



## CHEMISTRY

### BOOKS - CBSE COMPLEMENTARY MATERIAL

### CHEMISTRY (HINGLISH)

### CHEMICAL KINETICS

#### Multiple Choice Questions

1. The half life period of a first order reaction is  $100^\circ$  seconds. Its rate constant is:

A.  $0.693 \text{ sec}^{-1}$

B.  $6.93 \times 10^{-3} \text{ sec}^{-1}$

C.  $6.93 \times 10^{-2} \text{sec}^{-1}$

D. None of these

**Answer: B**



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2. In Arrhenius equation if a graph is plotted between  $\log K$  and  $1/T$ , the slope of the curve will be:

A.  $\frac{-E_a}{R}$

B.  $\frac{-E_a}{2.303R}$

C.  $\frac{E_a}{R}$

D.  $\frac{E_a}{2.303R}$

**Answer: B**



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**3.** The rate law for a reaction  $2C + D \rightarrow A + E$  is

$$\frac{-d[D]}{dt} = K[C]^2[D]$$

if C is present in large excess, the order of the reaction will be:

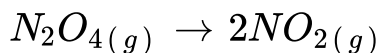
- A. zero
- B. first
- C. second
- D. third

**Answer: B**



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4. What is the activation energy for the reverse of this reaction?



Data for the given reaction is  $\Delta H = 54 \text{ KJ/mol}$  and  $\varepsilon_a = 57.2 \text{ KJ}$ .

A.  $-54 \text{ KJ}$

B.  $3.2 \text{ KJ}$

C.  $60.2 \text{ KJ}$

D.  $111.2 \text{ KJ}$

**Answer: B**



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5. The rate constant of a reaction becomes equal to the pre exponential factor when:

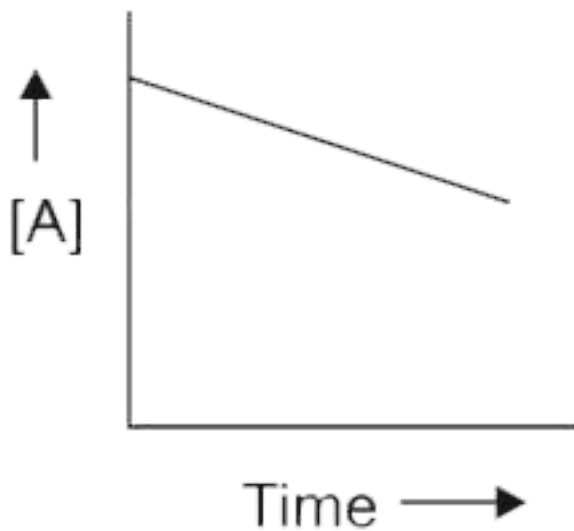
- A. the absolute temperature is zero
- B. the activation energy is infinity
- C. the absolute temperature is infinity
- D. the activation energy is zero

**Answer: C**



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6. The following graph show that the reaction is:



- A. zero order
- B. first order
- C. second order
- D. fractional order

**Answer: A**



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7. A second order reaction between A and B is elementary reaction:



rate law expression of this reaction will be:

A. Rate =  $K[A][B]$

B. Rate =  $K[A]^0[B]^2$

C. Rate =  $K[A]^2[B]^0$

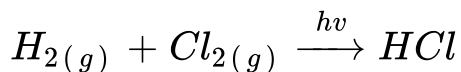
D. Rate =  $K[A]^{3/2}[B]^{1/2}$

**Answer: A**



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8. The order and molecularity of the chain reaction,



A. 2, 0

B. 0, 2

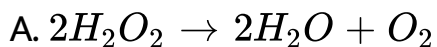
C. 1, 1

D. 3, 0

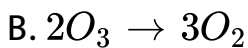
**Answer: B**

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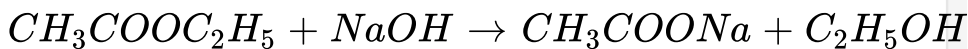
9. Which of the following is pseudo first order reaction?



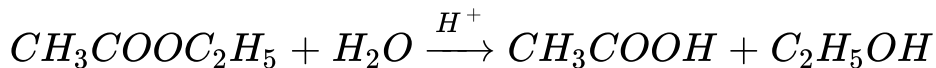




C.



D.



**Answer: D**



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**10.** A large increase in the rate of a reaction for a rise in temperature is due to

A. Increase in the number of collisions

B. Increase in the number of activated molecules

C. Lowering of activation energy

D. Shortening of the mean free path.

**Answer: B**



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**11. For a reaction, the following data were obtained:**

<b>Concentration (mol/L)</b>	0.1	0.05	0.025	0.0125
<b>Half life in (sec)</b>	30	29.9	30.1	30

the order of reaction is:

A. 2

B. 1

C. 0

D. fractional

**Answer: B**



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**12.** For the formation of  $SO_3$  in the following reaction, it is given that



A.  $E_a > E_a^1$

B.  $E_a < E_a^1$

C.  $E_a^1 = E_a^{1/2}$

D.  $E_a = E_a^1$

**Answer: D**

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13. A first order reaction is 20% complete in one hour. At the end of 3 hrs the extent of the reaction is:

- A. 60 %
- B. 52.2 %
- C. 63 %
- D. 44.4 %

**Answer: C**

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14. Radioactive decay is an example of:

A. first order

B. second order

C. zero order

D. 0.5 order

**Answer: A**



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15. At  $227^{\circ}C$ , the presence of catalyst causes the activation energy of a reaction to decrease by  $4.606Kcal$ . The rate of the reaction will be increased by : —

A. 2 times

B. 10 times

C. 100 times

D. 1000 times

**Answer: C**



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16. The decomposition of  $N_2O_5$  occurs as,  
 $2N_2O_5 \rightarrow 4NO_2 + O_2$  and follows first order kinetics,  
hence:

A. the reaction is bimolecular

B. the reaction is unimolecular

C.  $\frac{t_1}{2} \propto a^\circ$

D. unit of  $K = \frac{mol}{L} sec^{-1}$

**Answer: C**



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**17. Rate of which reactions increases with temperature:**

- A. of any reaction
- B. of exothermic reaction
- C. of endothermic reaction
- D. of none

**Answer: A**



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18. For the reaction,  $N_2O_5 \rightarrow 2NO_2 + O_2$ ,

Given  $\frac{-d}{dt}[N_2O_5] = K_1[N_2O_5]$

$$\frac{d}{dt}[NO_2] = K_2[N_2O_5]$$

$$\frac{d}{dt}[O_2] = K_3[N_2O_5], \text{ the relation in between of } K_1K_2K_3$$

is

A.  $2K_1 = K_2 = 2K_3$

B.  $K_1 = K_2 = K_3$

C.  $2K_1 = 4K_2 = K_3$

D.  $2K_1 = 2K_2 = 3K_3$

**Answer: A**



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19. Which of the following statement is/are correct about order of reaction:

- A. order of reaction is determined experimentally
- B. order of reaction can not have fractional value
- C. it does not necessarily depend on stoichiometric coefficients
- D. it is the sum of power of concentration terms in rate law expression

**Answer: A::C::D**



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20. Which one is correct for first order reaction.

A.  $\frac{t_{75\%}}{t_{50\%}} = 1.5$

B.  $\frac{t_{75\%}}{t_{50\%}} = 3$

C.  $\frac{t_{99.9\%}}{t_{50\%}} = 10$

D.  $\frac{t_{87.5\%}}{t_{50\%}} = 3$

Answer: C::D



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21. Match the column and found out correct option.

(A) zero order reaction

(B) first order reaction

(C) second order reaction

P. unit of K is  $\frac{\text{L}}{\text{mol}} \cdot \text{sec}^{-1}$

Q. unit of K is  $\frac{\text{mol}}{\text{L}} \cdot \text{sec}^{-1}$

R. unit of K is  $\text{sec}^{-1}$

A. A-R, B-Q, C-P

B. A-P, B-Q, C-R

C. A-Q, B-R, C-P

D. A-R, B-P, C-Q

**Answer: C**

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**22.** Statement 1: Lower the activation energy, faster is the reaction.

Statement 2 : Catalyst does not affect activation energy of the reaction.

- A. Statement 1: is true, Statement 2 is true, and Statement 2 is a correct explanation of statement 1
- B. Both statement are true but statement 2 is not a correct explanation for statement 1
- C. Statement 1 is true and statement 2 is false
- D. Statement 1 is false and Statement 2 is true

**Answer: C**

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23. For first order reaction:  $\frac{t_{99.9}}{t_{50}} = x$ , Here x is

A. 3

B. 5

C. 7

D. 10

**Answer: D**



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**24.** The reactions taking place in one step is called .....  
reactions.



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**25.** The order of reaction is ..... determined.



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## Very Short Answer Type Questions

1. The rate law for a reaction is  $\text{Rate} = K[A][B]^{3/2}$

Can the reaction be an elementary process ? Explain.

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2. For the reaction  $3H_2 + N_2 \rightarrow 2NH_3$ , how are the rate of reaction expressions  $-\frac{d[H_2]}{dt}$  and  $\frac{d[NH_3]}{dt}$  inter-related ?

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

$$k = 2.3 \times 10^{-5} \text{ litre mol}^{-1}\text{sec}^{-1}$$

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4. After five half-life periods for a first order reaction, what fraction of reactant remains ?

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5. What is the effect of adding catalyst on free energy change ( $\Delta G$ ) of a reaction ?

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6. What value of  $k$  is predicted for the rate constant by Arrhenius equation is  $T \rightarrow \infty$  ? Is this value physically reasonable ?

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7. Determine the order of reaction :

Step 1.  $2NO + H_2 \rightarrow N_2 + H_2O_2$  Slow

Step 2.  $H_2O_2 + H_2 \rightarrow 2H_2O$  Fast

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8. What is the order of reaction whose rate constant has the same units as rate of reaction ?





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9. Why are reactions of higher order less in number?



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10. What will be effect of temperature on rate constant ?



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



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

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13. The rate constant of a reaction is  $3 \times 10^2 \text{min}^{-1}$ . What is its order of reaction ? (On the basis of units of rate constant)

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14. Three-fourth of a reaction is completed in 32 minutes. What is the half life period of this reaction ?

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15. What is meant by an elementary reaction ?

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16. Give one example of a reaction where order and molecularity are equal ?

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17. For a reaction  $R \rightarrow P$ , the rate becomes 2 times when the concentration of the reactant P is increased 4 times. What is the order of reaction ?

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18. The rate constant of a zero order reaction in A is  $0.003 \text{ mol L}^{-1} \text{ sec}^{-1}$ . How long will it take for the initial concentration of A to fall from 0.10M to 0.075 M ?

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

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20. In some cases large number of colliding reactant molecules have energy more than threshold energy even then the reaction is slow. Why ?



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21. Give an example of a reaction having fractional order.



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22. Decomposition reaction of ammonia on Pt surface has rate constant =  $2.5 \times 10^{-1} \text{molL}^{-1} \text{sec}^{-1}$ . What is order of reaction ?



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23. What is order of radioactive decay ?



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24. For a reaction  $A + B \rightarrow \text{Product}$ , the rate law is given by

$r = k[A]^{1/2}[B]^2$ . What is the order of the reaction ?

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## Short Answer I Type Questions

1. The rate of a particular reaction quadruples when the temperature changes from 293 K to 313 K. Calculate activation energy in KJ/mol.

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2. If the decomposition of nitrogen oxide as



Calculate the rate constant for a 0.05M solution if the

instantaneous rate is  $1.5 \times 10^{-6}$  mol/l/s ?

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3. If the decomposition of nitrogen oxide as



$10^{(-5)} \text{ sec}^{(-1)} .$

What concentration of  $N_2O_5$  would give a rate of

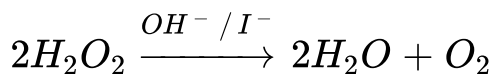
$2.45 \times 10^{-5} \text{ mol L}^{-1} \text{ s}^{-1}$  ?

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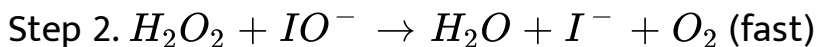
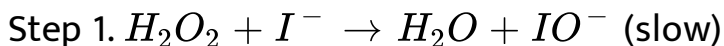
4. Write the difference between order and molecularity of reaction.

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5. Consider the decomposition reaction :



This reaction takes place in two steps as given below :

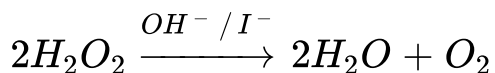


Determine rate law expression.

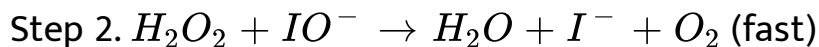
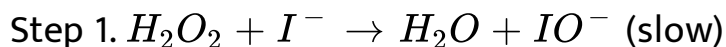
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6. Consider the decomposition reaction :



This reaction takes place in two steps as given below :



Determine the order of reaction.

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7. The decomposition of hydrocarbon follows the equation

$$k = (4.5 \times 10^{11} s^{-1}) e^{-28000K/T}$$

Calculate  $E_a$ .

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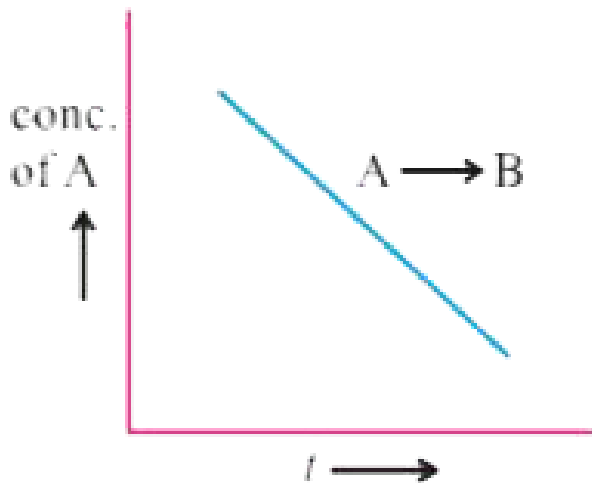
8. A reaction is of second order with respect to a reactant.

How is the rate of reaction affected if the concentration of the reactant is reduced to half ? What is the unit of rate constant of such a reaction ?

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9. For a first order reaction, time taken for half of the reaction to complete is  $t_1$  and  $\frac{3}{4}$  of the reaction to complete is  $t_2$ . How are  $t_1$  and  $t_2$  related?

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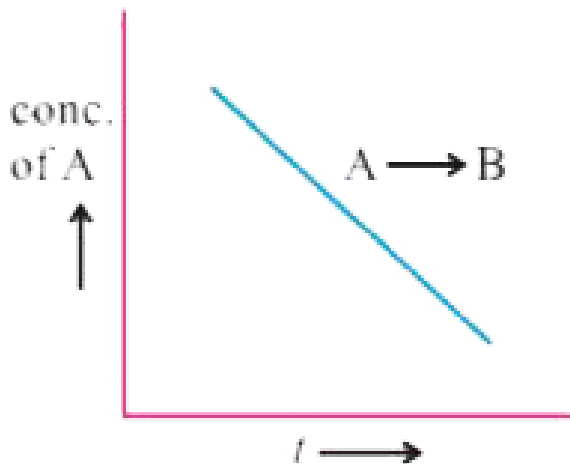


10.

What is the order of the reaction ?



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11.

What is the slope of the curve ?

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

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13. For the reaction  $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

How is the rate of formation of ammonia related to the rate of disappearance of  $H_2$  ?

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14. The rate of a gaseous reaction is halved when the volume of the vessel is doubled. What is the order of reaction ?

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15. A reaction which is first order with respect to A has rate constant  $6\text{min}^{-1}$ . If we start with  $[A] = 0.5\text{mol L}^{-1}$ , when

would [A] reach the value of  $0.05 \text{ ML}^{-1}$  ?

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

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

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18.  $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ . If rate of formation of NO is  $6 \times 10^{-4} \text{ atm min}^{-1}$ , calculate the rate of formation of  $H_2O$ .

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

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20. Explain with an example, what is a pseudo first order reaction ? The graphs (A and B) given below are plots of rate of reaction Vs concentration of the reactant. Predict the order from the graphs.

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21. Differentiate between :Average rate and instantaneous rate of a chemical reaction.

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22. Differentiate between :Molecularity and order of reaction.





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**23.** Show that in case of a first order reaction, the time required for 99.9 % of the reaction to take place is about 10 times that the required for half the reaction.

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**24.** For the reaction  $NO_2 + CO \rightarrow CO_2 + NO$ , the experimentally determined rate expression below 400 K is  $\text{rate} = k[NO_2]^2$ . What mechanism can be proposed for this reaction ?

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25. The half life period of a first order reaction is 60 min.  
What percentage will be left after 240 min.

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26. Time for half change for a first order reaction is 25 min.  
What time will be required for 99% reaction ?

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### Short Answer Type li Questions

1. The rate constant for first order reaction is  $60/s$ . How much time will it take to reduce the concentration of the

reaction to  $1/10$  of its initial value ?

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2. The rates of most reactions double when their temperature is raised from 298 K to 308 K. Calculate their activation energy.

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3. A first order reaction takes 69.3 min for 50% completion. Set up an equation for determining the time needed for 80% completion.

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4. The activation energy of a reaction is  $94.14 \text{ kJ/mol}$  and the value of rate constant at  $40^\circ \text{C}$  is  $1.8 \times 10^{-1} \text{ sec}^{-1}$ .

Calculate the frequency factor A.

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5. The rate constants of a reaction at  $500 \text{ K}$  and  $700 \text{ K}$  are  $0.02 \text{ s}^{-1}$  and  $0.07 \text{ s}^{-1}$  respectively. Calculate the values of  $E_a$  and A.

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6. The rate constants of a reaction at  $700 \text{ K}$  and  $760 \text{ K}$  are  $0.011 \text{ M}^{-1} \text{ s}^{-1}$  and  $0.105 \text{ M}^{-1} \text{ s}^{-1}$  respectively.

Calculate the values of Arrhenius parameters.

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7. The initial concentration of  $N_2O_5$  in the first order reaction

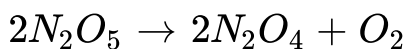
$$N_2O_5 \rightarrow 2NO_2 + 1/2O_2$$

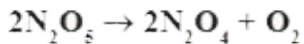
was

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

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8. The following data were obtained during the first order thermal decomposition of  $N_2O_5$  at constant volume :





S. No.	Time per second	Total pressure (atm)
1	0	0.5
2	100	0.512

Calculate rate constant.



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9. A first order reaction is 20% complete in 20 minutes. Calculate the time taken for the reaction to go to 80% completion.



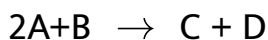
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10. For a first order reaction, calculate the ratio between the time taken to complete  $3/4$ th of the reaction and time to

complete half of the reaction.

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11. The following results have been obtained during the kinetics studies of the reaction :



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

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

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**12.** The rate of reaction triples 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.

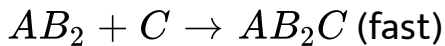
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**13.** The decomposition of A into product has value of K as  $4.5 \times 10^3 \text{ sec}^{-1}$  at  $10^\circ \text{ C}$  and energy of activation 60 kJ/mol. At what temperature would K be  $1.5 \times 10^4 \text{ sec}^{-1}$ .

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14. Write rate law and order of the following reaction :



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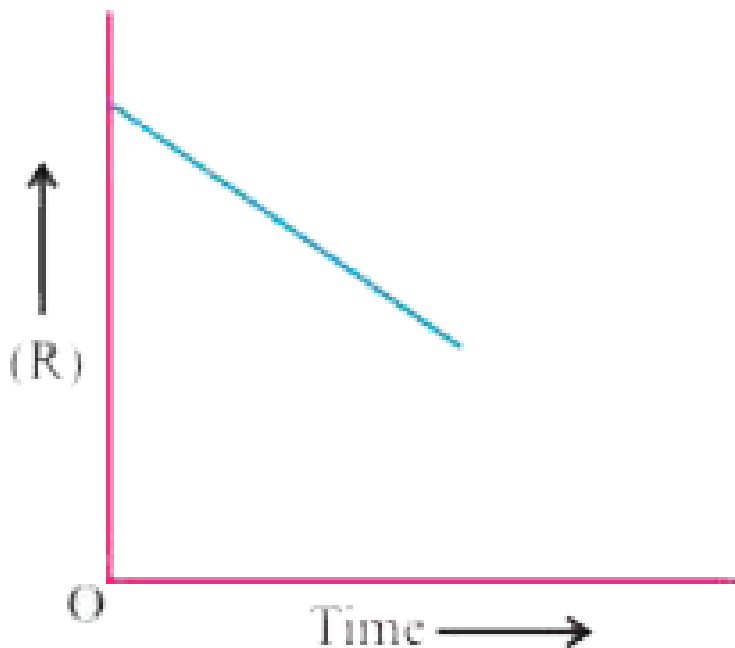
15. Define activation energy of a reaction.

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16. What is the relation between rate constant and activation energy of a reaction?

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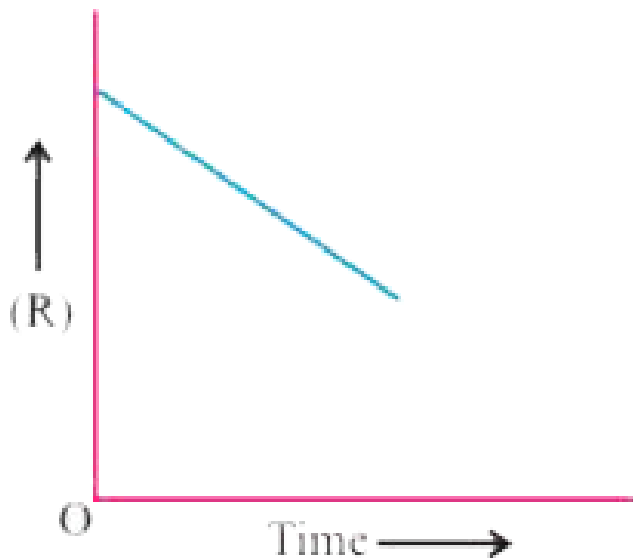
17. For a chemical reaction  $R \rightarrow P$ , the variation in the concentration (R) vs time (t) plot is given :



Predict the order of reaction.

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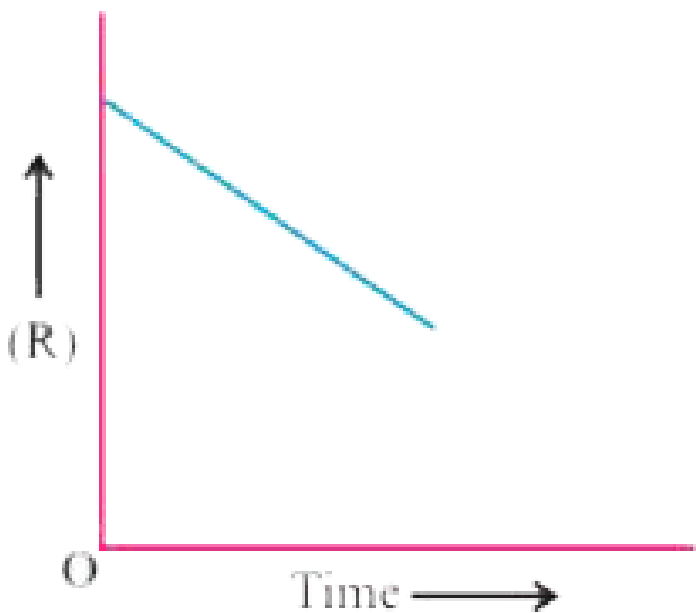
18. For a chemical reaction  $R \rightarrow P$ , the variation in the concentration (R) vs time (t) plot is given :



Write down its rate law.

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19. For a chemical reaction  $R \rightarrow P$ , the variation in the concentration (R) vs time (t) plot is given :



What is the slope of the curve ?

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**20.** What do you understand by a first order reaction ? Show that for a first order reaction time required to complete a definite fraction of the reaction is independent of initial concentration.



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21. In a pseudo first order reaction of hydrolysis of an ester in  $H_2O$ , the following results were obtained :

$t/s$	0	30	60	90
Ester (M/L)	0.55	0.31	0.17	0.085

Calculate the average rate of reaction between the time interval 30 to 60 sec.



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22. In a pseudo first order reaction of hydrolysis of an ester in  $H_2O$ , the following results were obtained :

$t/s$	0	30	60	90
Ester (M/L)	0.55	0.31	0.17	0.085

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

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

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Long Answer Type Questions

1. Define 'order of a reaction'.

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2. Rates of reaction double with every  $10^\circ$  rise in temperature. If this generalization holds for a reaction in the temperature ranges 298 K to 308 K, what would be the value of activation energy for their reaction ?  $R = 8.314 \text{ J K}^{-1}\text{mol}^{-1}$ .

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3. What are pseudo order reaction ? Give example.

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4. The rate constant 'k'. For a reaction varies with temperature 'T' according to the question.

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

Where  $E_a$  is the activation energy. When a graph is plotted for  $\log k$  vs  $1/T$ , a straight line with a slope of  $-4250$  K is obtained. Calculate  $E_a$  for this reaction.

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5. Determine the units of rate constant for first and zero order reaction.

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6. Show that time required for the completion of 99% of the first order reaction is twice the 90% of completion of the reaction.

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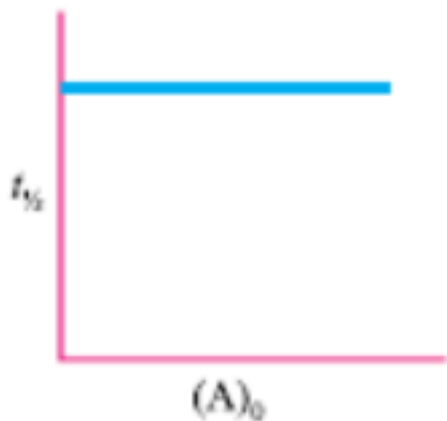
7. Define rate constant of reaction.

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

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9. Determine the order of reaction and also determine the units of rate constant



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10. The following data were given for thermal decomposition of  $SO_2Cl_2$  at a constant volume :



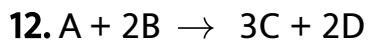
Exp.	Time/s	Total p/atm
1	0	0.5
2	100	0.6

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

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11. The energy of activation for a reaction is  $100\text{KJmol}^{-1}$ . The presence of a catalyst lowers the energy of activation by 75%. What will be the effect on the rate of reaction at  $20^\circ\text{C}$ , other things being equal?

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The rate of disappearance of B is  $1 \times 10^{-2} \text{ mol L}^{-1} \text{ sec}^{-1}$ .

What will be (i) rate of reaction (ii) rate of change in the concentration of A and C ?



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