



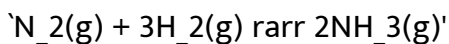
CHEMISTRY

BOOKS - BETTER CHOICE PUBLICATION

CHEMICAL KINETICS

Question Bank

1. Express the instantaneous rate of the reaction



In terms of various reactants and products.

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2. Define rate constant (k).

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3. What is the difference between instantaneous rate of a reaction and rate constant?

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4. For a reaction : $X \rightarrow Y$, what is the significance of plus and minus signs in the following expression ?

$$\text{rate} = \frac{-d[X]}{dt} = \frac{+d[Y]}{dt}$$

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5. What are the units of rate constant for a third order reaction ?

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6. Unit of rate constant for zero order reaction is

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7. Unit of rate constant for zero order reaction is

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8. Write the unit of the rate constant for a gaseous reaction for 1st order.

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9. What is the order of the reaction if the unit of rate constant is s^{-1} ?

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10. What is the unit of rate constant for second order reaction ?

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11. Explain the rate law.

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12. Define order of a reaction

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13. Does a zero order reaction has zero molecularity?

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14. Give four characteristics of rate constant.



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15. Can order of a reaction be fractional ? Give an example.



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16. Give one example of zero order reaction.



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17. Define molecularity of a reaction.



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18. Define average rate of a reaction.



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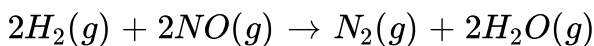
19. Write two three difference between average rate of reaction and instantaneous rate of reaction

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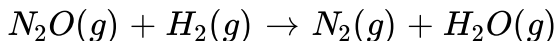
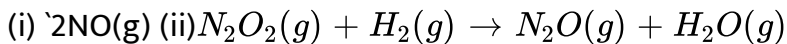
20. The rate of a zero reaction does not change with time. Explain.

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21. For the reaction



the proposed mechanism is as followed



If the second step is the rate determining step then what is the molecularity of the reaction

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22. If rate of reaction between a and B is expressed as $k[A][B]^2$, the reaction is

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23. The rate law for a reaction is

$$\text{Rate} = k[A]^{1/2}[B]^2$$

Can the reaction be an elementary reaction. Explain.

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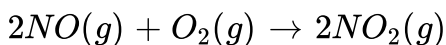
24. What is difference between order of reaction and molecularity of reaction ?

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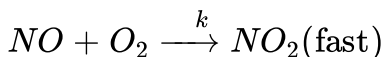
25. Explain why reactions with molecularity of three or more are rare ?

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26. Nitric oxide reacts with oxygen to produce nitrogen dioxide.

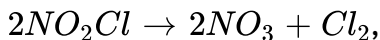


What is the predicted rate law, if the mechanism is ,



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27. The rate expression for the chemical reaction,



is given as : Rate = $k[NO_2Cl]$

Propose a possible mechanism for the above reaction and give the order of the reaction.

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28. Explain the factors affecting rate of a reaction.

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29. Discuss briefly the effect of concentration on the rate of a reaction.

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30. What is the effect of exposure to radiation on the rate of a chemical reaction.

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31. What is the effect of surface area on the rate of chemical reaction.

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32. Define half life period of a reaction.

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33. Define zero order reaction. Derive integrated rate equation for rate constant of a zero order reaction.

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34. Derive an expression for half life period of a zero order reaction.

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35. Derive the integrated rate equation for the rate constant for a first order reaction. What would be units of the first order rate constant, if

the concentration is expressed in moles per litre and time to seconds ?

Also give graphical representation of integrated rate law equation.

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36. Show that for a first order reaction, the time taken to complete half of the change is Independent of the initial concentration of the reactant.

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37. What are the difference between zero order and first order reactions.

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38. Explain with suitable example how the molecularity of a reaction is different from the order of reaction ?



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39. What are pseudochemical or pseudo-order reactions ? Give one example.



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40. What are pseudochemical reactions ? Give an example.



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41. Define threshold energy and activation energy. How are they related?



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42. What Is activated complex ?



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43. The energy of activation of a reaction cannot be zero. Explain.



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44. What is temperature coefficient of a reaction ? Why temperature coefficient for most of the reactions at room temperature is nearly two ?



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45. The rate of reactions become double by rise of 10° temperature. Explain



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46. What is the effect of temperature on rate of a reaction.

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47. What is Arrhenius equation to describe the effect of temperature on rate of a reaction ? How can it be used to calculate the activation energy of a reaction ?

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48. How is rate constant of a reaction related to its activation energy?

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49. Explain the effect of catalyst on the rate of reaction with diagram.

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50. Define collision frequency. Write short note on collision theory of chemical reactions.

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51. Write two postulates of collision theory of reaction rates.

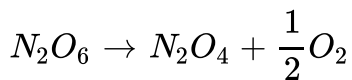
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Numerical Problems

1. The rate constant of a reaction is $1.5 \times 10^7 \text{ sec}^{-1}$ at 50°C and $4.5 \times 10^7 \text{ sec}^{-1}$ at 100°C . Calculate energy of the activation for the reaction.

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2. The rate constant for the decomposition of N_2O_6 ,



is 3.46×10^{-5} at 25°C and 4.87×10^{-3} at 65°C . Calculate the energy of activation of the reaction.

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3. The first order rate constant for the decomposition of ethyl iodide by the reaction $C_2H_5I(g) \rightarrow C_2H_4(g) + HI(g)$ at 600K is $1.60 \times 10^{-5} \text{ s}^{-1}$. Its energy of activation is 209 kJ/mol. Calculate the rate constant of the reaction at 700K.

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4. The three fourth of a first order reaction is completed in 32 minutes. What is the half-life period of the reaction ?

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5. 60% of a first order reaction was completed in 60 minutes. When was it half completed ?

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6. A first order reaction is 75% complete in 60 min. Find the half-life of the reaction.

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7. Ammonia and oxygen react at high temperature as $4NH_3(g) \rightarrow 4NO(g) + 6H_2O(g)$ in an experiment, the rate of formation of NO is $3.6 \times 10^{-3} molL^{-1} sec^{-1}$. Calculate the rate on formation of H_2O .

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8. The reaction $2N_2O_5(g) \rightarrow NO_2(g) + O_2(g)$ takes place in a closed container. It is found that the concentration of NO_2 increases by $1.6 \times 10^{-2} mol L^{-1}$ in four seconds. Calculate the rate of change of concentration of N_2O_5 .

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9. A reaction $3X \rightarrow 2Y + Z$ proceeds in a closed vessel. The rate of disappearance of X is found to be $0.072 mol L^{-1} s^{-1}$. Calculate the rate of appearance of Y.

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10. A first order reaction is 50% complete in 69.3 minutes. Calculate the time for 80% completion of the reaction.

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11. A first order reaction is 20% complete in the 10 minutes. Calculate the time period for 75% completion of the reaction.

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12. A first order reaction is 15% complete in 20 minutes. How long will it take to complete 60%?

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13. A first order reaction is 20% complete in the 10 minutes. Calculate the time period for 75% completion of the reaction.

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14. A first order reaction is 15% complete in 20 minutes. How long will it take to complete 60%?



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15. A first order reaction is 40% complete in 50 minutes. In what time will the reaction be 80% complete ?



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16. The rate constant for the first order reactor becomes three times when the temperature is raised from 20°C to 50°C . Calculate the energy of activation for the reaction.



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17. The rate constant for a first order reaction becomes six times when the temperature is raised from 350 K to 400 K. Calculate activation energy for the reaction.



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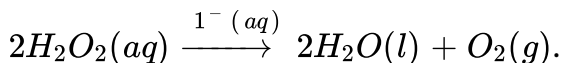
18. The rate constant for a first order reaction becomes six times when the temperature is raised from 350 K to 400 K. Calculate activation energy for the reaction.

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19. For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$ The rate of reaction measured as $\frac{\Delta[NH_3]}{\Delta t}$ we found to be $2 \times 10^{-4} \text{ mol L}^{-1} \text{ sec}^{-1}$. Calculate the rate of reaction expressed in terms of N_2 .

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20. The decomposition of hydrogen peroxide in the presence of iodide ion has been found to be first order in H_2O_2 :



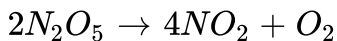
The rate constant has been found to be $1.01 \times 10^{-2} \text{ min}^{-1}$:

(a) Calculate the rate of reaction when $[H_2O_2] = 0.4 \text{ mol lit}^{-1}$.

(b) What concentration of $[H_2O_2]$ would give a rate of $1.12 \times 10^{-2} \text{ mol lit}^{-1} \text{ min}^{-1}$?

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21. For the reaction :

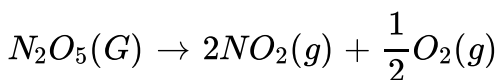


the rate of reaction measured as $\frac{\Delta[NO_2]}{\Delta t}$ was found to be $4 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$. Calculate the rate of reaction, expressed in terms of N_2O_5

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22. The decomposition of N_2O_5 in carbon tetrachloride solution has been found to be first order with respect to N_2O_5 with rate constant,

$$k = 6.2 \times 10^{-4} \text{ s}^{-1}$$



What concentration of N_2O_5 would give a rate of $4.2 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$?

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23. For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$ The rate of reaction measured as $\frac{\Delta[NH_3]}{\Delta t}$ we found to be $2 \times 10^{-4} \text{ mol L}^{-1} \text{ sec}^{-1}$.

Calculate the rate of reaction expressed in terms of N_2 .

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24. The rate of a reaction $A \rightarrow B$ has the rate law, rate = $k[A]$ with the rate constant, $k = 0.50 \text{ sec}^{-1}$.

What concentration of A would give a rate of $2.4 \times 10^{-2} \text{ mol L}^{-1} \text{ sec}^{-1}$?

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25. The rate constants of a reaction at 300 and 320 K are $0.0231s^{-1}$ and $0.0693s^{-1}$ respectively. Calculate the value of activation energy of the reaction. [$R=8.314J K^{-1}mol^{-1}$, $\log 3 = 0.4771$]

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26. The rate of decomposition of hydrogen peroxide at a particular temperature was measured by titrating its solution with acidic $KMnO_4$ solution. Following results were obtained :

Time t (s)	0	10	20
Vol. of $KMnO_4$ (ml)	11.4	6.9	4.15

Show that the reaction is of first order.

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

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28. The rate of decomposition of hydrogen peroxide at a particular temperature was measured by titrating its solution with acidic $KMnO_4$ solution. Following results were obtained.

time, t (min)	0	10	20
Vol. of $KMnO_4$ (ml.)	22.8	13.8	8.3

Show that the reaction is of first order.

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29. The rate constants of a reaction at 300 and 320 K are $0.0231s^{-1}$ and $0.0693s^{-1}$ respectively. Calculate the value of activation energy of the reaction. [$R=8.314J K^{-1}mol^{-1}$, $\log 3 = 0.4771$]

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

Time t(s)	0	30	60
Ester (mol L^{-1})	0.55	0.31	0.17

Calculate the pseudo first order rate constant

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31. For a chemical reaction $X \rightarrow Y$, the rate. increases by a factor 2.25 when the concentration of X is increased by 1.5. What is the order of reaction ?

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32. The rate of a reaction $2A + B \rightarrow A_2B$.

has rate law : rate = $k [A]^2$ with the rate constant equal to $0.50 \text{ mol}^{-1} \text{ L sec}^{-1}$. Calculate the rate of reaction when

(i) $[A] = 0.60 \text{ mol L}^{-1}$, $[B] = 0.05 \text{ mol L}^{-1}$ and

(ii) When concentration of A and B have been reduced to 1/4 th

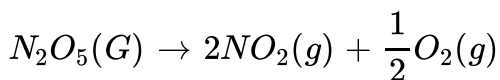
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33. For a chemical reaction $A \rightarrow B$, the rate of reaction doubles when the concentration of A is doubled. What is the order of reaction ?

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34. The decomposition of N_2O_5 in carbon tetrachloride solution has been found to be first order with respect to N_2O_5 with rate constant,

$$k = 6.2 \times 10^{-4} \text{ s}^{-1}$$



Calculate the rate of reaction when

$$[N_2O_5] = 2.50 \text{ mol L}^{-1}$$

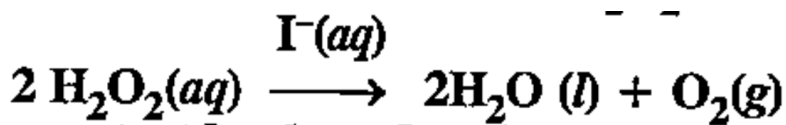
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35. For a chemical reaction $R \rightarrow P$, the rate of reaction does not change when the concentration of R is changed. What is the order of reaction ?

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36. The decomposition of H_2O_2 , in the presence of Iodide ion has been found to be first order in H_2O_2 .

The rate constant has been found to be $1.01 \times 10^{-2} \text{ min}^{-1}$. What concentration of H_2O_2 would give rate of $1.12 \times 10^{-2} \text{ mol L}^{-1} \text{ min}^{-1}$?



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37. A first order reaction taken 16 minutes for 50% completion. How much time will it take for 75% completion ?

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38. A first order reaction taken 32 minutes for 50% completion. How much time will it take for 90% completion ?

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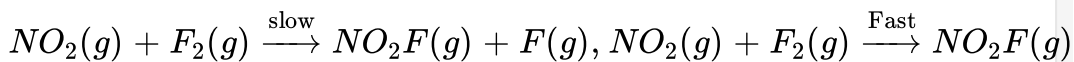
39. A first order reaction taken 45.4 minutes for 50% completion. How much time will it take for 60% completion ?

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40. Rate constant for a first order reaction is $60s^{-1}$. How much time will it take to reduce the concentration of the reaction on $\frac{1}{10}$ th of its initial value.

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41. Reaction between NO_2 and F_2 to give NO_2F takes place by the following mechanism:



Write the rate expression and order of the reaction.

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42. Calculate two-third life of a first order reaction having

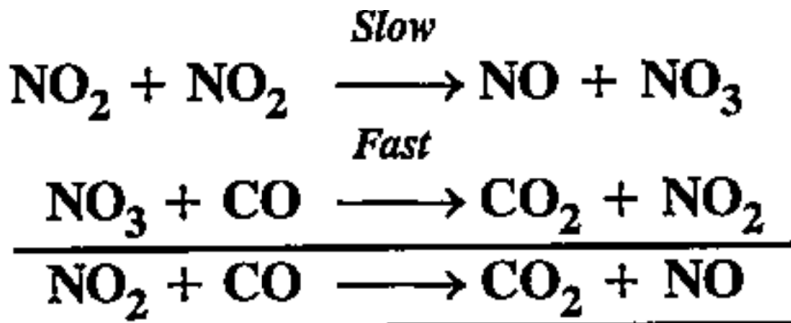
$$k = 5.48 \times 10^{-14} s^{-1}$$

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43. Reaction between NO_2 and CO to give CO_2 and NO takes place by the following mechanism:

Write the rate expression and order of the reaction. What is the unit of

rate constant ?



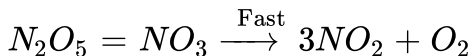
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44. The half life period for a reaction of first order is 2.31×10^3 min.

How long will it take for $\frac{1}{5^{\text{th}}}$ of the reactants to be left behind.

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45. Thermal decomposition of dinitrogen pentoxide takes place by the following mechanism :



Write the rate expression and order of the reaction.



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46. A reaction is of first order in reactant A and of second order in reactant B. How is rate of reaction affected when

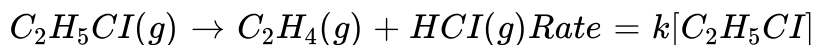
(a) Concentration of B alone is increased to three times.

(b) The concentration of A as well as B is doubled.



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



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48. For a decomposition reaction, the values of rate constants, k at two different temperatures are given below :

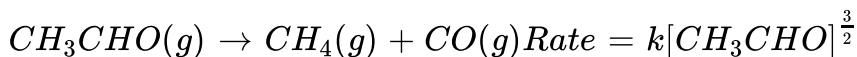
$$k_1 = 2.15 \times 10^{-7} \text{ L mol}^{-1} \text{ s}^{-1} \text{ at } 650\text{K}$$

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

calculate activation energy for the reaction.

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



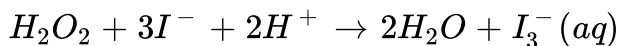
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50. In general it is observed that the rate of a chemical reaction becomes double for every 10° rise in temperature. If this generalisation holds for a reaction in the temperature range 2908 K to 398 K, what would be the value of activation energy for the reaction.

$$(R=8.314 \text{ J K}^{-1} \text{ mol}^{-1})$$

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51. State the order with respect to each reactant and overall order for the following reaction :



$$\text{Rate} = K[H_2O_2][I^-]$$

What are the units of rate constant?

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52. The rate constant for a first order reaction becomes six times when the temperature is raised from 350 K to 400 K. Calculate activation energy for the reaction.

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53. 60% of a first order reaction was completed in 60 minutes. When was it half completed ?

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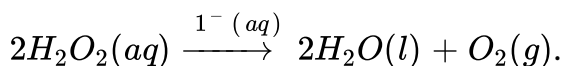
54. A first order reaction takes 69.3 minutes for 50% completion. Calculate the time required for 80% completion of the reaction.

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55. The half life period for a reaction of first order is 2.31×10^3 min. How long will it take for $\frac{1}{5^{th}}$ of the reactants to be left behind.

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56. The decomposition of hydrogen peroxide in the presence of iodide ion has been found to be first order in H_2O_2 :



The rate constant has been found to be $1.01 \times 10^{-2} \text{ min}^{-1}$:

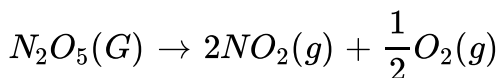
(a) Calculate the rate of reaction when $[H_2O_2] = 0.4 \text{ mol lit}^{-1}$.

(b) What concentration of $[H_2O_2]$ would give a rate of $1.12 \times 10^{-2} \text{ mol lit}^{-1} \text{ min}^{-1}$?

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57. The decomposition of N_2O_5 in carbon tetrachloride solution has been found to be first order with respect to N_2O_5 with rate constant,

$$k = 6.2 \times 10^{-4} \text{ s}^{-1}$$



Calculate the rate of reaction when

$$[N_2O_5] = 2.50 \text{ mol L}^{-1}$$

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58. The rate of a reaction $2A + B \rightarrow A_2B$.

has rate law : rate = $k [A]^2$ with the rate constant equal to $0.50 \text{ mol}^{-1} \text{ L sec}^{-1}$. Calculate the rate of reaction when

(i) $[A] = 0.60 \text{ mol L}^{-1}$, $[B] = 0.05 \text{ mol L}^{-1}$ and

(ii) When concentration of A and B have been reduced to $1/4$ th

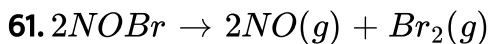
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59. First order reaction is found to have rate constant, $k = 5.5 \times 10^{-14} \text{ s}^{-1}$. Find the half life to the reaction.

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60. The half-life period of a chemical reaction is 1443.6 sec, find out k for this reaction.

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$$\text{Rate} = k[\text{NOBr}]_2$$

What are the units of rate constant.?



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62. A first order reaction is 20% complete in 20 minutes. Calculate the time it will take the reaction to complete 80%.



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63. Calculate the time required for the completion of 90% of a reaction of first order kinetics, $t_{\frac{1}{2}} = 44.1$ minutes.



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