



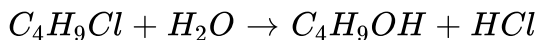
CHEMISTRY

NCERT - NCERT CHEMISTRY(HINGLISH)

CHEMICAL KINETICS

Solved Examples

1. From the concentrations of C_4H_9Cl (butyl chloride) at different times given below, calculate the average rate of the reaction:



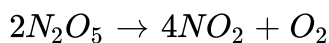
during different intervals of time.

t/s	0	50	100	150	200	300	400
$[C_4H_9Cl]/\text{mol}^{-1}$	0.100	0.0905	0.0820	0.0741	0.0671	0.0549	0.0439



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2. The decomposition of N_2O_5 in CCl_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:



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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3. Calculate the overall order of a reaction which has the rate expression.

(a) $\text{Rate} = k[A]^{\frac{1}{2}}[B]^{\frac{3}{2}}$, (b) $\text{Rate} = k[A]^{\frac{3}{2}}[B]^{-1}$

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4. Identify the reaction order from each of the following rate constants.

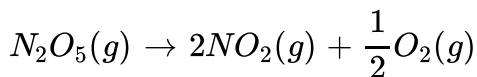
(i) $k = 2.3 \times 10^{-5} Lmol^{-1}s^{-1}$

(ii) $k = 3 \times 10^{-4} s^{-1}$



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

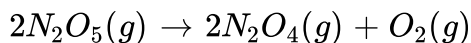


was $1.24 \times 10^{-2} \text{ molL}^{-1}$ at $318K$. The concentration of N_2O_5 after 60 min was $0.20 \times 10^{-2} \text{ molL}^{-1}$. Calculate the rate constant of the reaction at $318K$.



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



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

Calculate the rate constant.



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7. A first order reaction is found to have a rate constant $k = 5.5 \times 10^{-14} s^{-1}$. Find half-life of the reaction.

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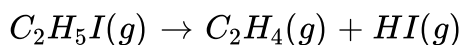
8. When reaction is completed 99.9%, $[R]_n = [R]_0 - 0.999[R]_0$

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9. The rate constant of a reaction at $500K$ and $700K$ are $0.02s^{-1}$, respectively. Calculate the values of E_a and A at $500K$.

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10. The first order rate constant for the decomposition of C_2H_5I by the reaction.



at 600K is $1.60 \times 10^{-5}\text{s}^{-1}$. Its energy of activation is 209kJmol^{-1} .

Calculate the rate constant at 700K

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

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

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13. The conversion of 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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14. A first order reaction has a rate constant $1.15 \times 10^{-3} s^{-1}$. How long will $5g$ of this reactant take to reduce to $3g$?

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

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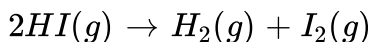
16. What will be effect of temperature on rate constant ?

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

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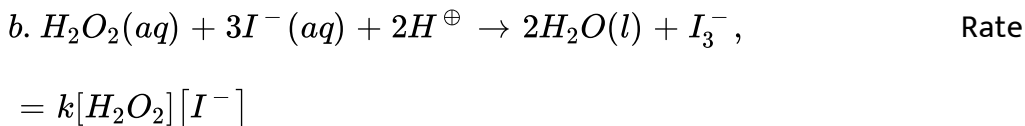
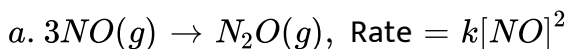
18. The activation energy for the reaction :

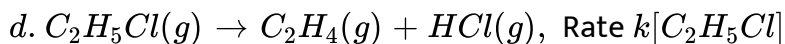
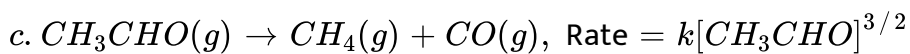


is $209.5 \text{ kJ mol}^{-1}$ at 581 K . Calculate the fraction of molecules of reactants having energy equal to or greater than activation energy ?

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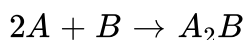
19. From the rate expression for the following reactions, determine their order of reaction and dimensions of the rate constants.





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20. For the reaction :



the rate = $k[A][B]^2$ with $k = 2.0 \times 10^{-6} \text{ mol}^{-2} \text{ L}^2 \text{ s}^{-1}$. Calculate the

initial rate of the reaction when $[A] = 0.1 \text{ mol L}^{-1}$, $[B] = 0.2 \text{ mol L}^{-1}$.

Calculate the rate of reaction after $[A]$ is reduced to 0.06 mol L^{-1} .

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21. The rate of decomposition of NH_3 on platinum surface is zero order.

What are rate of production of N_2 and H_2 if $k = 2.5 \times 10^{-4} \text{ Ms}^{-1}$?

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

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

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

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

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



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23. Mention the factors that affect the rate of a chemical reaction.



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

(a) doubled, (b) reduced to 1/2?

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25. What is the effect of temperature on the rate constant of a reaction ?

How can this temperature effect on rate constant be represented quantitatively ?

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26. In a pseudo first order hydrolysis of ester in water the following results were obtained:

t/s	0	30	60	90
[Ester]	0.55	0.31	0.17	0.085

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

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

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27. A reaction is first order in A second order in B :

(i) write differential rate equation.

(ii) How is the rate affected when the concentration of B is tripled ?

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

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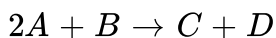
28. In a reaction between A and B , the initial rate of reaction was measured for different initial concentration of A and B as given below:

A / M	0.20	0.20	0.40	
B / M	0.30	0.10	0.05	Calculate the
r_0 / Ms^{-1}	5.07×10^{-5}	5.07×10^{-5}	7.6×10^{-5}	

order of reaction w.r.t. A and B .

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29. The following rate data were obtained at 303K for the following reaction:



Exp	[A] (mol L ⁻¹)	[B] (mol L ⁻¹)	Initial rate of formation of D
I	0.1	0.1	$6.0 \times 10^{-3} \text{ mol L}^{-1} \text{ min}^{-1}$
II	0.3	0.2	$7.2 \times 10^{-2} \text{ mol L}^{-1} \text{ min}^{-1}$
III	0.3	0.4	$2.88 \times 10^{-1} \text{ mol L}^{-1} \text{ min}^{-1}$
IV	0.4	0.1	$2.4 \times 10^{-2} \text{ mol L}^{-1} \text{ min}^{-1}$

What is the rate law? What is the order with respect to each reactant and the overall order? Also calculate the rate constant and write its units.

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

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

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

a. $200s^{-1}$, b. $2min^{-1}$, c. $4years^{-1}$

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32. 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. Estimate the age of the sample.

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

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

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

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

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37. For the decomposition of azoisopropane to hexane and nitrogen at 54K , the following data are obtained.

t (sec)	P (mm of Hg)
0	35.0
360	54.0
720	63.0

Calculate the rate constant.

Calculate the rate constant.



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



Experiment	Time/ s^{-1}	Total pressure/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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39. The rate constant for the decomposition of N_2O_5 at various temperatures

is given below:

$T/^{\circ}\text{C}$	0	20	40	60	80
$10^5 \times k/\text{s}^{-1}$	0.0787	1.70	25.7	178	2140

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

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

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41. 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 100s if the initial concentration of A is 1.0molL^{-1} .

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

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43. The decomposition of hydrocarbon follows the equation

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

Calculate E_a .

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44. The rate constant for the first order decomposition of a certain reaction is described by the equation

$$\log k(\text{s}^{-1}) = 14.34 - \frac{1.25 \times 10^4 \text{K}}{T}$$

(a) What is the energy of activation for the reaction?

(b) At what temperature will its half-life period be 256 min ?



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



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



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



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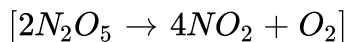
Exercise

1. The concentration of a reactant changes from $0.03M$ to $0.02M$ in 25 min . Calculate the average rate of reaction using of time both in minutes and seconds.

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Solved Example

1. The experimental data for decomposition of N_2O_5



in gas phase at 318K are given below:

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

- (i) Plot $[N_2O_5]$ against t .
- (ii) Find the half-life period for the reaction.
- (iii) Draw a graph between $\log[N_2O_5]$ and t .
- (iv) What is the rate law ?
- (v) Calculate the rate constant.
- (vi) Calculate the half-life period from k and compare it with (ii).



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