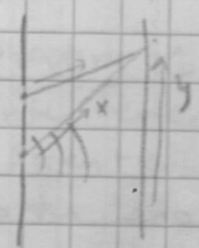
Quantum description of 2-slit experiment:



Particle w/ wavelength $\lambda = \frac{2\pi}{k}$

$\psi(x,t) = Ae^{i(kx-\omega t)}$

Superposition of paths:

$\psi(y,t) = A(e^{ikr_1} + e^{ikr_2})e^{-i\omega t}$

$P(y,t) = |A|^2 |e^{ikr_1} + e^{ikr_2}|^2$

If this is true, then passing particles through slits would result in interference fringes in the probability that they arrive @ the screen.

$(e^{ikr_1} + e^{ikr_2})(e^{-ikr_1} + e^{-ikr_2})$

$\Rightarrow 1 + e^{ik(r_1-r_2)} + e^{-ik(r_1-r_2)} + 1$

$= 2 + e^{ik(r_1-r_2)} + e^{-ik(r_1-r_2)} = 2 + 2\cos(k(r_1-r_2)) = 4\cos^2\left(\frac{k(r_1-r_2)}{2}\right)$

HW 5: Probability + Complex numbers

2) $KE = 10\,eV$ $\quad N = 10^{16}$ electrons/s $\quad 0 \le x \le 20\,nm$

$p(x) = \frac{A}{x+b}$ $\quad b = 1\,nm$

1. Normalization constant $A = ?$ $\quad A = \sqrt{\frac{1}{2}}$

$\int_0^{20} \frac{A}{x+1}\,dx = 1 \rightarrow A\ln(x+1)\Big|_0^{20} = 1$ $\quad A\ln(21) - \cancel{A\ln(1)} = 1$

$A = \frac{1}{\ln(21)} \approx \boxed{0.328}$

2. Sensor from 1-5 nm

$\int_1^5 \frac{0.328}{x+1}\,dx = 0.328\ln(x+1)\Big|_1^5 = 0.328\ln(6) - 0.328\ln(2)$

≈ 0.3608

3. Power $P = ?$

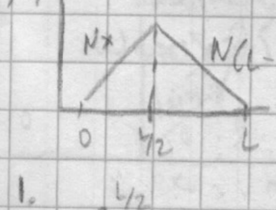
P_{detect}

$P = 10\frac{eV}{e} \cdot 10^{16}\frac{e}{s} = 16.02\,mW \leftarrow P_{TOTAL}$

J/s

$P_{detect} = P_{TOTAL} \cdot p(x) \approx \boxed{5.78\,mW}$

3)



$0 \le x \le \frac{L}{2}$ $\quad p(x) = Nx$

$\frac{L}{2} \le x \le L$ $\quad p(x) = N(L-x)$

$p(x) = 0$ outside box

$L = 3.5\,nm$

1. $\int_0^{L/2} Nx\,dx + \int_{L/2}^{L} N(L-x)\,dx = 1$ $\quad N\left[\frac{1}{2}x^2\Big|_0^{1.75nm} + 3.5nm\,x - \frac{1}{2}x^2\Big|_{1.75nm}^{3.5nm}\right] = 1$

$\Rightarrow N[1.53\times10^{-18} + [6.125\times10^{-18}] - (6.125\times10^{-18} - 1.53125\times10^{-18})] = 1$

$= N(3.0625E-18) = 1$ $\quad N \approx 0.3265\,(nm)^{-2}$

2. Pdensity @ $x = L/3$

$\boxed{N \cdot \frac{L}{3} \approx 0.3809\,(nm)^{-1}}$

3. $\int_0^{L/4} Nx\,dx \approx \boxed{0.125}$