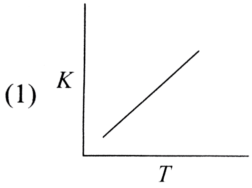
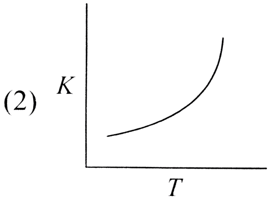
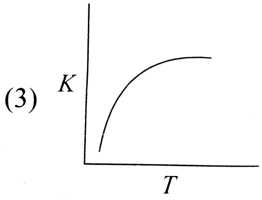
10. Which of the following graphs describes the typical dependence of the rate constant of a reaction on temperature ?



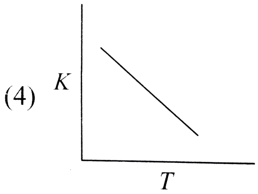
A.



B.



C.



D.

Answer:

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11. Which of the following relations represents the temperature coefficient of a reaction ?

A. $\frac{r_{t+10}}{r_t}$

B. $\frac{t_k}{t_t + 10}$

C. $\frac{k_{t+10}}{k_t}$

D. $\frac{E_a - K_{t+10}}{E_a + K_t}$

Answer: C

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12. Arrheniusd eqwuation shows similarity with

A. Nernst equation

B. Maxwell equation

C. Clausius - Clapeyron equation

D. van't Hoff equation

Answer: D

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Follow Up 6

1. Which one of the following statements regarding catalysis is true ?

A. A catalyst alters the position of equilibrium.

B. A catalyst speeds up the reaction by providing an altrnative path of lower activation energy

C. A catalyst speeds up the reaction by decreasing the frequency factor

D. A catalyst speed up the reaction by providing an altranative path of higher activation energy

Answer: B

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2. Which one of the following statements regarding catalysis in not true ?

A. A small amount of the catalyst can catalyse a large amount of reactants.

B. A catalyst does not alter Gibbs energy, $\Delta_r G^\circ$ of a reaction

C. It catalyses the spontaneous but does not catalyse non-spontaneous reactions.

D. A catalyst changes the equilibrium constant of a reversible reaction.

Answer: D

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Question Bank Building The Knowledge

1. In the reaction, $2NO(g) + O_2(g) \to 2NO_2(g)$, the rate to change of concentration of NO is

A. twicer that of NO_2

B. equal to that of NO_2

C. four times as fast as that of NO_2

D. equal and opposite to that of NO_2

Answer: D

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2. The specific rate constant of a first order reaction depends on the

A. time

B. concentration of the reactant

C. temperature

D. concentration of the product

Answer: C

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3. In a reaction $2A \rightarrow B$ the concentration of A decreases from $0.3 mol L^{-1} \rightarrow 0.2 mol L^{-1}$ in 10 minutes. The reaction rate during trhis interval is mol $L^{-1} \min ute^{-1}$

A. 0.01

B. -0.005

C. -0.01

D. 0.005

Answer: D

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4. For an elementary process

A. the order and the molecularity are identical

B. the order is always fraction

C. the order is lesser than the molecularity

D. the order is greater than the molecularity

Answer: A

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5. For a first order reaction, the half-life period is independent of

A. initial concentration

B. cube root of initial concentration

C. first power of final concentration

D. square root of final concentration

Answer: A

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6. Consider the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$ If the conc. Of N_2O_5 is reduced from $2.33M \rightarrow 2.08M$ after 184 minutes, the rate of production of NO_2 during this period will be ------- mol $L^{-1}\min^{-1}$.

A. 2.72×10^{-3}

B. 1.36×10^{-3}

C. 0.68×10^{-3}

D. 8.16×10^{-3}

Answer: A

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7. The average rate of a reaction iws calculated from the

A. tangent of a graph

B. slope of a graph

C. intercept of a graph

D. equation of a parabola

Answer: B

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8. The gas phase reaction $2NO_2 + O_3 \rightarrow N_2O_5 + O_2$ has the rate constant $k = 2.0 \times 10^{-4} dm^3 mol^{-1} s^{-1}$ at 300 K. The order of the reaction is

A. 0

B. 3

C. 2

D. 1

Answer: C

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9. Which of the following statements is correct ?

A. Order of a reactoin is an experimental quantity. It can be zero and even a fraction but molecularity cannot be zero or a non-integer.

B. Order is applicable to elementary as well as complex reactions whereas molecularity is applicable only for elementary reactions. For a complex reaction molecularity has no meaning.

C. For a complex reaction, order is given by the slowest step and generally, molecularity of the slowest step is same as the order of the overall reaction

D. All of these

Answer: D

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10. The rate of a reaction increases eight times when the concentration of the reactant increases four times. The order of the reaction is

A. 0.5

B. 1.5

C. 2.5

D. 2.0

Answer: B

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11. For a first - order reaction, the rate of reaction is $1.0 \times 10^{-2} molL^{-1}s^{-1}$ and the initial concentration of the reactant is 1 M. The half-life period for the reaction is

A. $6.93 \times 10^{-3}s^{-1}$

B. $0.693s^{-1}$

C. $69.3s$

D. $0.693s^{-1}$

Answer: C

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12. The half life for a given reaction was doubled as the initial concentration of a reactant was doubled. What is the order of reaction.

A. 0

B. 4

C. 1

D. 2

Answer: A

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13. A transition state represents a transition between the

A. products and the activated complex

B. reactants and the activated complex

C. reactants and the products

D. reactants and the intermdiates

Answer: D

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14. For an endothermic reaction, where ΔH represents the enthalpy of reaction in $kJmol^{-1}$, the minimum value for the energy of activation will be

A. equal to $\Delta_r H^\circ$

B. more than $\Delta_r H^\circ$

C. less than $\Delta_r H^\circ$

D. zero

Answer: B

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

A. evaluting rate constant at standard temperature

B. evaluting velocities of reaction at two different temperatures

C. evaluating rate constants at two different temperatures

D. changing concentration of reactants

Answer: C

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16. The experiment data for the reaction $2A + B_2 \rightarrow 2AB$ is

Experiment	$[A]M$	$[B_2]M$	Initial rate$(molL^{-1}s^{-1})$
I	0.50	0.5	1.6×10^{-4}
II	0.50	1.0	3.2×10^{-4}
III	1.00	1.0	3.2×10^{-4}

Write the most probable rate equation for the reacting giving reason

for you answer.

A. $Rate = k[A][B_2]^2$

B. $Rate = k[A]^2[B_2]$

C. $Rate = k[B_2]$

D. $Rate = k[B_2]^2$

Answer: C

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17. The activation energy for a simple chemical reaction $A \rightarrow B$ is E_a

in the forward reaction: The activation of the reverse reaction

A. $< 50 kcal$

B. 50 kcal

C. $> 50 kcal$

D. Either greater than or less than 50 kcal

Answer: D

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18. The plot of concentration of the reactant vs time for a reaction is a straight line with a negative slope. This reaction follows

A. zero order reaction

B. first order reaction

C. second order reaction

D. third order reaction

Answer: A

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19. A chemical reaction has catalyst X. Hence X

A. reduces enthalpy of the reaction

B. decreases rate constant of the reaction

C. increases activation energy of the reaction

D. does not effect equilibrium constant of the reaction

Answer: D

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20. For an exothermic reaction, the energy of activation of the reactants is

A. equal to the energy of activation of products

B. less than the energy of activation of products

C. greater than energy of activation of products

D. sometimes greater and sometimes less than that of the products

Answer: B

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21. Higher order (> 3) reaction are rare due to :

A. increases in entropy and activation energy as more molecules are involved.

B. shifting of equilibrium towards reactants energy due to elastic collisions

C. loss of active species on collision

D. low probability of simultaneous collision of all the reacting species

Answer: D

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22. The rate of a reaction doubles when its temperature changes form $300K$ to $310K$. Activation energy of such a reaction will be:

$\left(R = 8.314JK^{-1}mol^{-1} \text{ and } \log 2 = 0.301\right)$

A. $48.6kJ$

B. $58.5kJmol^{-1}$

C. $60.5kJ$

D. $53.6kJmol^{-1}$

Answer: D

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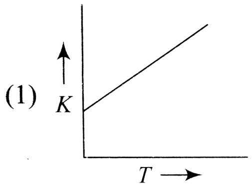
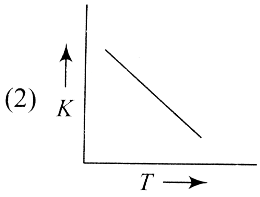
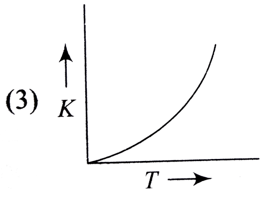
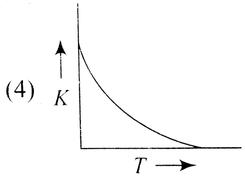
23. Plots showing the variation of the rate constant (k) with temperature (T) are given below. The plot that follows the Arrhenius equation is

A. 

B. 

C. 

D. 

Answer: C

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24. For a first order reaction $A \to P$, the temperature (T) dependent rate constant (k) was found to follow the equation $\log k = -2000(1/T) + 6.0$. The pre-exponential factor A and the activation energy E_a, respective, are

A. $1.0 \times 10^6 s^{-1}$ and $9.2kJmol^{-1}$

B. $6.0s^{-1}$ and $16.6kJmol^{-1}$

C. $1.0 \times 10^6 s^{-1}$ and $16.6kJmol^{-1}$

D. $1.0 \times 10^6 s^{-1}$ and $38.3kJmol^{-1}$

Answer: D

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25. Conisder a reaction $aG + bH \rightarrow$ Products. When concentration of both the reactants G and H is doubled, the rate increases eight times. However, when the concentration of G is doubled, keeping the concentration of H fixed, the rate is doubled. The overall order of reaction is

A. 0

B. 1

C. 2

D. 3

Answer: D

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26. The time for half-life period of a certain reaction, $A \rightarrow$ products is $1h$. When the initial concentration of the reactant $'A'$ is $2.0 \mathrm{mol} L^{-1}$, how much time does it take for its concentration to come from 0.50 to $0.25 \mathrm{mol} L^{-1}$, if it is zero order reaction ?

A. $4h$

B. $0.5h$

C. $0.25h$

D. $1h$

Answer: C

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27. Rate of a reaction can be expressed by Arrhenius equation as:

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

In this equation, E_a represents:

A. the fraction of molecules with energy greater than the activation energy of the reaction.

B. the total energy of the reacting molecules at a temperature, T

C. the energy below which colliding molecules will not react

D. the energy above which all the coliding molecules will react

Answer: C

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28. The reaction $M_2(g) \to N(g) + \frac{1}{2}R(g)$ shows increase in pressure from 100 mm to 120 mm in 5 minutes. The rate of reaction is ------- mm $\min^{-1}$

A. 12

B. 8

C. 4

D. 16

Answer: B

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29. The raction $2FeCl_3 + SnCl_2 \rightarrow 2FeCl_2 + SnCl_4$ is an example of

A. fourth order reaction

B. half order reaction

C. third order reaction

D. second order reaction

Answer: C

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30. A first order gas reaction has $k = 1.5 \times 10^{-6} s^{-1}$ at $200^{\circ} C$. If the reaction is allowed to run for $10h$, what have changed in the Product? What is the half-life of this reaction?

A. 5.3%

B. 94.8%

C. 6.7%

D. 93.3%

Answer: A

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31. While studying the decompoistion of gaseous N_2O_5, it is observed that a plot of logarithm of its partial pressure versus time is linear. What kinetic parameters can be obtained form this observation?

A. (i), (ii), (iii), (iv)

B. (iv), (iii), (ii)

C. (ii), (iii)

D. (i), (ii), (iii)

Answer: C

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32. 99% at a first order reaction was completed in 32 min . When will 99.9% of the reaction complete.

A. 48 min

B. 50 min

C. 35 min

D. 39 min

Answer: A

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33. If the rate constant for a reaction repreasented by $2HI \rightarrow H_2 + I_2$ is denoted by k then for the same reaction if represented by

$HI \rightarrow \frac{1}{2}H_2 + \frac{1}{2}I_2$, the rate constant shall be equal to

A. $k+2$

B. k

C. $k/2$

D. $2k$

Answer: C

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34. In an exothermic reaction $A \to B$, the activation energy of the forward reaction is $200 kJmol^{-1}$. The enthalpy of the reaction is $280 kJmol^{-1}$. The activation energy of the reverse reaction $B \to A$ is

A. $280 kJmol^{-1}$

B. $480 kJmol^{-1}$

C. $200 kJmol^{-1}$

D. $80 kJmol^{-1}$

Answer: B

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35. In Arrhenius equation $k = Ae^{-E_a/RT})$, A is the value of the rate constant

A. when $E_a > RT$

B. $at 0^\circ C$

C. at absolute zero $(0K)$

D. when the temperature is infinite

Answer: D

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36. Two reaction proceed at $35^\circ C$ at the same rate. The temperature coefficient of the first reaction is 4 and thatr of the second is 2. The ratio of the rates of these reaction at $75^\circ C$ is

A. 2

B. 4

C. 16

D. 8

Answer: C

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37. A substance 'A' decomposes by a first order reaction starting initially with $[A] = 2.00M$ and after 200 min, [A] becomes $0.15M$. For this reaction, $t1/2$ is

A. 53.49 min

B. 50.49 min

C. 48.45 min

D. 46.45 min

Answer: A

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38. The concentration of R in the reaction $R \rightarrow P$ was measured as a function of time and the following data were obtained. What is the order of the reaction?

$$\begin{vmatrix} [R](mol) & 1.0 & 0.75 & 0.40 & 0.10 \\ T(\text{ min }) & 0.0 & 0.05 & 0.12 & 0.18 \end{vmatrix}$$

A. 0

B. 3

C. 2

D. 1

Answer: A

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39. Under the same reaction conditions, the intial concentration of $1.386 moldm^{-3}$ of a substance becomes half in $40s$ and $20s$ theough first order and zero order kinetics, respectively.

The ratio (k_1 / k_0) of the rate constants for first order (k_1) and zero order (k_0) of the reaction is

A. $0.5 mol^{-1} dm^3$

B. $1.0 moldm^{-3}$

C. $1.5 moldm^{-3}$

D. $2.0 mol^{-1} dm^3$

Answer: A

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40. Consider a reaction, $2A + B \rightarrow$ Products

When concentration of B alone was doubled, the half-life did not change. When the concentration of A alone was doubled, the rate increased by two times. The unit of rate constant for this reaction is :

A. $Lmol^{-1}s^{-1}$

B. s^{-1}

C. $molL^{-1}s^{-1}$

D. no unit

Answer: A

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41. The energies of activation for forward and reverse reaction for $A_2 + B_2 \Leftrightarrow 2AB$ are $180 kJ \text{mol}^{-1}$ and $200 kJ \text{mol}^{-1}$ respectively. The presence of catalyst lowers the activation energy of both (forward and reverse) reactions by $100 kJ \text{mol}^{-1}$. The enthalpy change of the reaction $(A_2 + B_2 \rightarrow 2AB)$ in the presence of catalyst will be (in $kJ \text{mol}^{-1}$):

A. 380

B. 280

C. 20

D. 120

Answer: C

Watch Video Solution

42. NH_3 gaws is adsorbed on the metal surface like tungsten This follows .... order kinetics.

A. first

B. third

C. second

D. zero

Answer: D

Watch Video Solution

43. The rate law for a reaction between A and B is given by rate $= k[A]^n[B]^m$. On doubling the concentration of A and halving the concentration of B, the ratio of the new rate to the earlier rate of the reaction becomes

A. $\frac{1}{2^{m+n}}$

B. $2^{(n-m)}$

C. $(m+n)$

D. $(n-m)$

Answer: B

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44. In a first order reaction, the concentration of the reactant decreases form $0.8M$ to $0.4M$ in 15 min . The time taken for the concentration to change form $0.1M$ to $0.025M$ is

A. 30 minutes

B. 60 minutes

C. 7.5 minutes

D. 15 minutes

Answer: A

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45. The hydrogenation of vegetable ghee at $25^\circ C$ reduces the pressure of H_2 form $2atm$ to $1.2atm$ in $50 \min$. Calculate the rate of reaction in terms of change of

(a) Pressure per minute

(b) Molarity per second

A. $1.09 \times 10^{-5} molL^{-1}s^{-1}$

B. $2.67 \times 10^{-4} molL^{-1}s^{-1}$

C. $8.94 \times 10^{-7} molL^{-1}s^{-1}$

D. $3.25 \times 10^{-3} molL^{-1}s^{-1}$

Answer: A

Watch Video Solution

46. t some temperature, the rate constant for the reaction of the type

$2A \rightarrow$ Products

is $0.08Ms^{-1}$. The time it takes for the concentration of A to drop from $1.50M \rightarrow 0.30M$ is

A. $7.5s$

B. $9.5s$

C. $11.5s$

D. $13.5s$

Answer: A

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47. For first order reaction involving $2A \rightarrow$ products the specific reaction rate is $0.0084s^{-1}$. If 2.50 moles of A are taken in a 5.0 litre flask, then moles of A remaining after 60 seconds will be

A. 0.637

B. 0.786

C. 0.555

D. 0.913

Answer: D

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48. The rate of first order reaction is $0.04 mol L^{-1} s^{-1}$ at 10 min and $0.03 mol L^{-1} s^{-1}$ at 20 min after initiation. Find the half life of the reaction.

A. 34 min

B. 45 min

C. 24 min

D. 60 min

Answer: C

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49. The rate expression for an nth - order reaction $(n \neq 1)$ is

A. $In\frac{[R]_0}{[R]} = -kt$

B. $\frac{[R]^{-n+1} - [R]_0^{-n+1}}{-n+1} = -kt$

C. $\frac{[R]_0^{-n+1} - [R]^{-n+1}}{-n+1} = -kt$

D. $\frac{[R]^{-n-1} - [R]_0^{-n+1}}{n+1} = kt$

Answer: B

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50. The general expression for half-life period of an nth order reaction $(f \text{ or } n \neq 1)$ is

A. $t_{1/2} = \dfrac{2^{n} - 1}{(n-1)[A]_0^{n-1}k}$

B. $t_{1/2} = \dfrac{2^{n-1} - 1}{(n+1)[A]_0^{n-1}k}$

C. $t_{1/2} = \dfrac{2^{n+1} + 1}{(n+1)[A]_0^{n-1}k}$

D. $t_{1/2} = \dfrac{2^{n-1} - 1}{(n-1)[A]_0^{n-1}k}$

Answer: D

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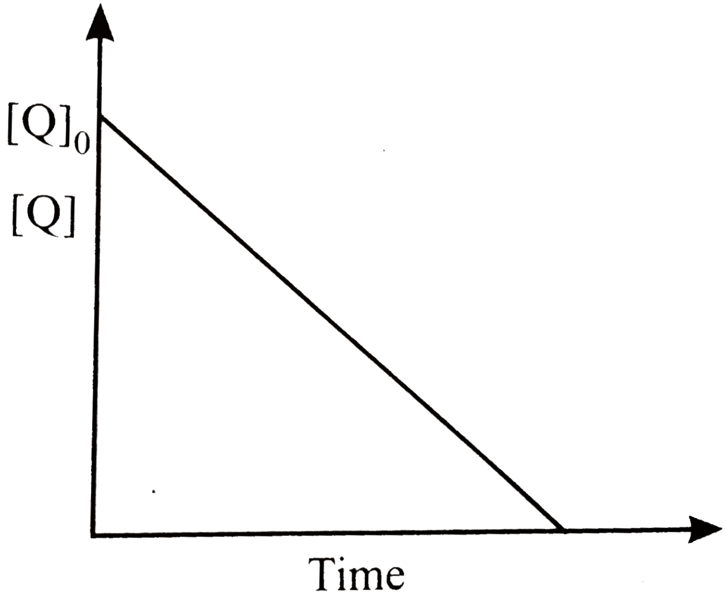
51. In the reaction, $P + Q \rightarrow R + S$

the time taken for $75\,\%$ reaction of P is twice the time taken for $50\,\%$ reaction of P. The concentration of Q varies with reaction time as shown in the figure. The overall order of the reaction is



A. 2

B. 3

C. 0

D. 1

Answer: D

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52. Which or the following is correct for the first order reaction ?

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

(i) The concentration of the reactant decreases exponentially with time.

(ii) The half life of the reaction decreases with increaseing temperature.

(iii) The half life of the reaction depends on the initial concentration of the reactant.

(iv) The reaction proceeds to 99.6% completion in eigth half-life duration.

A. (i), (ii), (iv)

B. (i), (iv)

C. only (iv)

D. inly (i)

Answer: A

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53. For the reaction system $2NO(g) + O_2(g) \to 2NO(g)$ volume is suddenly produced to half its value by increasing the pressure on it. If the reaction is of first order with respect to O_2 and second order with respect to NO. The rate of reaction will

A. increase to four times of its initial value

B. increase to eight times of its initial value

C. diminish to one-eight of its initial value

D. diminish to one-fourth of its initial value

Answer: B

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Archives

1. The addition of a catallystic during a chemical reaction alters which of the following quantities ?

A. Activation energy

B. Entropy

C. Internal energy

D. Ethalpy

Answer: A

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2. The rate of a first-order reaction is $0.04 \text{mol L}^{-1} s^{-1}$ at 10 seconds and $0.03 \text{mol L}^{-1} s^{-1}$ at 20 seconds after initiation of the reaction.

The hlaf-life period of the reaction is :

A. $54.1s$

B. $24.1s$

C. $34.1s$

D. $44.1s$

Answer: B

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3. The rate constant of the reaction $A \rightarrow B$ is 0.6×10^{-3} mole per second. If the concentration of A is $5M$, then concentration of B after 20 minutes is:

A. $0.36M$

B. $0.72M$

C. $1.08M$

D. $3.60M$

Answer: B

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4. The activation energy of a reaction can be determined from the slope of which of the following graphs ?

A. $\frac{T}{Ink}vs.\frac{1}{T}$

B. $Inkvs.T$

C. $\frac{Ink}{T}vs.T$

D. $Inkvs.\frac{1}{T}$

Answer: D

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5. When initial concentration of a reactant is doubled in a reaction, its half-life period is not affected. The order of the reaction is

A. more than zero but less than first

B. zero

C. first

D. second

Answer: C

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6. What is the activation energy for a reaction if its rate doubles when the temperature is raised from $20^{\circ} C$ to $35^{\circ} C$? $\left(R = 8.314 J \text{mol K}^{-}\right)$

A. $269 kJmol^{-1}$

B. $34.7 kJmol^{-1}$

C. $15.1 kJmol^{-1}$

D. $342 kJmol^{-1}$

Answer: B

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7. A reaction having equal energies of activation for forward and reverse reactions has

A. $\Delta G = 0$

B. $\Delta H = 0$

C. $\Delta H = \Delta G = \Delta S = 0$

D. $\Delta S = 0$

Answer: B

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8. In a reaction , $A + B \rightarrow$ Product, rate is doubled when the concentration of B is doubled, and rate increases by a factor of 8 when the concentration of both the reactants (A and B) are doubled, rate law for the reaction can be written as

A. $Rate = k[A][B]^2$

B. $Rate = k[A]^2[B]^2$

C. $Rate = k[A][B]$

D. $Rate = k[A]^2[B]$

Answer: D

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9. In a zero-order reaction for every 10° rise of temperature, the rate is doubled. If the temperature is increased from $10^\circ C$ to $100^\circ C$, the rate of the reaction will become

A. 256 times

B. 512 times

C. 64 times

D. 128 times

Answer: B

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10. Activation energy (E_a) and rate constants (k_1 and k_2) of a chemical reaction at two different temperatures (T_1 and T_2) are related by

A. $In\frac{k_2}{k_1}=\frac{E_a}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$

B. $In\frac{k_2}{k_1}=-\frac{E_a}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$

C. $In\frac{k_2}{k_1}=-\frac{E_a}{2.303R}\left(\frac{1}{T_2}-\frac{1}{T_1}\right)$

D. $In\frac{k_2}{k_1}=-\frac{E_a}{R}\left(\frac{1}{T_2}+\frac{1}{T_1}\right)$

Answer: A

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

A. Order of reaction is always a whole number

B. Order can be determined only experimentally

C. Order is not influenced by stoichiometric coefficients of the reactants.

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

Answer: A

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12. The unit of rate constant for a zero order reaction is s^{-1}.

A. s^{-1}

B. $molL^{-1}s^{-1}$

C. $Lmol^{-1}s^{-1}$

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

Answer: B

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13. The half life of a substance in a certain enzyme catalyzed reaction is 138s. The time required for the concentration of the substance to fall from $1.28mgL^{-1} \rightarrow 0.04mgL^{-1}$:

A. 267s

B. 414s

C. 552s

D. 690s

Answer: A

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14. $2N_2O_5 \rightarrow 4NO_2 + O_2$

If $\dfrac{-d[N_2O_5]}{dt} = k_1[N_2O_5]$

$$\frac{d[NO_2]}{dt} = k_2[N_2O_5]$$

$$\frac{d[O_2]}{dt} = k_3[N_2O_5]$$

What is the relation between k_1, k_2, and k_3?

A. $k' = k, k = k$

B. $k' = 2k, k = k$

C. $k' = 2k, k = k/2$

D. $k' = 2k, k = 2k$

Answer: C

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15. For the reaction $N_2O_5 \rightarrow 2NO_2 + \frac{1}{2}O_2$, the rate of disappearance of N_2O_5 is $6.25 \times 10^{-3} \text{mol L}^{-1} s^{-1}$. The rate of formation of NO_2 and O_2 will be respectively.

A. $1.25 \times 10^{-2} molL^{-1}s^{-1}$ and $6.25 \times 10^{-3} mol^{-1}L^{-1}s^{-1}$

B. $6.25 \times 10^{-3} molL^{-1}s^{-1}$ and $6.25 \times 10^{-3} mol^{-1}L^{-1}s^{-1}$

C. $1.25 \times 10^{-2} molL^{-1}s^{-1}$ and $3.125 \times 10^{-3} mol^{-1}L^{-1}s^{-1}$

D. $6.25 \times 10^{-3} molL^{-1}s^{-1}$ and $3.125 \times 10^{-3} mol^{-1}L^{-1}s^{-1}$

Answer: C

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16. During the kinetic study of the reaction $2A + B \rightarrow C + D$ following results were obtained.

	$Run[A]$	$[B]inM$	Initial rate of fo rmation of D in ms^{-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}

On the basis of above data which one is correct ?

A. $Rate = k[A][B]^2$

B. $Rate = k[A]^2[B]$

C. $Rate = k[A][B]$

D. $Rate = k[A]^2[B]^2$

Answer: A

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17. For an endothermic reaction, where ΔH represents the enthalpy of reaction in $kJmol^{-1}$, the minimum value for the energy of activation will be

A. equal to zero

B. less than ΔH

C. equal to ΔH

D. more than ΔH

Answer: D

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18. The rate of the reaction

$2NO + CI_2 \rightarrow 2NOCI$

is given by the rate equation

$Rate = k[NO]^2[CI_2]$

The value of the rate constant can be increased by

A. increasing the rate temperature

B. increasing the constration of NO

C. increasing the concentration of the CI_2

D. doing all of these

Answer: A

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19. For the reaction, $N_2 + 3H_2 \rightarrow 2NH_3$, if $\frac{d[NH_3]}{dt} = 2 \times 10^{-4}\text{mol L}^{-1}s^{-1}$, the value of $\frac{-d[H_2]}{dt}$ would be:

A. $4 \times 10^{-4} molL^{-1}s^{-1}$

B. $6 \times 10^{-4} molL^{-1}s^{-1}$

C. $1 \times 10^{-4} molL^{-1}s^{-1}$

D. $3 \times 10^{-4} mol L^{-1} s^{-1}$

Answer: D

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20. In the reaction

$$BrO^{-3}(aq) + 5Br^{-}(aq) + 6H^{+} \rightarrow 3Br_2(1) + 3H_2O(1)$$

The rate of appearance of bromine (Br_2) is related to rate of disapperance of bromide ions as folllwoing :

A. $\frac{d[Br_2]}{dt} = -\frac{5}{3}\frac{d[Br^{-}]}{dt}$

B. $\frac{d[Br_2]}{dt} = \frac{5}{3}\frac{d[Br^{-}]}{dt}$

C. $(d[Br_2]) = \frac{3}{5}\frac{d[Br^{-}]}{dt}$

D. $\frac{d[Br_2]}{dt} = -\frac{3}{5}\frac{d[Br^{-}]}{dt}$

Answer: D

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21. Half-life period of a first-order reaction is 1386 seconds. The specific rate constant of the reaction is

A. $0.5 \times 10^{-2} s^{-1}$

B. $0.5x10^{-3} s^{-1}$

C. $5.0 \times 10^{-2} s^{-1}$

D. $5.0 \times 10^{-3} s^{-1}$

Answer: B

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22. The bromination of acetone that occurs in acid solution is represented by this equation.

$CH_3COCH_3(aq) + Br_2(aq) \rightarrow$

$CH_3COCH_2Br(aq) + H^+(aq) + Br(aq)$

These kinetic data were obtained for given reaction concentrations.

Initial concentration, M

$[CH_2COCH_3]$	$[Br_2]$	$[H^+]$	$(\text{Initail rate})\ (\text{disappearance of } Br_2)$
0.30	0.05	0.05	5.7×10^{-5}
0.30	0.10	0.05	5.7×10^{-5}
0.30	0.10	0.10	1.2×10^{-4}
0.40	0.5	0.20	3.1×10^{-4}

A. $Rate = k[CH_3COCH_3][Br_2][H^+]$

B. $Rate = k[CH_3COCH_3][H^+]$

C. $Rate = k[CH_3COCH_3][Br_2]$

D. $Rate = k[CH_3COCH_3][Br_2][H^+]^2$

Answer: B

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23. The rate constant k_1 and k_2 for two different reactions are $10^{16}e^{-2000/T}$ and $10^{15}e^{-1000/T}$, respectively. The temperature at which $k_1 = k_2$ is

A. $\frac{1000}{2.303}K$

B. $1000K$

C. $\frac{2000}{2.303}K$

D. $2000K$

Answer: A

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24. In a first-order reaction $A \rightarrow B$, if K is the rate constant and initial concentration of the reactant is $0.5M$, then half-life is

A. $\frac{\log 2}{k\sqrt{0.5}}$

B. $\frac{In2}{k}$

C. $\frac{0.693}{0.5k}$

D. $\frac{\log 2}{k}$

Answer: B

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25. 60% of a first order reaction was completed in 60 min . The time taken for reactants to decompose to half of their original amount will be

A. 60 Minutes

B. 4 minutes

C. 50 minutes

D. 45 minutes

Answer: D

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26. The reaction obey I order with respect to H_2 and ICl both.

$H_2(g) + 2ICl(g) \rightarrow 2HCl(g) + I_2(g)$

Which of the following mechanism is in consistent with the given fact

?

Mechanism A: $H_2(g) + 2Cl \rightarrow 2HCl(g) + I_2(g)$

Mechanism B: (i) $H_2(g) + ICl(g) \xrightarrow{\text{slow}} HCl(g) + HI(g)$

(ii) $HI(g) + ICl(g) \rightarrow HCl(g) + I_2$

A. Neither A nor B

B. A only

C. B only

D. A and B both

Answer: C

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27. for the reaction, $2A + B \to 3C + D$, which of the following does not express the reaction rate

A. $\frac{-d[A]}{2dt}$

B. $\frac{-d[C]}{3dt}$

C. $\frac{-d[B]}{dt}$

D. $\frac{d[D]}{dt}$

Answer: B

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28. Consider the reaction:

$N_{2(g)} + 3H_{2(g)} \to 2NH_{3(g)}$.

The equally relationship between $-\frac{d[NH_3]}{dt}$ and $-\frac{d[H_2]}{dt}$ is:

A. $\frac{d[NH_3]}{dt} = -\frac{d[H_2]}{dt}$

B. $\frac{d[NH_3]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt}$

C. $+\frac{d[NH_3]}{dt} = -\frac{2}{3}\frac{d[H_2]}{dt}$

D. $+\frac{d[NH_3]}{dt} = -\frac{3}{2}\frac{d[H_2]}{dt}$

Answer: C

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29. The rate of reaction between two A and B decreases by factor 4 if the concentration of reactant B is doubled. The order of this reaction with respect to B is

A. -1

B. -2

C. 1

D. 2

Answer: B

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30. For a first-order reaction $A \rightarrow B$ the reaction rate at reactant concentration of $0.10M$ is found to be $2.0 \times 10^{-5} \text{mol} L^{-1} s^{-1}$. The half-life period of the reaction is

A. 220s

B. 30s

C. 300s

D. 347s

Answer: D

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31. The rate of first-order reaction is $1.5 \times 10^{-2} M \min^{-1}$ at $0.5M$ concentration of reactant. The half-life of reaction is

A. 0.383 min

B. 23.1 min

C. 8.73 min

D. 7.53 min

Answer: B

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32. The activation energy for a simple chemical reaction $A \rightarrow B$ is E_a in the forward reaction: The activation of the reverse reaction

A. can be less than or more than E_a

B. is always double of E_a

C. is negative of E_a

D. is always less than E_a

Answer: A

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33. If the rate of the reaction is equal to the rate constant, the order of the reaction is

A. 2

B. 3

C. 0

D. 1

Answer: C

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34. The temperature dependence of rate constant (k) of a chemical reaction is written in terms of Arrhenius equation, $k = Ae^{-E_a/RT}\Big)$ Activation energy (E_a) of the reaction can be calculate by plotting

A. $\log kvs\frac{1}{T}$

B. $\log kvs\frac{1}{\log T}$

C. $kvs.\,T$

D. $kvs\frac{1}{\log T}$

Answer: A

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35. The reaction $A \rightarrow B$ follows first order kinetics. The time taken for $0.8mol$ of A to produce $0.6mol$ of B is $1hr$. What is the time taken for the conversion of $9.0mol$ of A to Product $0.675mol$ of B ?

A. $0.25h$

B. $2h$

C. $1h$

D. $0.5h$

Answer: C

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36. $2A \rightarrow B + C$. It would be a zero-order reaction when

A. the rate of reaction is proportional to square of concentration of A

B. the rate of reaction remains same at any concentration of A

C. the rate remains unchanged at any concentration of B and C

D. the rate of reaction doubles if concentration of B is incereased to double

Answer: B

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37. If $3A \rightarrow 2B$, then the rate of reaction of $+\frac{dB}{dt}$ is equal to

A. $-\frac{3}{2}\frac{d[A]}{dt}$

B. $-\frac{2}{3}\frac{d[A]}{dt}$

C. $-\frac{1}{3}\frac{d[A]}{dt}$

D. $+2\frac{d[A]}{dt}$

Answer: B

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38. When a biochemical reaction is carried out in laboratory from outside of human body in the absence of enzyme, the rate of reaction obtained is 10^{-6} times, then activation energy of the reaction in the presence of enzyme is

A. $\frac{6}{RT}$

B. P is required

C. different from E_a obtained in laboratory

D. can't say anything

Answer: C

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39. For the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$ rate of reaction and rate constant are 1.02×10^{-4} and $3.4 \times 10^{-5}\,\text{sec}^{-1}$ respectively. The concentration of N_2O_5 at that time will be

A. 1.732

B. 3

C. 1.02×10^{-4}

D. 3.4×10^{5}

Answer: B

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