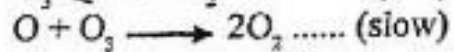
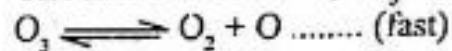


The chemical reaction, $2O_3 \longrightarrow 3O_2$ proceeds as follows:



The rate law expression should be:

- a. $r = K [O_3]^2$ b. $r = K [O_3]^2 [O_2]^{-1}$ c. $r = K [O_3][O_2]$ d. Unpredictable

$$K_c = \frac{[O_2][O]}{[O_3]} \rightarrow [O] = \frac{K_c [O_3]}{[O_2]}$$

$$r = k' [O][O_3]$$

$$r = \frac{k' K_c [O_3]^2}{[O_2]} ; r = \frac{k [O_3]^2}{[O_2]}$$

A hydrogenation reaction is carried out at 500 K.

If the same reaction is carried out in presence of a catalyst at the same rate, the temperature required is 400 K. Calculate the activation energy of the reaction if the catalyst lowers the activation energy barrier by 20 kJ mol⁻¹.

$$k = A e^{-\frac{E_a}{RT}}$$

$$k_1 = A e^{-\frac{E_a}{R \cdot 500}} \quad \text{①}$$

$$k_2 = A e^{-\frac{E_a'}{R \cdot 400}}$$

$$r_1 = r_2, \quad k_1 = k_2$$

$$\frac{E_a}{500R} = \frac{E_a'}{400R}$$

$$\frac{E_a}{500} = \frac{E_a - 20}{400}$$

$$E_a - E_a' = 20$$

$$E_a = 100 \text{ kJ/mole}$$

3. Mechanism of a hypothetical reaction

$X_2 + Y_2 \rightarrow 2XY$, is given below :

- (i) $X_2 \rightarrow X + X$ (fast)
- (ii) $X + Y_2 \rightleftharpoons XY + Y$ (slow) ✓
- (iii) $X + Y \rightarrow XY$ (fast)

The overall order of the reaction will be

- (a) 2 (b) 0 ~~(c) 1.5~~ (d) 1 (2017)

$$K_c = \frac{[X]^2}{[X_2]}$$

$$r = k' [X][Y_2]$$

$$[X]^2 = K_c [X_2]$$

$$[X] = K_c^{1/2} [X_2]^{1/2}$$

$$r = k' K_c^{1/2} (X_2)^{1/2} (Y_2)^1$$

$$r = K (X_2)^{1/2} (Y_2)^1$$

10. In a reaction, $A + B \rightarrow \text{product}$, 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) $\text{rate} = k[A][B]^2$

(b) $\text{rate} = k[A]^2[B]^2$

(c) $\text{rate} = k[A][B]$

(d) $\text{rate} = k[A]^2[B]$ (2012)

$$r = k[A][B]$$

$$8r = [2]^3 \text{ — Over all order}$$

$$2r = [2]^1$$

$$\boxed{[B]^1[A]^2}$$

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

- (a) Order can be determined only experimentally.
- (b) Order is not influenced by stoichiometric coefficient of the reactants.
- (c) Order of a reaction is sum of power to the concentration terms of reactants to express the rate of reaction.

(d) Order of reaction is always whole number. (2011)

↳ 0, -ve, +ve, fractions

16. The half-life of a substance in a certain enzyme-catalysed reaction is 138 s. The time required for the concentration of the substance to fall from 1.28 mg L^{-1} to 0.04 mg L^{-1} is

- (a) 414 s (b) 552 s (c) 690 s (d) 276 s

(2011)

$$T = n t_{1/2}$$

↳ 5

$$C_t = \frac{C_0}{(2)^n} \rightarrow \text{left}$$

$$5 \times 138 = \underline{\underline{690 \text{ sec}}}$$

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

(a) $\frac{\log 2}{k}$

(b) $\frac{\log 2}{k\sqrt{0.5}}$

~~(c)~~ $\frac{\ln 2}{k}$

(d) $\frac{0.693}{0.5k}$

(2007)

$$k = \frac{2.303}{t} \log_{10} \frac{a}{a-x}$$

$$k = \frac{2.303}{t_{1/2}} \log_{10} \frac{a}{a-a/2}$$

$$t_{1/2} = \frac{2.303}{k} \log_{10} 2 = \frac{\ln 2}{k}$$

32. Which option is valid for a zero order reaction?

(a) $t_{3/4} = \frac{3}{2}t_{1/2}$

(b) $t_{1/2} = \frac{4}{2}t_{3/4}$

(c) $t_{1/2} = 2t_{3/4}$

(d) $t_{3/4} = (t_{1/2})^2$ (2018)

$$k = \frac{C_0 - C_t}{t} \quad t_{50\%} = \frac{C_0 - \frac{C_0}{2}}{k} = \frac{C_0}{2k}$$

$$t = \frac{C_0 - C_t}{k} \quad t_{75\%} = \frac{C_0 - \frac{C_0}{4}}{k} = \frac{3C_0}{4k}$$

$$\frac{t_{50\%}}{t_{75\%}} = \frac{2}{3}$$

$$t_{75\%} = \frac{3t_{50\%}}{2}$$

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

- (a) 2000 K ~~(b)~~ $\frac{1000}{2.303}$ K
- (c) 1000 K (d) $\frac{2000}{2.303}$ K (2008)

$$10^{16} e^{-2000/T} = 10^{15} e^{-1000/T}$$

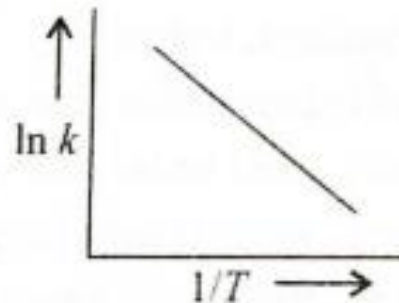
$$e^{-\frac{1000}{T}} = 10^{-1}$$

$$T = \frac{1000}{2.303} \text{ K}$$

34. The temperature dependence of a reaction is represented by the Arrhenius equation :

$$\ln k = -\frac{E_a}{RT} + \ln A$$

Which among the following is wrong conclusion about the given plot?



(a) Intercept of the line = $\ln A$

(b) Slope = $-\frac{E_a}{RT}$

$$\log k = \log A - \frac{E_a}{2.303RT}$$

(c) Reaction with high activation energy is more temperature sensitive than that of low activation energy (E_a).

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

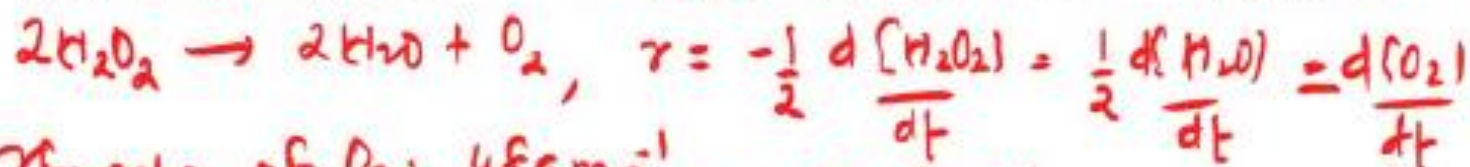
(d) Slope = $-\frac{E_a}{R}$

$$\ln k = \ln A - \frac{E_a}{RT}$$

(2017)

35. During the decomposition of H_2O_2 to give oxygen, 48 g O_2 is formed per minute at a certain point of time. The rate of formation of water at this point is

- (a) $0.75 \text{ mol min}^{-1}$ (b) 1.5 mol min^{-1}
 (c) $2.25 \text{ mol min}^{-1}$ ✓ (d) 3.0 mol min^{-1} (2016)



Formation of $\text{O}_2 = 48 \text{ g min}^{-1} = 1.5 \text{ mol min}^{-1}$

$$\frac{1}{2} \frac{d[\text{H}_2\text{O}]}{dt} = \frac{d[\text{O}_2]}{dt}$$

36. For the reaction $A_{(g)} \rightarrow B_{(g)} + C_{(g)}$, the rate constant is given as (P_i is initial pressure and P_t is pressure at time t)

(a) $k = \frac{2.303}{t} \log \frac{P_i}{P_t}$ ~~(b)~~ $k = \frac{2.303}{t} \log \frac{P_i}{(2P_i - P_t)}$

(c) $k = \frac{2.303}{t} \log \frac{2P_i - P_t}{P_i}$ (d) $k = \frac{2.303}{t} \log \frac{P_i - P_t}{2P_i}$



$$k = \frac{2.303}{t} \log \frac{P_i}{P_i - x}$$

61. At 518 °C, the rate of decomposition of a sample of gaseous acetaldehyde, initially at a pressure of 363 Torr, was 1.00 Torr s⁻¹ when 5% had reacted and 0.5 Torr s⁻¹ when 33% had reacted. The order of the reaction is

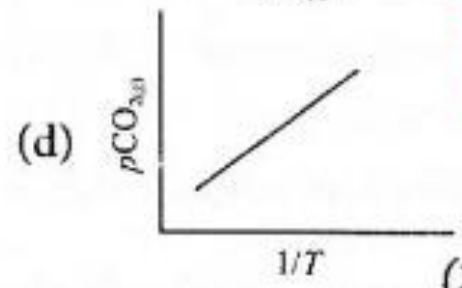
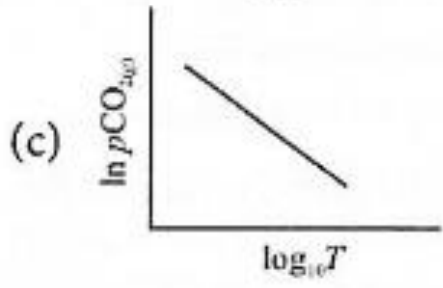
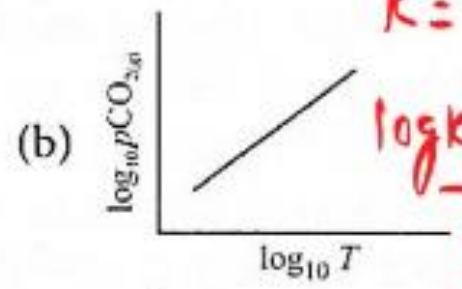
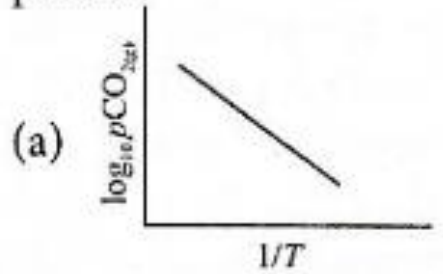
- (a) 2 (b) 3 (c) 1 (d) 0 (2018)

$$r \propto (a-x)^n \quad \text{at } t, \quad r \propto (a-x)^n$$

$$\frac{r_1}{r_2} = \left(\frac{a-x_1}{a-x_2} \right)^n, \quad \frac{1}{0.5} = \left(\frac{100-5}{100-33} \right)^n \quad \underline{\underline{n=2}}$$

$k_p = p_{CO_2}$

57. For the chemical equilibrium,
 $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$,
 ΔH_r° can be determined from which one of the following plots?



$$k = A e^{-\frac{\Delta H_r^\circ}{RT}}$$

$$\log k_p = \log A - \frac{\Delta H_r^\circ}{2.303RT}$$
 slope = $\frac{-\Delta H_r^\circ}{2.303R}$

(2005)

65. Two reactions R_1 and R_2 have identical pre-exponential factors. Activation energy of R_1 exceeds that of R_2 by 10 kJ mol^{-1} . If k_1 and k_2 are rate constants for reactions R_1 and R_2 respectively at 300 K , then $\ln(k_2/k_1)$ is equal to ($R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$)

- (a) 6 ~~(b) 4~~ (c) 8 (d) 12 (2017)

$$k = A e^{-E_a/RT}$$

$$\ln k_1 = \ln A - \frac{E_{a1}}{RT}$$

$$\ln k_2 = \ln A - \frac{E_{a2}}{RT}$$

$$\ln \frac{k_2}{k_1} = \frac{E_{a1} - E_{a2}}{RT} = \frac{\Delta E_a}{RT}$$

$$= \frac{10 \times 10^3}{8.314 \times 300} = 4.0093$$

68. Decomposition of H_2O_2 follows a first order reaction. In fifty minutes the concentration of H_2O_2 decreases from 0.5 to 0.125 M in one such decomposition. When the concentration of H_2O_2 reaches 0.05 M, the rate of formation of O_2 will be

- (a) $6.93 \times 10^{-2} \text{ mol min}^{-1}$ ~~(b) $6.93 \times 10^{-4} \text{ mol L}^{-1} \text{ min}^{-1}$~~
 (c) 2.66 L min^{-1} at STP (d) $1.34 \times 10^{-2} \text{ mol min}^{-1}$

$t_{1/2} = 25 \text{ min}$ rate = $k[\text{H}_2\text{O}_2]$ of H_2O_2 decomposition (2016)

$k = \frac{0.693}{t_{1/2}}$ $\frac{0.693 \times 0.05}{25} = 1.38 \times 10^{-3}$

Rate of $\text{O}_2 = \frac{1}{2}$ rate of decomposition of H_2O_2

$= \frac{1}{2} \times 1.38 \times 10^{-3} = \boxed{6.93 \times 10^{-4}}$

85. In a first order reaction, the concentration of the reactant, decreases from 0.8 M to 0.4 M in 15 minutes. The time taken for the concentration to change from 0.1 M to 0.025 M is

- (a) 30 minutes (b) 15 minutes
(c) 7.5 minutes (d) 60 minutes. (2004)

$$0.8 \longrightarrow 0.4 \quad 15 \text{ min}, \quad \underline{t_{1/2} = 15 \text{ min}}$$

$$0.1 \longrightarrow 0.025$$

$$2t_{1/2} = 2 \times 15 = \underline{30 \text{ min}}$$

78. The half-life period of a first order chemical reaction is 6.93 minutes. The time required for the completion of 99% of the chemical reaction will be

($\log 2 = 0.301$)

(a) 230.3 minutes

(b) 23.03 minutes

(c) 46.06 minutes

(d) 460.6 minutes. (2009)

$$k = \frac{0.693}{6.93}$$

$$k = \frac{2.303}{t} \log_{10} \frac{C_0}{C_t}$$

$$k = \frac{2.303}{t_{99\%}} \log_{10} \frac{100}{1}$$

100. The reaction, $X \rightarrow \text{Product}$, follows first order kinetics. In 40 minutes the concentration of X changes from 0.1 to 0.025 M. The rate of reaction, when concentration of X is 0.01 M is

- (a) $1.73 \times 10^{-4} \text{ M min}^{-1}$ (b) $3.47 \times 10^{-5} \text{ M min}^{-1}$
~~(c) $3.47 \times 10^{-4} \text{ M min}^{-1}$~~ (d) $1.73 \times 10^{-5} \text{ M min}^{-1}$

(2004)

$$0.1 \rightarrow 0.025$$

$$0.1 \quad \text{---} \quad 0.05 \quad \text{---} \quad 0.025$$



$$T = n t_{1/2}$$

$$t_{1/2} = 20 \text{ min}$$

$$\frac{\quad}{2 t_{1/2} = 40}$$

$$r = k[A]$$

↓

$$\frac{0.693}{2} \times 0.01$$

$$t_{1/2}$$

A drop of solution (volume 0.05 mL) contains 3.0×10^{-6} moles of H^+ . If the rate constant of disappearance of H^+ is 1.0×10^7 mole litre⁻¹ sec⁻¹. How long would it take for H^+ in drop to disappear:

- a. 6×10^8 sec b. 6×10^7 sec c. 6×10^9 sec d. 6×10^{10} sec

$$k = \frac{C_0 - C_t}{t}$$

$$k = \frac{C_0}{t}$$

$0.05 \text{ mL} \quad \text{---} \quad 3 \times 10^{-6} \text{ moles}$
 $10^3 \text{ mL} \quad \text{---} \quad ?$

$t = \underline{6 \times 10^{-9} \text{ sec}}$

1×10^7

92. An organic compound undergoes first order decomposition. The time taken for its decomposition to $1/8$ and $1/10$ of its initial concentration are $t_{1/8}$ and $t_{1/10}$ respectively. What is the value of $\frac{[t_{1/8}]}{[t_{1/10}]}$ $\times 10$?

(take $\log_{10} 2 = 0.3$)

(2012)

$$k = \frac{2.303}{t} \log \frac{C_0}{C_t} \quad \text{---} \quad k = \frac{2.303}{t_{1/8}} \log \frac{C_0}{C_0/8}$$

$$k = \frac{2.303}{t_{1/10}} \log \frac{C_0}{C_0/10}$$