Thus elemortary cell in phase space or phase cell has volume h^3.

In cartesian co-ordinate

$(d\Gamma)_{min} = 0$ → point element can never be possible in phase space.

→ **Volume of phase space :**

$$= \iiiiiint dx\, dy\, dz\, dp_x\, dp_y\, dp_z$$

$$-\infty < x, y, z < +\infty$$
$$-\infty < p_x, p_y, p_z < +\infty$$

macro-state $\begin{cases} p_x \to p_x + dp_x \\ p_y \to p_y + dp_y \\ p_z \to p_z + dp_z \end{cases}$

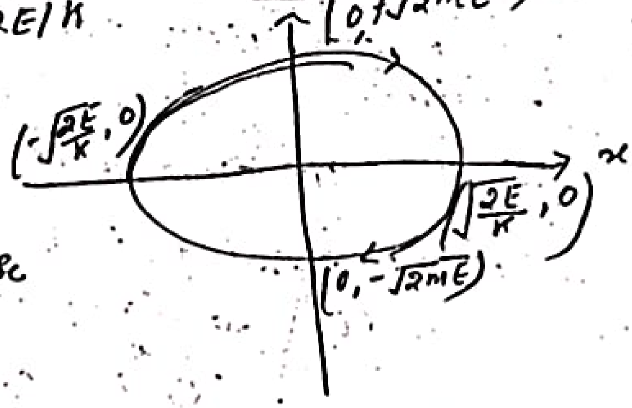
$p \to p + dp$
or
$E = E + dE$
macrostate

Application of phase space :

Ex: 1-D H.O.

$$E = \frac{p_x^2}{2m} + \frac{1}{2}Kx^2$$

$$\Rightarrow \frac{p_x^2}{2mE} + \frac{x^2}{2E/K} = 1$$



Accessible area to the O.sc

$$= \pi ab$$
$$= \pi \sqrt{2mE}\sqrt{\frac{2E}{K}}$$
$$= E\, 2\pi \sqrt{\frac{m}{K}} = \frac{E}{\nu}$$

No. of possible μ-state :

$$= \frac{\text{Accessible area to the osc}}{\text{Area of 1 phase cell}}$$

$$n = \frac{E/\nu}{dx\,dp_x} = \frac{E}{h\nu}$$

$$\boxed{n = \frac{E}{h\nu}}$$

$$\boxed{E = nh\nu}$$

$n = 0, 1, 2 \ldots$

* free particle:

$P.E. = 0$

$$E = \frac{p^2}{2m} = \frac{p_x^2 + p_y^2 + p_z^2}{2m}$$

No. of μ-state in momentum range $p \to p+dp$
or
In energy range $E \to E+\delta E$

$$\Omega(p)\,dp = \frac{\text{Volume of phase space in mom. range } p \to p+\delta p}{\text{Volume of 1 phase cell}}$$

$$\Omega(p)\,dp = \frac{\iiiiiint dx\,dy\,dz\,dp_x\,dp_y\,dp_z}{h^3}$$

$$= \frac{\iiint dx\,dy\,dz \iiint dp_x\,dp_y\,dp_z}{h^3}$$

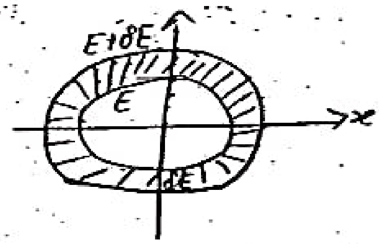
$$\Omega(p)\,dp = \frac{V}{h^3}\int_p^{p+dp} d^3p$$

$d^3p \to p^2 \sin\theta\, d\theta\, d\phi\, dp$

$0 < r < \infty$

$0 < p < \infty$

$$= \frac{V}{h^3} 4\pi p^2 dp$$



$$\delta n = \frac{\delta E}{h\nu}$$

$$\frac{\delta n}{\delta E} = \frac{1}{h\nu}$$

$$D(E) = \frac{1}{h\nu}$$

OR

$$D(E)\,\delta E = \frac{\delta E}{h\nu} = \delta n$$

Density of state i.e. no. of states per unit energy range.

$E \to E+\delta E$

no. of states in En. range $\delta E = \dfrac{\delta E}{h\nu}$

$$\Omega(E)\,\delta E = \frac{\delta E}{h\nu}$$

$0 \longrightarrow E$

$$\int_0^E \Omega(E)\,\delta E = \Omega = \text{Total no. of } \mu\text{-states in range } E$$