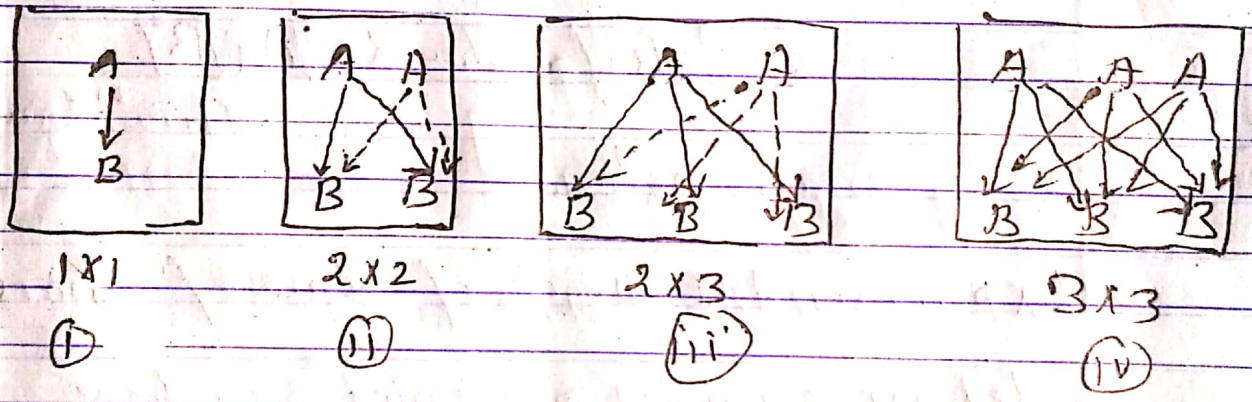
B.SC.I(H), Paper - IA.

Kinetic derivation of Law of mass action

According to Kinetic consideration number of reaction per second between two gases is proportional to number of collission between molecules per second.

Let us consider a homogeneous reaction between gas as

$$A + B \longrightarrow \text{products}$$



1×1 (I) 2×2 (II) 2×3 (III) 3×3 (IV)

(I) – Unit volume contain one molecule of A and B then probality of collission per second will be $1 \times 1 = 2$

(II) When unit volume contain two molecules of A and B, it is probality to number of collisions per second will be $2 \times 2 = 4$.

(III) When unit volume contain 2 molecules of A and 3 molecules of B, probable collission for reaction is $2 \times 3 = 6$.

(iv) Similarly when unit volume contain 3 molecules of A and B, probable collission for reaction is $3 \times 3 = 9$.

Thus chances of collisions are equal to the product of number of molecules present per unit volume.

Therefore

Rate of reaction $\propto$ product of molecules of A and B per unit volume

$\therefore$ Rate of reaction $= [A][B]$

This is Law of mass action.

Experimental proofe of law of mass action—

Let us consider reversible reaction

$$H_2 + I_2 \rightleftharpoons 2HI$$

H_2 and I_2 different varying composition are taken in three sealed bulb and they are heated at boiling sulphur (444°C) rapidly to attain a chemical equilibrium as given in figure. The sealed bulbs are cooled to the room temperature to fix equilibrium and then broken in the NaOH solution where HI and I_2 are absorbed but H_2 free.

If we consider if a moles and b moles is the initial concentration of H_2 and I_2 and volume of bulb is V and after analysis HI concentration is 2x then.

The equilibrium concentration of

$$[H_2] = (a-x)/V$$

$$[I_2] = (b-x)/V$$

$$[HI] = 2x/V$$

According to law of mass action for the reaction $H_2 + I_2 \rightleftharpoons 2HI$

$$K = \frac{[HI]^2}{[H_2][I_2]}$$

$$= \frac{(2x/V)^2}{(a-x/V)^2\left(\frac{b-x}{V}\right)^2}$$

$$K = \frac{4x^2}{(a-x)(b-x)}$$

The value of x is analysed and substituted in above reaction K is calculated. As K is being found same for all three bulb, Hence Law of mass action is verified experimently.