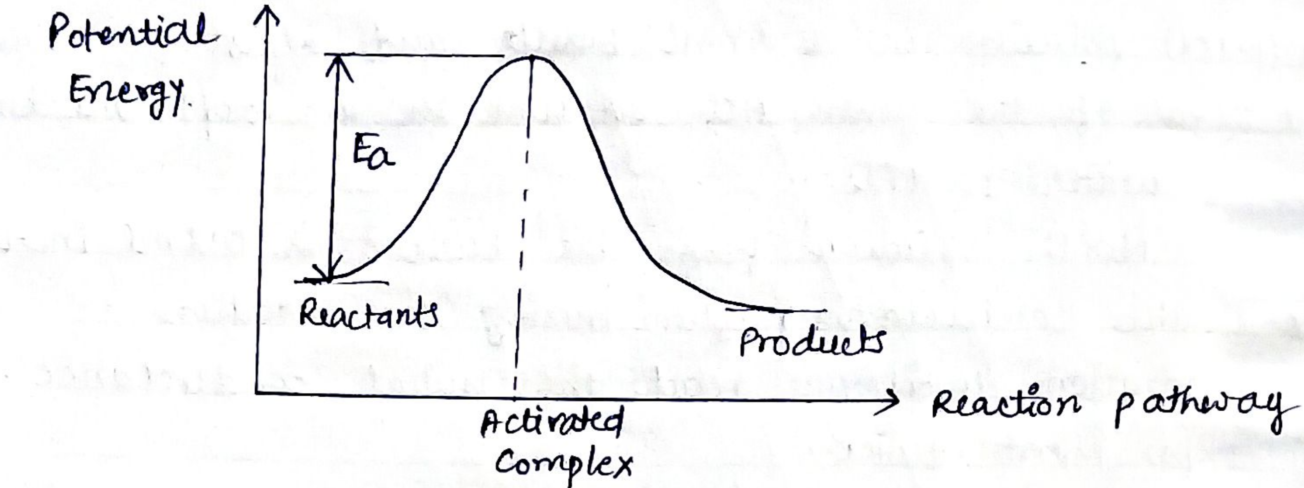
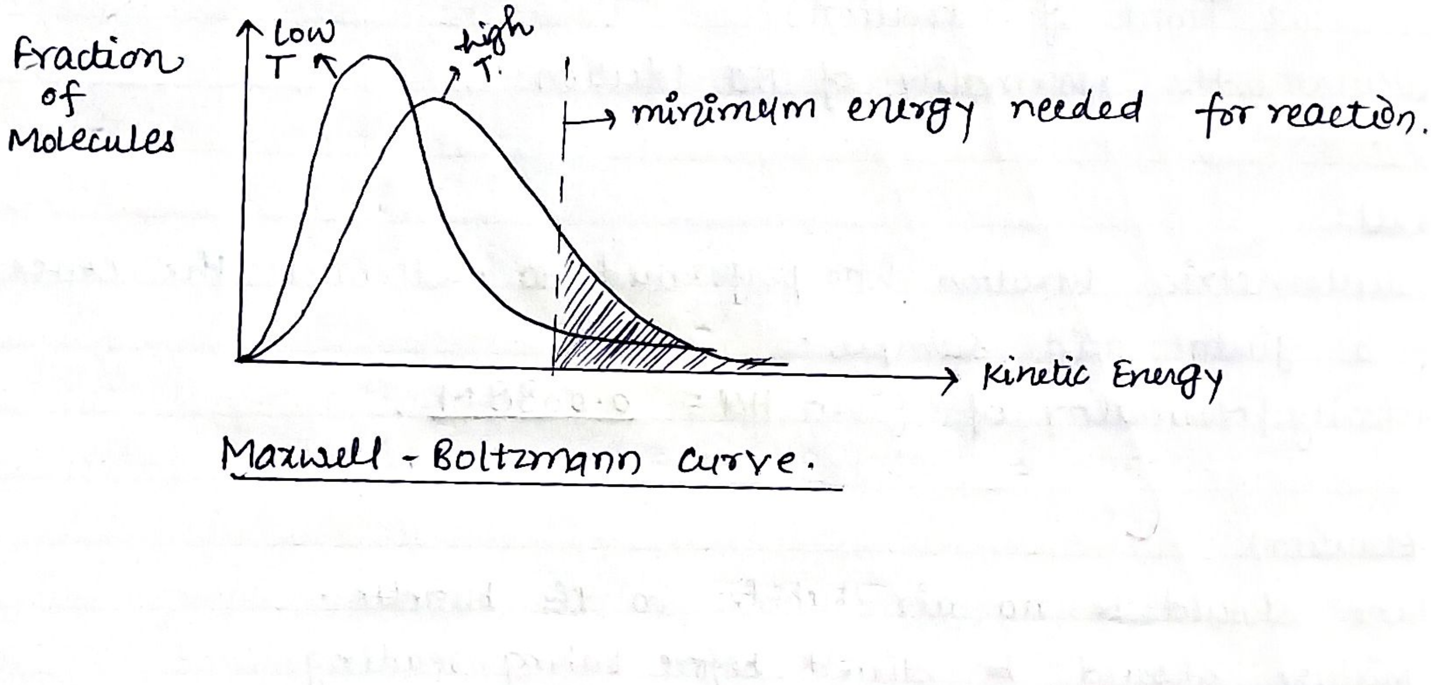


E_a = Activation Energy.



Maxwell - Boltzmann curve.

Aim: To determine the activation energy of a chemical reaction.

Apparatus Required: Water bath, test tube, burette, conical flask

Chemicals Required: Potassium Permanganate ($KMnO_4$), oxalic acid.

Principle: Every chemical reaction is characterised by an energy that the reactants need to overcome in order to form the products; known as activation energy. A reaction cannot occur until the reactant molecules possess sufficient energy to overcome the activation energy barrier. The energy gap between the reactants and activated complex is activation energy. The distribution of kinetic energies of reactants are given by Maxwell Boltzmann distribution. As the temp increases, the curve broadens and more number of molecules possess higher energies. So, the fraction of molecules overcoming the barrier is high and product formation increases. Arrhenius eq^n gives a mathematical relationship between K and E_a as; $K = A e^{-E_a/RT}$ where A is the pre-exponential factor, a number which represents the likelihood that effective collisions will occur. In our reaction of $KMnO_4$ and oxalic acid, we shall determine the E_a by finding rate constants at different temperatures.

Procedure:

1) Using burettes, place 20 ml oxalic acid (0.5M) in a conical flask and 10 ml $KMnO_4$ (0.02M) in test tube.
2) Immerse both conical flask and test tube in water bath to equilibrate for atleast 5 minutes.

Observations and Calculations:

[$KMnO_4$] = 0.02M [oxalic Acid] = 0.5M

S.No.	Temp (°C)	Temp (K)	1/T (K^{-1})	Time for trial 1 (s)	Time for trial 2 (s)	Average time (s)	Rate = [$KMnO_4$]/time	K = Rate / [$KMnO_4$][ox. Acid]	ln K
1.	0	273	36.6×10^{-4}	2160	2160	2160	9.26×10^{-6}	9.26×10^{-4}	-6.98
2.	28	301	33×10^{-4}	204	207	205.5	9.73×10^{-5}	9.73×10^{-3}	-4.63
3.	40	313	31.95×10^{-4}	65	68	66.5	3.00×10^{-4}	3×10^{-2}	-3.50
4.	50	323	31×10^{-4}	24	26	250	8×10^{-4}	8×10^{-2}	-2.52
5.	60	333	30×10^{-4}	15	14	14.5	1.37×10^{-3}	1.37×10^{-1}	-1.98

By Arrhenius Equation,

$$K = A e^{-Ea/RT}$$

$$\therefore \ln K = \ln A - \frac{Ea}{RT} = \frac{-Ea}{RT} + \ln A.$$

So, slope of the plot of $\ln K$ vs $1/T$ = $-Ea/R$

from graph, slope = $\left(\frac{-6.98+1.98}{36.6-30}\right)\times10^{4} = -7575.75$

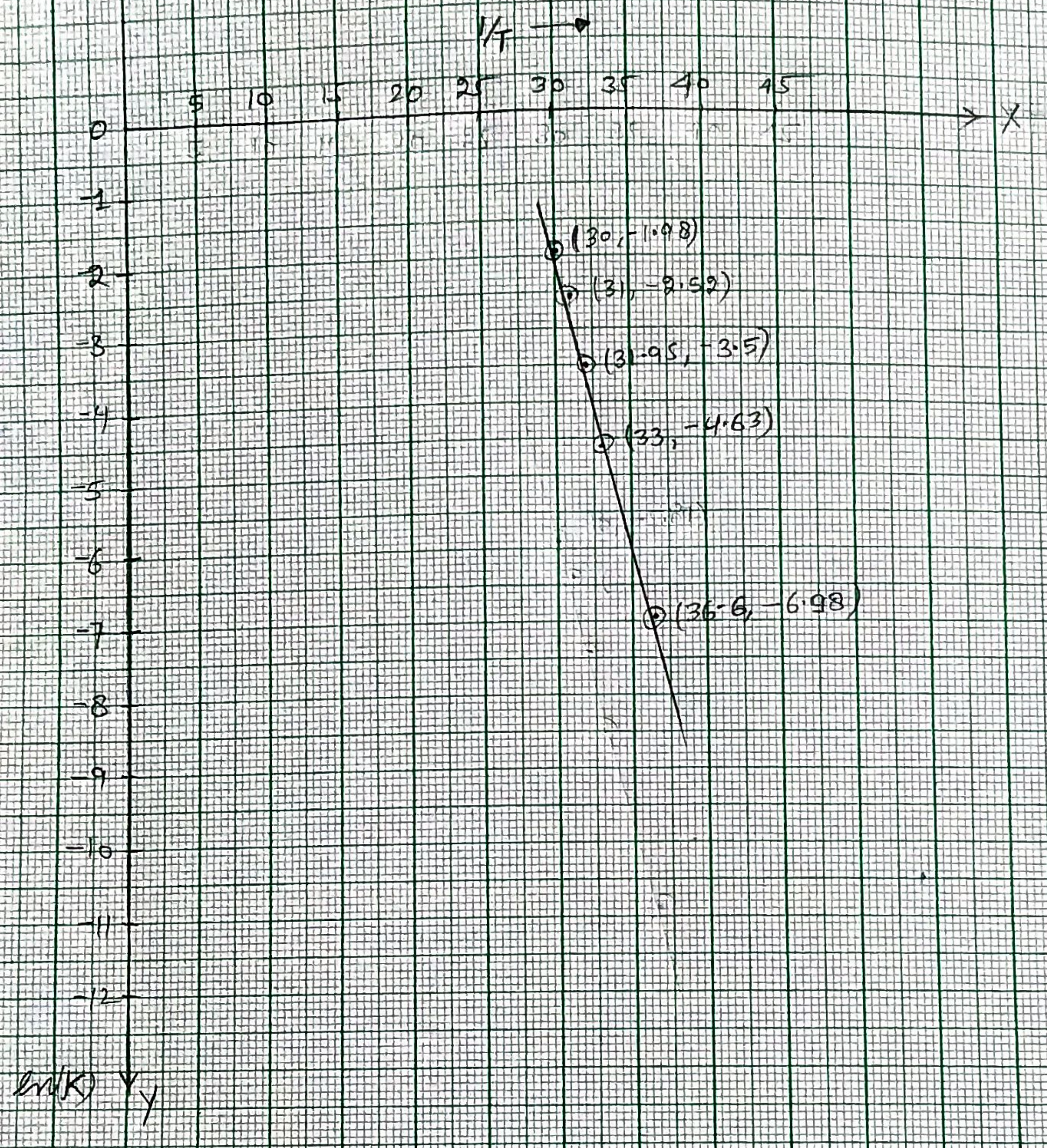
$$\therefore -\frac{Ea}{R} = -7575.75$$

$$\therefore Ea = 7575.75\times8.314$$

$$Ea = 62984.84 \text{ J/mol}$$

$$Ea = 62.98 \text{ KJ/mol}.$$

Scale: on x axis: 1 cm = 5×10^{-4} unit
on Y axis: 1 cm = 1 unit



3) Mix the reactants in a conical flask and immediately start stopwatch.
4) Swirl the reaction mixture regularly without removing it from the water bath.
5) Record the time it takes for the mixture to turn yellow / brown (indication of reduction of MnO_4^- to MnO_2).
6) Repeat the procedure with another mixture at same temperature.
7) Repeat the steps 1-6 for three different temperatures.
8) Determine the activation energy by plotting $\ln(K)$ vs $1/T$.

Results:

1) The rate of reduction of MnO_4^- to MnO_2 was monitored at different temperatures to determine the activation energy of the reaction.
2) Activation energy = 62.984 KJ/mol.

Precautions:

1) Handle glassware carefully.
2) Temperature measurement should be accurate.
3) Temperature should be nearly uniform throughout the reaction.