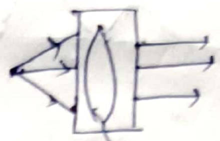
S.R.P

Diffraction

Fresnel vs Fraunhofer

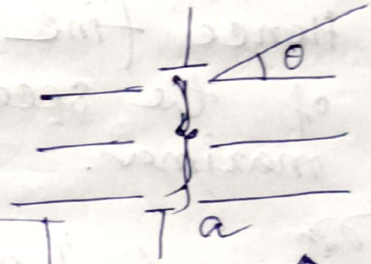
Fresnel → no use of lence, point, spherical/cylindrical wave, any kind of wave

Fraunhofer → use of convex lence; → plane wave



convex lence used

Single slit of Fraunhofer Diffraction



θ = diffration angle

a = slit width

Wave function

$$\boxed{y = ka\frac{\sin\alpha}{\alpha}\sin 2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)}$$

k = propotionality const.

a = slit width

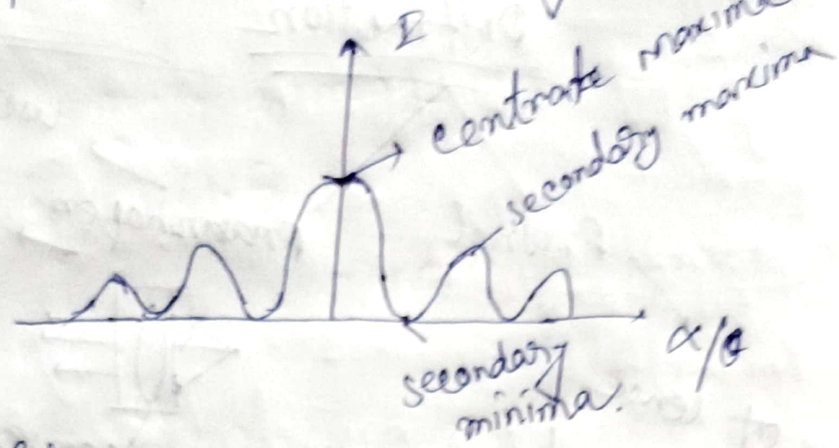
$$\alpha = \frac{\pi a \sin\theta}{\lambda}$$

$$y = A\sin 2\pi(\omega t - \phi)$$

$$\therefore A = ka\frac{\sin\alpha}{\alpha}$$

$$\boxed{\text{Intencity } (I) = A^2 = k^2a^2 \cdot \frac{\sin^2\alpha}{\alpha^2}}$$

Fraunhofer diffraction graph



Question

1) Write down and expression for the intensity due to single slit fraunhofer diffraction

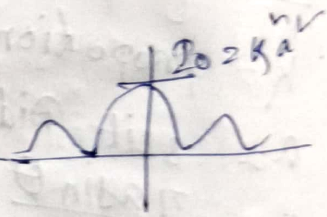
2) Hence fine the position and the condition of the secoandary minima and secondary maxima.

Soln

(1) central maxima

(2) position of secondary minima and condition

(3) position ~~of os~~ and condition of secondary maxima.



$$I = \frac{k^2 a^2 \sin^2\alpha}{\alpha^2}$$

$\theta \to 0 \approx \alpha \to 0$

$$\therefore \lim_{\alpha \to 0} \frac{\sin\alpha}{\alpha} = 1$$

$$\therefore I = k^2a^2 \cdot 1 = k^2a^2 = I_0$$

electron $E_F = \frac{h^2}{8m}\left(\frac{3N}{\pi V}\right)$

S.bl

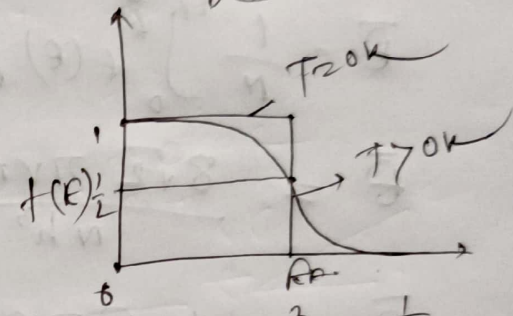
$$f(E) = \frac{n(E)}{g(E)}$$ → Number of quantum state

$$n(E) = f(E) \cdot g(E)$$

$$\int_0^\infty n(E)\,dE = \int_0^\infty f(E) \cdot g(E)\,dE$$

$$N = \int_0^{E_F} \underbrace{f(E)}_{\text{one}} \cdot g(E)\,dE + \int_{E_F}^{\infty} \underbrace{f(E)}_{0}\,g(E)\,dE$$

$8\sqrt{2}\pi V$



$$N = \int_0^{E_F} g(E)\,dE$$

$N/2$

$$g(E)\,dE = \frac{8\sqrt{2}\,\pi V m^{\frac{3}{2}} E^{\frac{1}{2}}\,dE}{h^3}$$

$$N = \frac{8\sqrt{2}\,\pi V m^{\frac{3}{2}}}{h^3} \int_0^{E_F} E^{\frac{1}{2}}\,dE$$

$$\boxed{N = \frac{16\sqrt{2}\,\pi V m^{\frac{3}{2}} E_F^{\frac{3}{2}}}{3h^3}}$$

multiplying the both side of the equation each term with the power of $\frac{2}{3}$ then we get

$$E_F = \frac{h^2}{8m}\left(\frac{3N}{\pi V}\right)^{\frac{2}{3}}$$

Scanned with OKEN Scanner

$\bar{E} = \frac{3}{5} E_F$ VVI

$\downarrow$

Average Energy or mean internal Energy

$$\bar{E} = \frac{1}{N} \int_0^{\infty} n(E) \cdot E \, dE$$

$$\bar{E} = \frac{1}{N} \int_0^{\infty} f(E) \cdot g(E) \cdot E \cdot dE$$

$$\bar{E} = \frac{1}{N} \int_0^{E_F} f(E)\, g(E) \cdot E \cdot dE + \frac{1}{N} \int_{E_F}^{\infty} f(E) g(E) \cdot E \cdot dE$$

$$\bar{E} = \frac{1}{N} \int_0^{E_F} f(E)\, g(E)\, E \, dE.$$

$$\bar{E} = \frac{8\sqrt{2}\, \pi V m^{\frac{3}{2}}}{N h^3} \int_0^{E_F} E^{\frac{3}{2}} dE$$

$$\bar{E} = \frac{16 \sqrt{2} \pi V m^{\frac{3}{2}}}{5 N h^3} \cdot E_F^{\frac{5}{2}}$$

$$= \frac{\cancel{16} \cancel{\sqrt{2}} \cancel{\pi} \cancel{V} \cancel{m^{3/2}}}{5 \cancel{h^3}} \cdot \frac{E_F^{\frac{5}{2}} \times 3 \cancel{h^3}}{\cancel{16} \cancel{\sqrt{2}} \cancel{\pi} \cancel{V} \cancel{m^{\frac{3}{2}}} E_F^{\frac{3}{2}}}$$

$$= \frac{3}{5} E_F$$

Scanned with OKEN Scanner