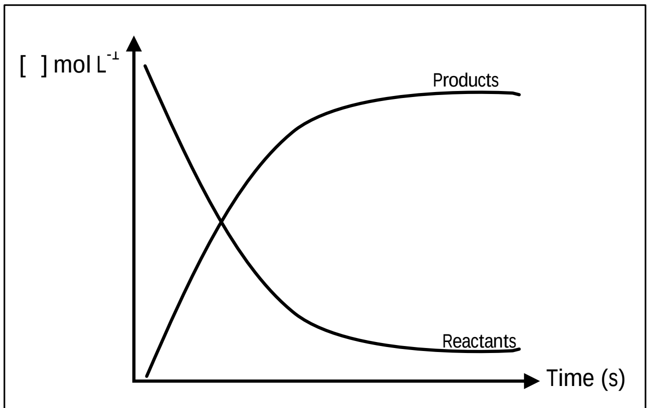
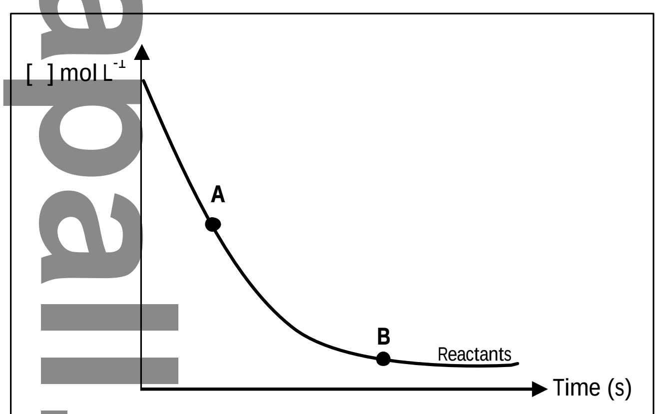
Graphs: Kinetic Unit

1) Reactant and Product Concentration vs. time



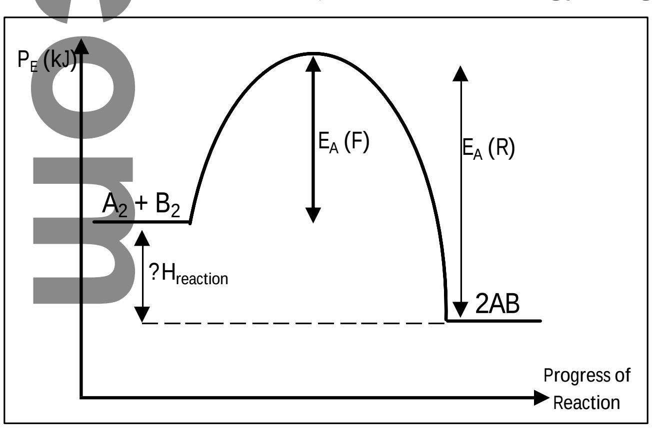
2) Graphically Determining Rate of a Reaction



To determine rates:

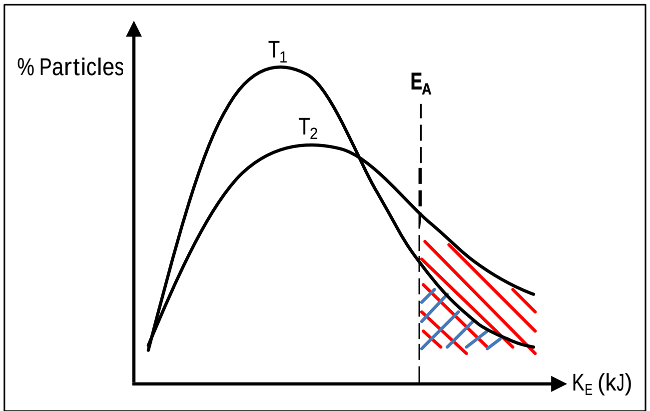
- Instantaneous Rate at **A**: slope of tangent at **A**
- Average Rate from **A** to **B**: slope of secant

3) Potential Energy Diagram [$A_2 + B_2 \rightarrow 2AB$]



E_A (F) + ?H = E_A (R)

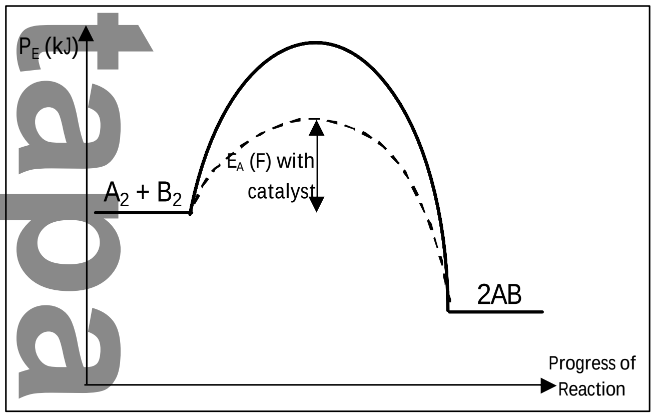
4) Maxwell – Boltzmann Distribution Graph: Effect of Temperature



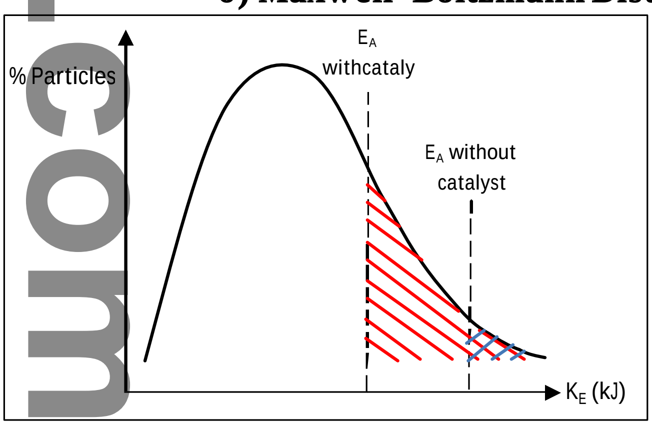
$T_1 < T_2$

Particles with activation energy to react

5) Potential Energy Diagram with Catalyst [A2 + B2 → 2AB]

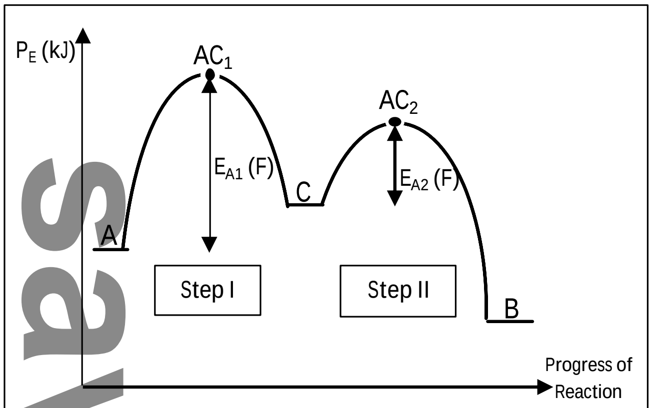


6) Maxwell- Boltzmann Distribution Graph: Catalyst



Particles with activation energy to react

7) Reaction Mechanism



A ⟶ B ? H= – kJ

Step I: **A** ⟶ **C** E_A = 50 kJ (slow)

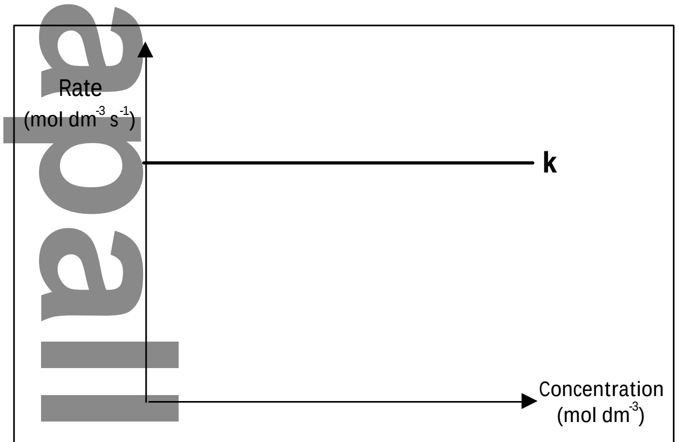
Step II: **C** ⟶ **B** E_A = 10 kJ (fast)

Overall Equation: **A** ⟶ **B** ? H= – kJ

- **C** is the intermediate
- **A** ⟶ **C** is the Rate Determining Step

8) Zero Order – Rate vs. Concentration

[Reaction: A → Product]

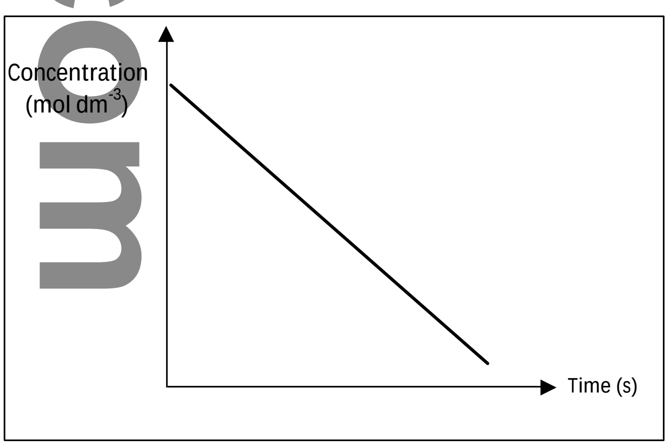


Rate = k $[A]^0$

Rate = k

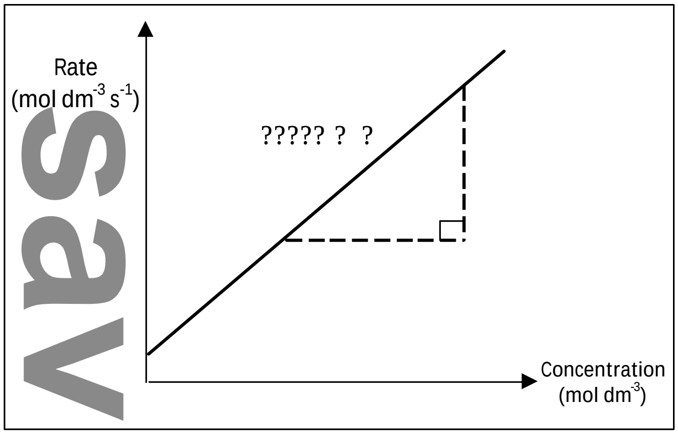
9) *Zero Order* – Concentration vs. time

[Reaction: A → Product]



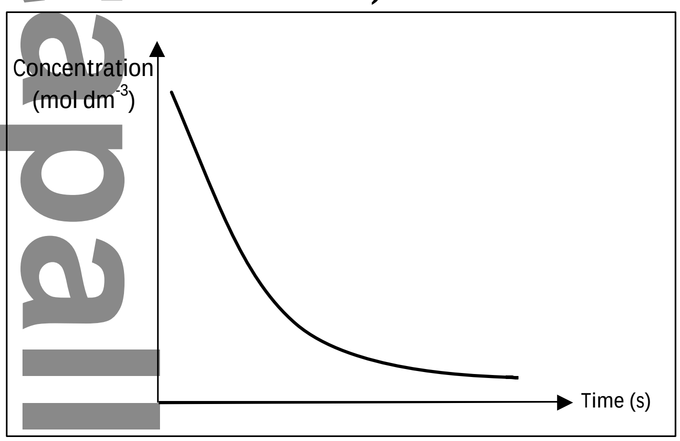
10) *First Order* – Rate vs. Concentration

[Reaction: A → Product]

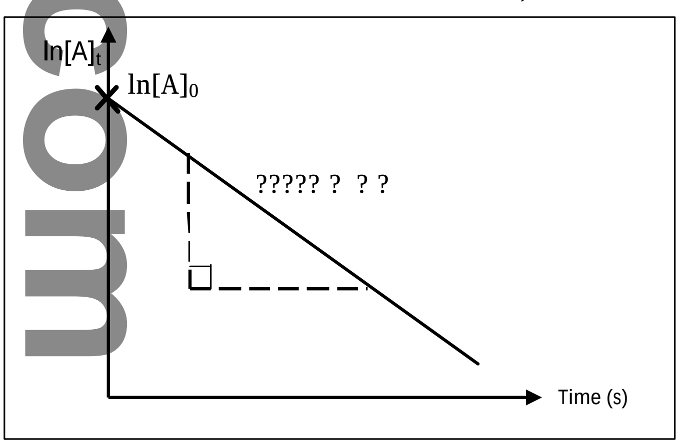


$$\text{Rate} = k\,[A]^1$$

11) *First Order* – Concentration vs. time



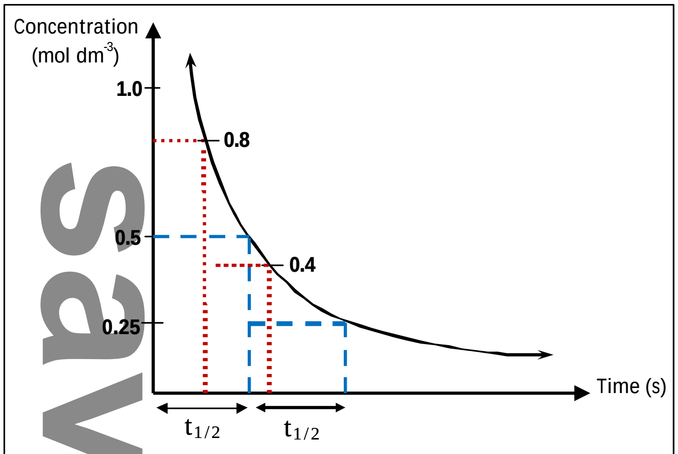
12) ln $[A]_t$ vs. time



$$\ln [A]_t = -kt + \ln [A]_0$$

- y-intercept = ln$[A]_0$
- Slope = – k (rate constant)

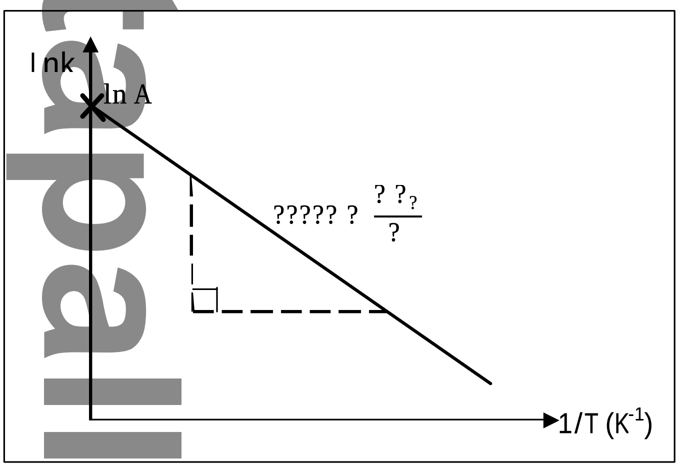
13) *First Order* – Half-Life Graph



- Half –life of a 1st order reaction is **independent** of the initial concentration

?? ? ?(???/?

14) Graph Using Arrhenius Equation

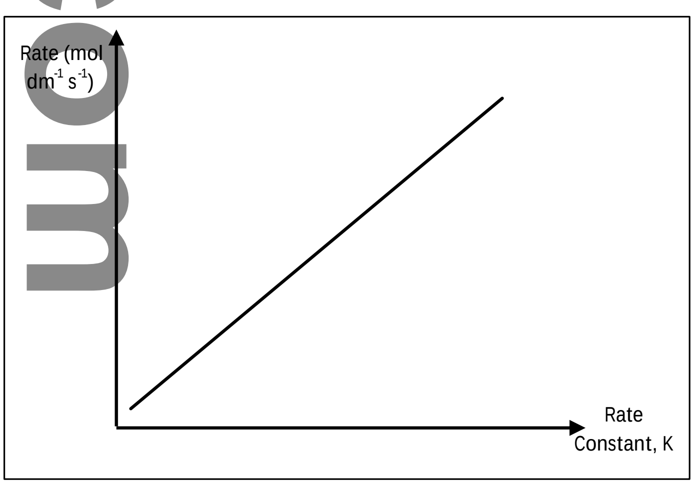


?? ? ? ? ??/? ? ?/? ? ???

- y-intercept = ln A
- Slope = ? ??/?
- *A* = Pre-exponential factor/ frequency factor

  -Product of collision frequency, Z, and an orientation probability factor, q

15) Rate of reaction vs. Rate constant, k



Rate ∝ k

Higher T = larger k = higher rate

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

As the temperature increases, the negative exponent becomes smaller, thus the value of k becomes larger, which means that the rate increases.