

PAPER - 1

1. The generation time of any substance is the time in which its concentration doubles. The growth of a certain bacteria follows first order kinetics. If the population of bacteria triples in 96 hours, what is the generation time (in hours) for it? ($\log 2 = 0.3, \log 3 = 0.48$)

$$\frac{d[A]}{dt} = k[A]$$

$$[A]_t = [A]_0 e^{kt}$$

$$k = \frac{1}{t} \ln \frac{[A]_t}{[A]_0} = \frac{1}{96} \ln 3 = \frac{1}{t} \ln 2$$

4. Find (O – O) bond enthalpy in H_2O_2 (kJ/mol)

Given: $\Delta H_f(\text{H}_2\text{O}_2, l) = -200 \text{ kJ/mol}$



$\Delta H_f(\text{H}_2\text{O}, l) = -285 \text{ kJ/mol}$

$\Delta H_{\text{vap.}}(\text{H}_2\text{O}_2, l) = 60 \text{ kJ/mol}$

$\Delta H_{\text{vap.}}(\text{H}_2\text{O}, l) = 40 \text{ kJ/mol}$

$\Delta H_{\text{atomisation}}(\text{O}_2, g) = 300 \text{ kJ/mol}$

Fill your answer as sum of digits (excluding decimal places) till you get the single digit answer.

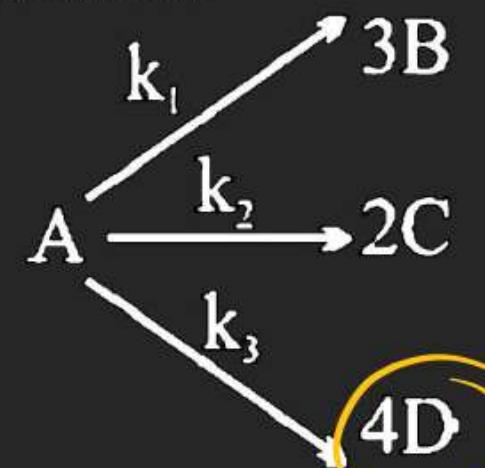


9. Which of the following statements is/are correct:

- (A) The coordination number of each type of ion in CsCl is 8
- (B) A metal that crystallises in BCC structure has a coordination number 8
- (C) A unit cell of an ionic crystal shares some of its ions with other unit cells
- (D) The length of the unit cell in NaCl is 552pm

$$[r_{\text{Na}^+} = 95\text{pm}; r_{\text{Cl}^-} = 181\text{pm}]$$

12. For the 1 order parallel reaction



$$k_1 : k_2 : k_3 = 3 : 2 : 4$$

If $k_1 : k_2 : k_3$ is 1: 2: 3, then, select the correct statement(s) ($[A]_0 = 1M$)

(A) at ∞ time $[C]$ is $2/3M$

(B) $[B]_t > [C]_t$

(C) When $[A]_t = 1/2M$ then $[D] = 1M$

(D) $[A]_t + \frac{[B]_t}{3} + \frac{[C]_t}{2} + \frac{[D]_t}{4} = 1M$

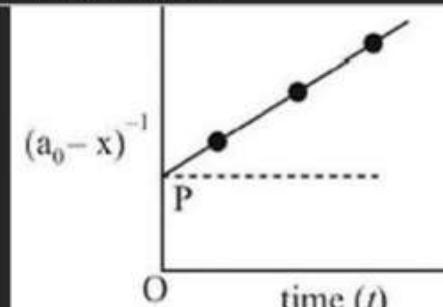
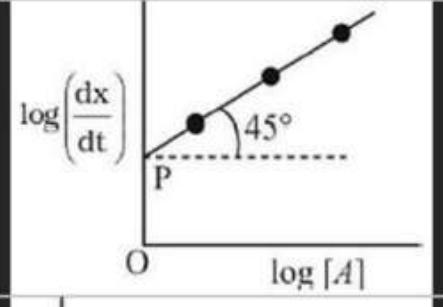
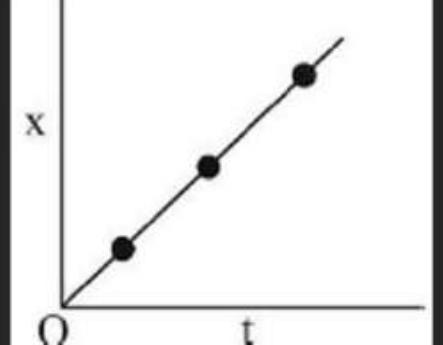
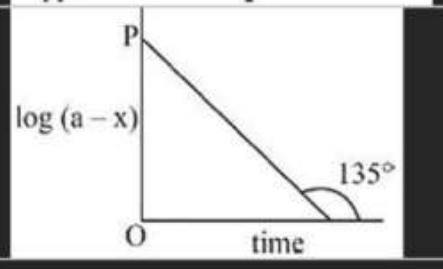
$$\frac{k_3}{k_1+k_2+k_3} \times 1 \times 2$$

$$\frac{3}{6} \times \frac{1}{2} \times 4$$

— —

$$\frac{k_2}{k_1+k_2+k_3} \times 1 \times 2$$

15. Match the graph in Column I with their, related properties in Column II.

	Column I		Column II
(P)		(1)	Rate constant is equal to rate of reaction
(Q)		(2)	If OP = 0.5 [A]₀ = 2
(R)		(3)	If OP = 0.3010 Half-life = 0.693 at [A]₀ = 2M
(S)		(4)	If OP = 0.3010k = 2
		(5)	Half-life is independent of initial concentration
		(6)	Rate becomes 4 times on doubling [A]

(A)(P - 2, 6; Q - 1; R - 4, 5; S - 3, 5)

(B)(P - 4, 5; Q - 2, 6; R - 1; S - 3, 5)

(C)(P - 2, 6; Q - 4, 5; R - 3, 5; S - 1)

(D)(P - 2, 6; Q - 4, 5; R - 1; S - 3, 5)

$$\log \frac{dx}{dt} = \log k + \log [A]^n$$

$$\frac{dx}{dt} = k [A]^n$$

Q.9 For which of the following process entropy of system containing ideal gas increases

T (A) Single stage adiabatic compression

$$\Delta S_{SWR} = 0$$

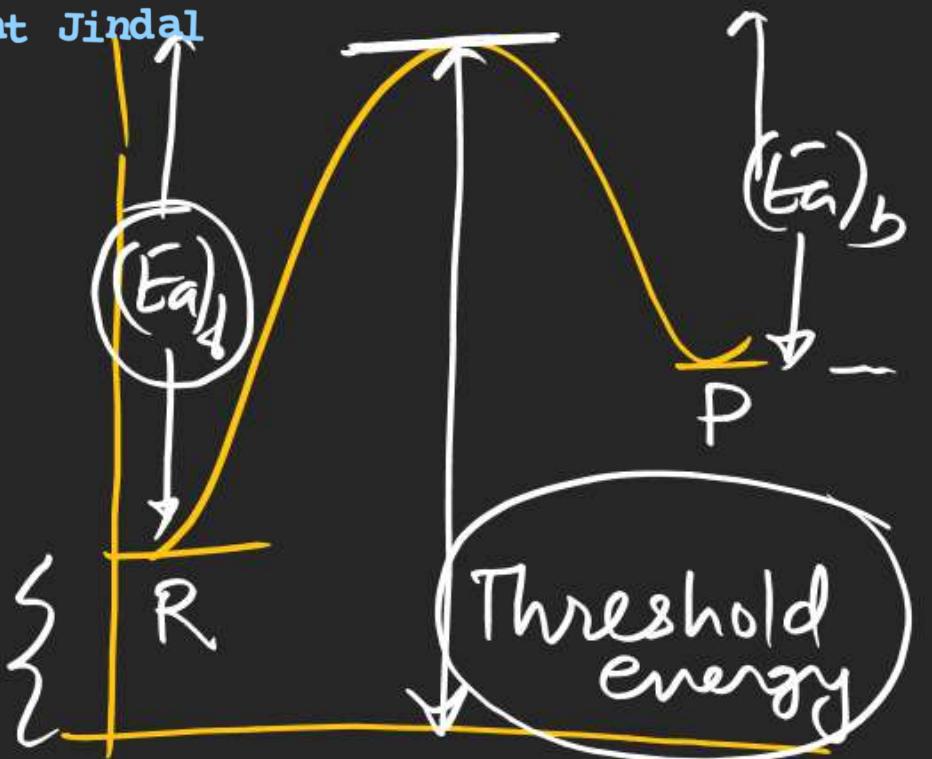
F (B) Reversible adiabatic expansion $\Delta S = 0$

T (C) Irreversible adiabatic expansion

F (D) Isobaric cooling

$$\Delta S = nC_p \ln \frac{T_2}{T_1} + nR \ln \frac{P_1}{P_2}$$

PE



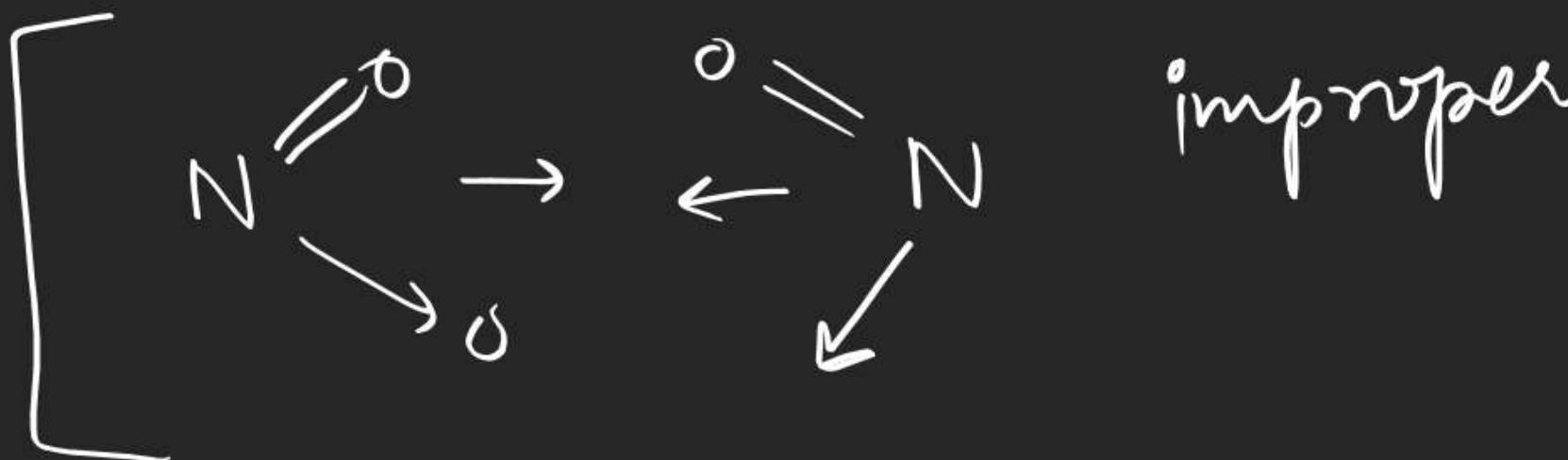
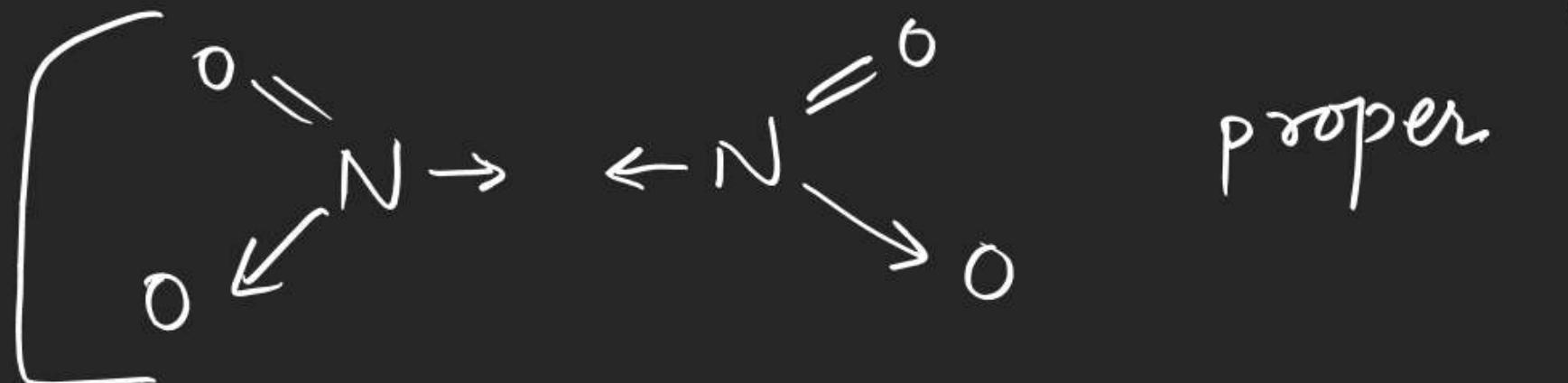
Rxn coordinate

$$\Delta H = (E_a)_f - (E_a)_b$$



Threshold energy: Minimum Energy required to form product is called threshold energy

② Orientation barrier : →



Probability of proper orientation (steric factor) = P

$$\text{Rate} = \Sigma_{AB} \times e^{-E_a/RT} \times P$$

$$\text{Rate} = \underbrace{\pi \sigma^2 V_{\text{rel}}(N_A)^2 P}_{\text{Collision frequency}} \underbrace{e^{-E_a/RT}}_{[A][B]} [A][B]$$

$$= \frac{A e^{-E_a/RT}}{} [A][B]$$

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

$$\boxed{k = A e^{-E_a/RT}} \leftarrow \begin{array}{l} \text{Arrhenius} \\ \text{eqn} \end{array}$$

rate constant

A = frequency factor
or
Arrhenius const

or
pre-exponential factor

$$\Sigma_{AB} = \pi \sigma^2 V_{\text{rel}}(N_A)^2 [A][B]$$

↑
collision
frequency

$$\sigma = \sigma_A + \sigma_B$$

V_{rel} = relative speed of
A w.r.t B

Acc to Arrhenius
A & E_a are temperature
independent.

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

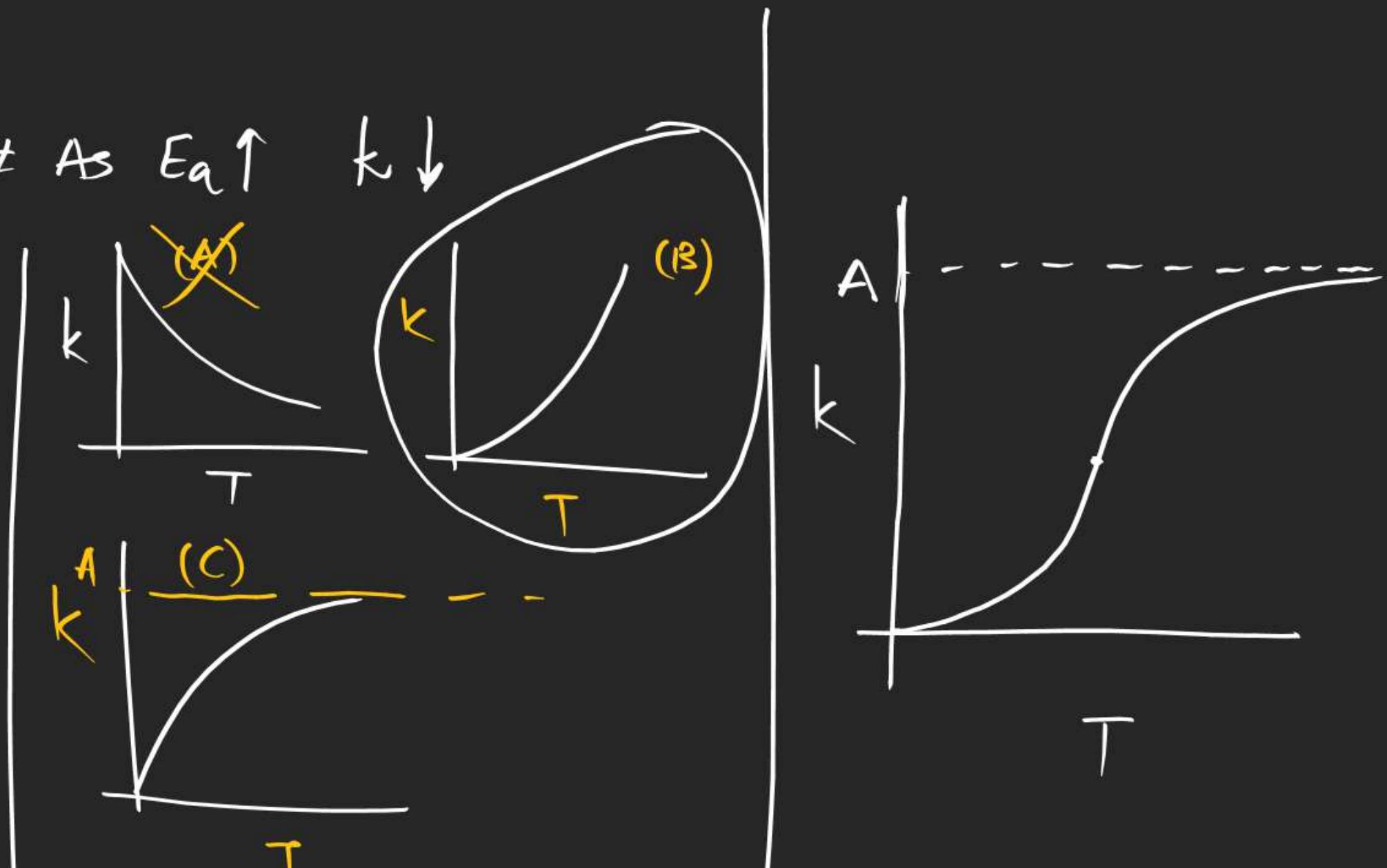
As $T \uparrow$ $k \uparrow$

As $T \uparrow$ rate also rises
mainly because fraction of
molecules having $KE > E_a$
increases.

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

$T \rightarrow \infty$ $k \rightarrow A$

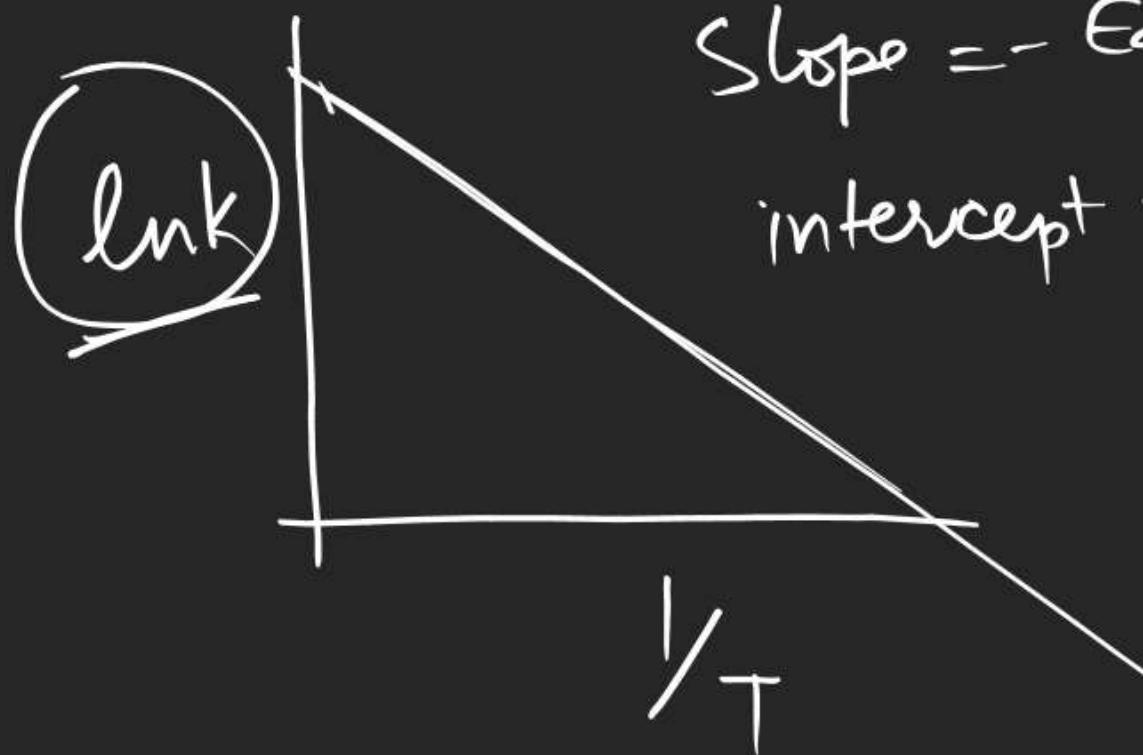
As $E_a \uparrow$ $k \downarrow$



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

$$y = e^{-\frac{1}{x}}$$

$$\ln k_1 = \ln A - \frac{E_a}{R} \left(\frac{1}{T_1} \right) \quad \textcircled{1} \quad \ln k_2 = \ln A - \frac{E_a}{R} \left(\frac{1}{T_2} \right) \quad \textcircled{2}$$



$$\text{slope} = -E_a/R$$

$$\text{intercept} = \ln A$$

rate const

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R} \left[\frac{1}{T_1} - \frac{1}{T_2} \right]$$

eglb^m const

$$\ln \frac{K_2}{K_1} = \frac{\Delta H}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$



$$E_a = 20 \text{ kJ}$$

$$\frac{200}{100} \left(\frac{k_{T_2}}{k_{T_1}} \right) < \left(\frac{k_{T_2}}{k_{T_1}} \right) 40$$



$$E_a = 40 \text{ kJ}$$

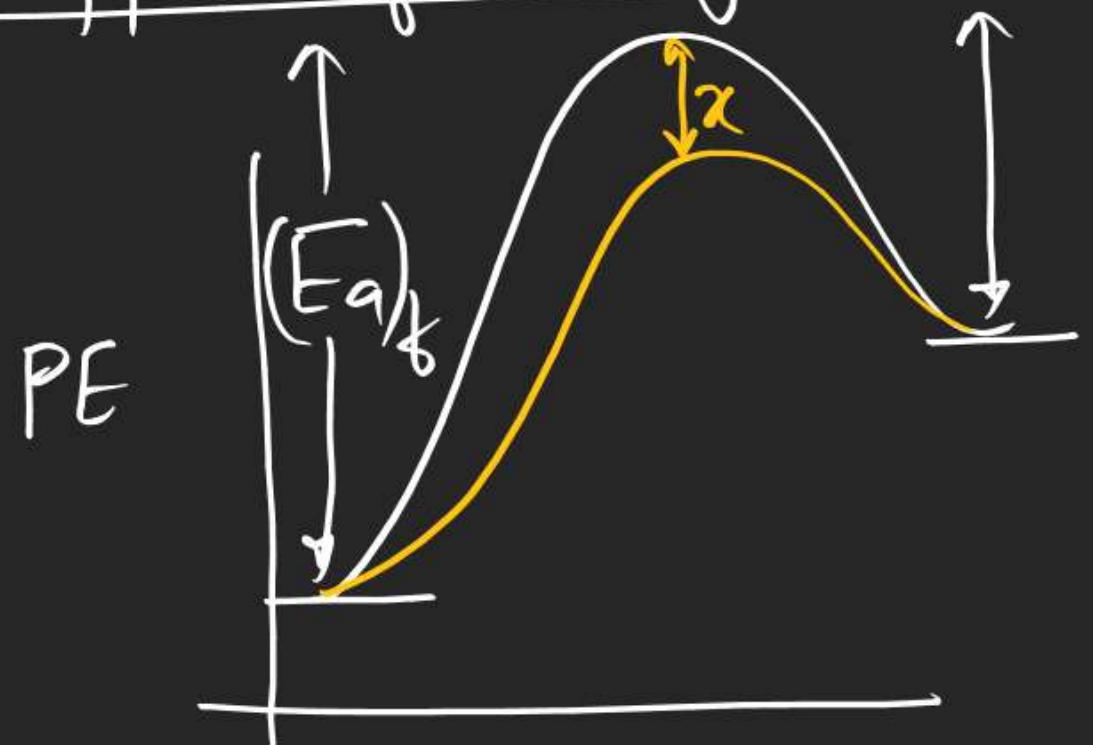
$$\ln \frac{k_2}{k_1} = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$



$$\frac{k_{310}}{k_{300}} > \frac{k_{410}}{k_{400}}$$

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R} \left(\frac{T_2 - T_1}{T_1 T_2} \right)$$

Effect of catalyst



$$k_f = A_f e^{-(E_a)_f / RT}$$

$$k'_f = A_f e^{-[(E_a)_f - x] / RT}$$

$$= \underbrace{A_f e^{-(E_a)_f / RT}}_{\text{constant factor}} e^{x / RT}$$

$$\frac{k'_f}{k'_b} = \frac{k_f}{k_b} = k_{eq}$$

$$k'_f = k_f e^{x / RT}$$

$$k'_b = k_b e^{x / RT}$$

Remaining

