$$V(x,y) = \begin{cases} 0, & 0 \le x \le L_x \;\&\; 0 \le y \le L_y \\ \infty & \text{otherwise} \end{cases}$$

PARTICLE IN A TWO-DIMENSIONAL INFINITE POTENTIAL

Symmetric 2D

$L_x = L_y = L$

$$\psi(x,y) = \sqrt{\frac{2}{L}} \sin\frac{n_x \pi x}{L} \sin\frac{n_y \pi y}{L}$$

$$\therefore -\frac{\hbar^2}{2m} \sqrt{\frac{2}{L}} \left(-\sin\frac{n_x\pi x}{L} \sin\frac{n_y \pi y}{L} \cdot \frac{n_x^2 \pi^2}{L^2} - \sin\frac{n_x \pi x}{L} \sin\frac{n_y \pi y}{L} \cdot \frac{n_y^2\pi^2}{L^2} \right) = E\psi$$

$$\therefore E_{m,n} = \frac{\hbar^2}{2m} \cdot \frac{(n_x^2 + n_y^2)\pi^2}{L^2} = \boxed{\frac{\hbar^2 \pi^2}{2mL^2}(n_x^2 + n_y^2)}$$

Asymmetric 2D

$$\psi(x,y) = A \sin\frac{n_x \pi x}{L_x} \sin\frac{n_y \pi y}{L_y}$$

$$\therefore -\frac{\hbar^2}{2m} A \left\{ -\sin\frac{n_x \pi x}{L_x} \times \sin\frac{n_y \pi y}{L_y} \right) \times \frac{n_x^2 \pi^2}{L_x^2} - \sin\frac{n_x\pi x}{L_x} \sin\frac{n_y \pi y}{L_y} \frac{n_y \pi^2}{L_y^2} \Big) = E$$

$$\therefore \boxed{E_{(m,n)} = \frac{\hbar^2 \pi^2}{2m} \left\{ \frac{n_x^2}{L_x^2} + \frac{n_y^2}{L_y^2} \right\}}$$ KNOW!

Energy Eigen values.

Normalization

$$A^2 \int_{-\infty}^{\infty} \sin^2\frac{n_x \pi x}{L_x} \sin^2 \frac{n_y \pi y}{L_y}\, dx\, dy = 1$$

$$\Rightarrow A^2 \int_0^{L_1} \sin^2 \frac{n_x \pi x}{L_1} dx \int_0^{L_2} \sin^2 \frac{n_y \pi y}{L_y} dy = 1$$

$$\Rightarrow \frac{A^2}{4} \left[\left(\frac{1}{2}\right) \int_0^{L_1} 1 - \cos\frac{2 n_x \pi x}{L_x} dx \right] \left[\left(\frac{1}{2}\right) \int_0^{L_2} 1 - \cos\frac{2n_y \pi y}{L_y} dy \right] = 1$$

$$\Rightarrow \left[x - \sin\frac{2 n_x \pi x}{L_x} \cdot \frac{L_1}{2 n_x \pi} \right]_0^{L_1} \left[y - \sin\frac{2 n_y \pi x}{L_y} \cdot \frac{L_2}{2 n_y \pi} \right]_0^{L_2} = \frac{4}{A^2}$$

$$\Rightarrow [L_x][L_y] = \frac{4}{A^2} \quad \therefore \quad A = \frac{2}{\sqrt{L_x L_y}} = \sqrt{\frac{2}{L_x}} \sqrt{\frac{2}{L_y}}$$

$\therefore$ Normalised wave function,

$$\boxed{\psi(x,y) = \sqrt{\frac{2}{L_x}} \sqrt{\frac{2}{L_y}} \sin\frac{n_x \pi x}{L_x} \sin \frac{n_y \pi y}{L_y}}$$ KNOW!

Similarly extend to 3D.

- Jacobian – matrix / det of all 1st order partial derivatives of a vector-valued function.

$$J_{ij} = \frac{\partial f_i}{\partial x_j} \quad \text{or for } f_1, f_2\ (x,y) - J = \begin{vmatrix} f_{1x} & f_{1y} \\ f_{2x} & f_{2y} \end{vmatrix}$$

- Trace – sum of elements of main diagonal
- Zenor diode – Choose R_s such that $I_z \gg I_L$
- C_v & degree of freedom (n) :

$$C_v = \frac{dU}{dT} = \frac{d}{dT}\left[\frac{n}{2}RT\right] = \frac{n}{2}R \quad ; \quad C_p = R + C_v$$

- Vibrations of diatomic molecules – 2-body oscillator

$$T = 2\pi\sqrt{\frac{\mu}{c}}, \quad \mu = \frac{m_1 m_2}{m_1 + m_2} = \text{reduced mass}, \quad c = \text{force const.}$$

Vibrational states – $E_n = \left[n + \frac{1}{2}\right] h\nu_0$, $n = 0, 1, 2, 3 \ldots$

- Beats (waves) – $\nu_{beat} = \nu_1 - \nu_2$.
- Doppler effect – $\nu = \nu_0 \left[\frac{V + V_{obs}}{V + V_{source}}\right]$ {V = speed of wave}
  obs $\xrightarrow[+ve]{}$ source
- Poynting vector – See 9-Jan.
- Hydrogen spectra –

ser. Name	L	B	P	B	P
m	1	2	3	4	5

$$\frac{1}{\lambda} = R\left[\frac{1}{m^2} - \frac{1}{n^2}\right] \quad ; \quad n = m+1, m+2 \ldots$$

- Displacement current inside a capacitor :-

$$i_d = \varepsilon_0 \frac{d\Phi_E}{dt} = \frac{dQ}{dt} = \varepsilon_0 \oint_S d\vec{s} \cdot \frac{\partial \vec{E}}{\partial t} \approx S\varepsilon_0 \frac{dE}{dt}$$

- De Broglie wavelength of electron :-

$$\lambda = \frac{h}{\sqrt{2meV}} = \frac{1.227}{\sqrt{V}} \text{ nm} \rightarrow V = \text{accelerating potential}$$

- Compton effect :- inelastic scattering of photon by a charged particle (electron) –

$$\lambda' - \lambda = \underbrace{\frac{h}{m_e c}}_{\text{Compton wavelength.}} (1 - \cos\theta)$$

θ ↓ scattering angle.

Diode equat^n (Shokley) : $\boxed{I_D = I_0\left[e^{\frac{V_D}{nV_T}} - 1\right]}$ $\left\{V_T = \frac{kT}{q}\right\}$

8 (n = 1 for Ge, 2 for Si) $\approx$ 26mV @ 300K

9 • RI and ε_r :-

$\mu = \sqrt{\varepsilon_r \mu_r} \approx \sqrt{\varepsilon_r}$ for most natural materials.

10 • Basic eqn. of entropy :-

(Macroscopic) $\Delta S = \int \frac{\delta Q_{rev}}{T}$

11

• Calorie → specific heat capacity of water in $J k^{-1} g^{-1}$

12 ∴ 1 Calorie = 4.184 J ≈ 4.2 J

• $\boxed{\frac{1}{4\pi\varepsilon_0} = 9\times10^{9}}$ $\boxed{\frac{\mu_0}{4\pi} = 10^{-7}}$

1

• Magnetic field due to finite piece of conductor :-

2 $B = \frac{\mu_0 I}{4\pi d}\left[\cos\theta\right]_f^i$; d = $\perp^r$ dist, θ = angle b/w $d\vec{l}$ & $\vec{r}$

3 * • Taylor series of log and ln :-

$\ln(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \ldots$

4

• Capacitance of a single shell :-

5 $\boxed{C = 4\pi\varepsilon_0 R}$

6 • Perfectly inelastic collision –

* Particles stick together after colliding
* Momentum conserved * KE loss ✓

• Disk with mass per unit area ∝ distance from centre:

$I_G = \frac{3}{5}MR^2$, $I_D = \frac{3}{10}MR^2$

• Magnetic field at the centre of a current-loop :

$\boxed{B = \frac{\mu_0 I}{2R}}$

I {[illegible], 32}

I {33 - 35}

NOTES

- LORRENT'S TRANSFORMATIONS :

$t' = \gamma\left(t - \frac{vx}{c^2}\right)$	$t = \gamma\left(t' + \frac{vx'}{c^2}\right.$
$x' = \gamma(x - vt)$	$\dot{x} = \gamma(x' + vt)$

- $C_p - C_v$ relation for real gases :-

$$\boxed{C_p = C_v + \frac{Tv\alpha^2}{k_T}.}$$

where T = temp., v = specific volume at T

α = coeff. of volume expansion

k_T = isothermal compressibility.

- Sum of Trigonometric series :-

$$\left[\sum_{n=0}^{\infty} r^n \sin n\theta = \frac{r\sin\theta}{r^2-2r\cos\theta+1} \;\middle|\; \sum_{n=0}^{\infty} r^n \cos n\theta = \frac{1-r\cos\theta}{r^2-2r\cos\theta+1}\right]$$

- Entropy change : (C be the heat capacity of substance)

[* Substance :- $\Delta S = C \ln \frac{T_2}{T_1}$ {T varying} | * Reservoir :- (T const) $\Delta S = \frac{C\Delta T}{T}$ {ΔT of substance}]

- Force on a whole body (rod) pivoted at an end :-

Effective Torque $\tau_{ext} = \frac{\vec{L}}{2} \times \vec{F}$ { $\because$ F effectively acts on CM} transient reponse of L

$$\Rightarrow I = e^{-Rt/L} \times \frac{+\varepsilon}{L} \cdot e^{+\frac{Rt}{L}} \times \frac{L}{+R} \Big|_0^t$$

$$\Rightarrow I = e^{-Rt/L} \times \frac{\varepsilon}{R}\left(e^{+\frac{Rt}{L}} - 1\right) = \boxed{\underbrace{\frac{\varepsilon}{R}}_{I_0 //}\left(1 - e^{-Rt/L}\right)}$$

KNOW! //

substitute I, $\frac{R}{L}$ for Q, $\frac{1}{RC}$ in capacitor.

$$\boxed{\text{for small oscillations, } k = V''(x_0)}$$

Where V is the potential energy function and x_0 is the equilibrium position

$$\boxed{\text{Resolving power of grating} = \text{No. of Lines}}$$

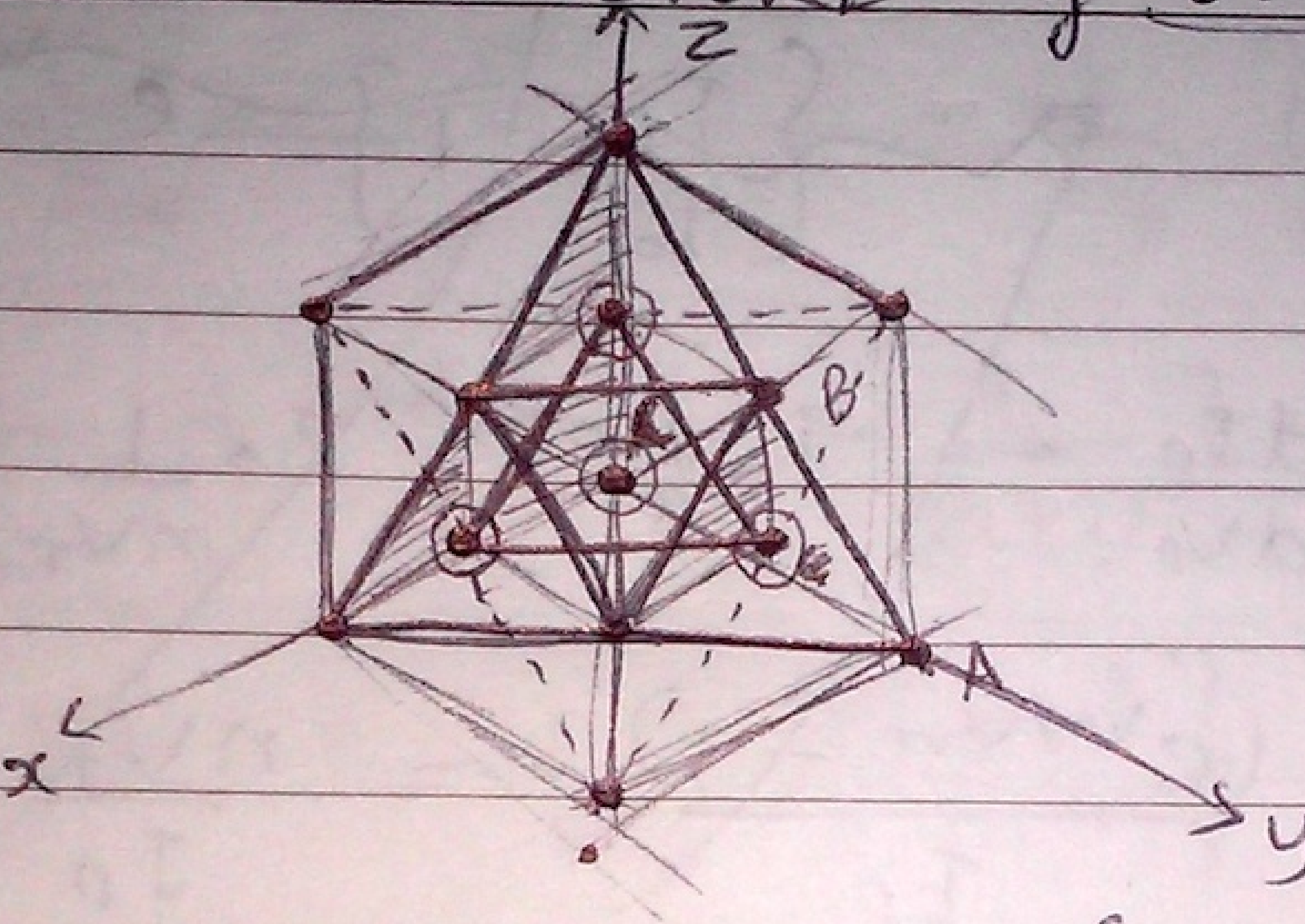
$$\boxed{\text{Resolving power a system of gratings} = R_1 \cdot R_2 \cdot R_3 \ldots}$$

$$\boxed{\lambda^2 - (\text{trace})\lambda + \text{determinant} = 0}$$

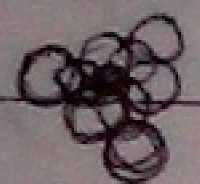
Where trace = sum of elements of main diagonal

λ = Eigen value.

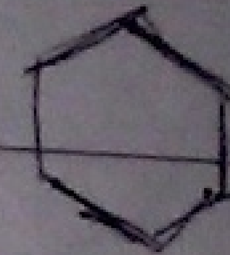
DIAMOND STRUCTURE of GaAs.

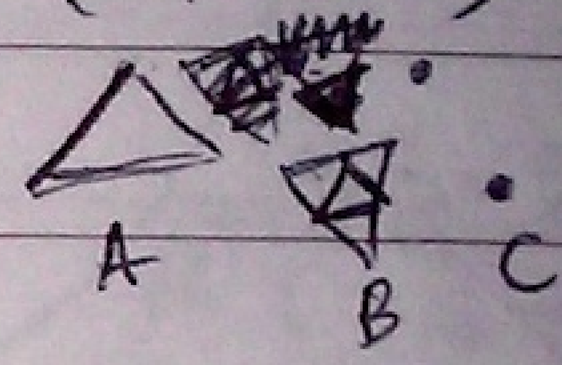


• Ga o As



double fcc
→ hcp II
(ABCA)





IAM 15 ard.

Q10 : Each Ga atom in the xy plane is bonded to 2 As atom ABOVE the plane & 2 As atoms BELOW the plane. So, when fracturing the crystal in xy (001) plane, either of these two pairs of bond per ~~pla~~ atom has to be broken.

∴ Ans :- $\boxed{2}$