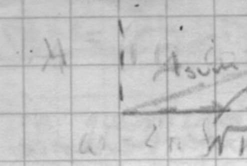
$I = \frac{A^2}{2}$

$I = 6\,W^2/m$

$A = \sqrt{12}$



$I_{TOT} = 2A^2\cos^2\left(\frac{kr_1 + \varphi_1 - kr_2 - \varphi_2}{2}\right)$

$= 2A^2\cos^2(\varphi/2) = \boxed{19.2\ W/m^2}$

5. $I_{max} = 2A^2\cos^2(0) = 2A^2 = 2 \cdot 12 = \boxed{24\ W/m^2}$

$f_{min,n,1} = ?$ $\quad I_{TOT} = I_{max}$ $\quad \varphi = 2\pi n$ $\quad f = \frac{v}{\lambda}$ $\quad 2\pi n = \frac{2\pi(r_2 - r_1)}{\lambda}$

$\lambda = \frac{L_2 - L_1}{n}$ $\quad f = \frac{335}{L_2 - L_1/n} = 335n/(4\sqrt{2} - 4) \approx 202n$ $\quad$ 202 Hz

$\lambda = \frac{L_2 - L_1}{n + 1/2}$ $\quad f = \frac{335(n + 1/2)}{L_2 - L_1} = 202.19(n + 1/2) = 202.19n + 101$

$f \approx 101$ Hz

5)

$6 = 24\cos^2(\varphi/2)$ $\quad \frac{1}{4} = \cos^2(\varphi/2)$ $\quad \frac{1}{2} = \cos(\varphi/2)$ $\quad \frac{\varphi}{2} = \pm\pi/3$ $\quad \varphi = \pm 2\pi/3$

$2\pi/3 = \frac{2\pi(L_2 - L_1)}{\lambda}$ $\quad \lambda = 3(4\sqrt{2} - 4)m$ $\quad f = \frac{v}{\lambda} \approx \boxed{67.4\,Hz}$

$\lambda \approx 4.97$

8/25/23 Lecture 3: Practice w/ interference

Specialized formulae (good for 2 slit, interferometer):

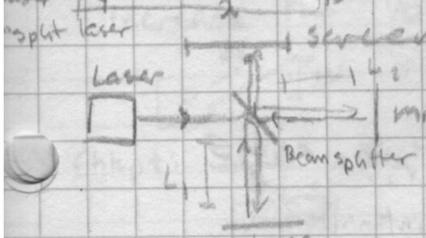
$\boxed{I = 2A^2\cos^2\frac{\varphi}{2} \quad \varphi = \frac{2\pi(r_2 - r_1)}{\lambda}}$ } Same amplitude

maxima @ $\varphi = 2\pi m$ $\qquad$ * m is any int

Minima @ $\varphi = 2\pi(m + \frac{1}{2})$

laser

split laser



$r_2 - r_1 = 2L_2 - 2L_1$

$r_2 = 2L_2 + d_1$

$r_1 = 2L_1 + d_1$

How far would you need to move the mirror 1 to find the next max intensity?

$r_2 - r_1 = 2L_2 - 2L_1$ $\quad \varphi = 2\pi n = \frac{2\pi(r_2 - r_1)}{\lambda}$ $\quad n \in \mathbb{Z}$

$n = \frac{2(L_2 - L_1)}{\lambda}$ $\quad L_2 - L_1 = \frac{\lambda n}{2}$ $\quad \frac{\lambda(n+1)}{2} - \frac{\lambda(n)}{2} = \boxed{\frac{\lambda}{2}}$

Idealization: $I_{max} = I_{Laser}$

(no losses, narrow beam)

$\boxed{I = I_{laser}\cos^2\left(\frac{2\pi(L_2 - L_1)}{\lambda}\right)}$

Diffraction Grating:

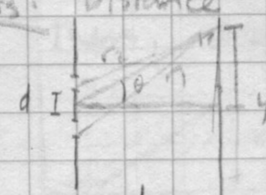
Light source

Hold the grating horizontally:

How do the peaks correspond to wavelength?

Larger wavelength → larger angle

Slits: Distance



$E_1 = E\cos(\omega t - kr_1)$

$E_2 = E\cos(\omega t - kr_2)$

Approximation: L is very big compared to d and y

$d\sin\theta = \delta$ $\quad d\sin\theta_{max} = \lambda m$

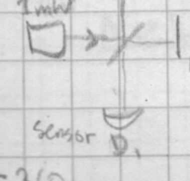
Maxima 2 vs 3 slits:

$\theta_{max}(2\ \text{slit}) = \theta_{max}(3\ \text{slit})$

Constructive interfer.: $\varphi = 2m\pi = \frac{2\pi d\sin\theta}{\lambda}$

HW 1 cont...

8) interferometer



$\lambda = 360$ nm

1. $0 = 1\,mW\cos^2\left(\frac{2\pi(L_2 - L_1)}{\lambda}\right)$

$0 = \cos^2\left(\frac{2\pi(L_2 - L_1)}{\lambda}\right)$

$\frac{\pi}{2} = \frac{2\pi(L_2 - L_1)}{\lambda}$ $\quad x = \lambda/4$

$\frac{\lambda}{4} = L_2 - (L_2 + x) \approx \boxed{90\,nM}$

2. $\varphi = \frac{2\pi r_2}{\lambda} - \frac{2\pi r_1}{\lambda} = \boxed{90°}$

3. Power detected

1 mW beam each

$1\,mW(1 + \cos\varphi) = 1(1 + 0) = \boxed{1\,mW}$

4) $2 = 2\cos^2\left(\frac{2\pi(L_2 - L_1)}{\lambda}\right)$ $\quad \pm 1 = \cos\left(\frac{2\pi x}{\lambda}\right)$

$1 = \cos^2\left(\frac{2\pi(L_2 - L_2 + x)}{\lambda}\right)$ $\quad \frac{2\pi x}{\lambda} = 0$ or π

$x = 0$

Physics 214 - Quantum Mechanics

HW 2: Interference

1) $I_A = 20\ W/m^2$ $\quad I_B = 7\ W/m^2$ $\quad I = \frac{A^2}{2}$ $\quad A_A = \sqrt{40} = 2\sqrt{10}$

$A_B = \sqrt{14}$

We usually ignore the prop constant so $I = A^2$

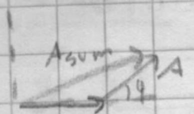
$A_A = \sqrt{20}$ $\quad A_B = \sqrt{7}$ $\quad$ Max amplitude $= \sqrt{20} + \sqrt{7} \approx 7.12$

Min amplitude $= 1.826$

$\left.\begin{array}{l} I_{max} = 50.66 \\ I_{min} \approx 3.34 \end{array}\right\} A^2$ $\quad$ * When 2 waves interfere, the amplitudes add, not intensity

$I_{min}/I_{max} \approx \boxed{0.0658}$

2)

1. 

$\varphi = 30°$

$A_{sum,y} = A \sin\varphi = A \sin 30° = \boxed{0.5A}$

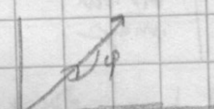
2. $A_{sum x} = A\cos\varphi + A \Rightarrow A\cos 30° + A \Rightarrow A + A(\sqrt{3}/2) \approx \boxed{1.866A}$

3. $A_{sum} = \sqrt{A_{sum x}^2 + A_{sum y}^2}$ $\quad$ LoC: $c = \sqrt{a^2+b^2-2ab\cos\theta}$

$\approx \boxed{1.93A}$

4. $\varphi_{max} = ?$ $\quad$ $\varphi_{max} = 0°$ since

$A_{sum} = A_{summax}$



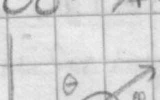
5. $A_{sum} = A_{summin}$ $\quad \boxed{\varphi_{min} = 180°}$

6.

$A_{sum} = A_{avg} = (A_{summax} + A_{summin})/2$ $\quad A_{summax} = 2A$ $\quad A_{avg} = A$

$A_{summin} = 0A$

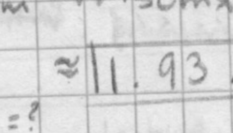
LOC: $A = \sqrt{A^2 + A^2 - 2A^2\cos\theta}$



$A = \sqrt{2A^2 - 2A^2\cos\theta}$ $\quad 1 = 2(1-\cos\theta)$ $\quad \cos\theta = 1/2$

$A^2 = 2A^2(1-\cos\theta)$ $\quad \frac{1}{2} = 1 - \cos\theta$ $\quad \theta = \pi/3 = 60°$

$180 - \theta = \varphi_{avg} = \boxed{120°}$

7. 

$2A\ \omega$ $\quad \varphi = 30°$ $\quad$ LOC: $A_{sum} = \sqrt{A^2 + (2A)^2 - 4A^2\cos\theta}$

$\theta = 180 - \varphi = 150°$ $\quad = \sqrt{A^2 + 4A^2 - 4A^2(-\sqrt{3}/2)}$

$= \sqrt{5A^2 + 2A^2\sqrt{3}}$

$= A\sqrt{5+2\sqrt{3}} \approx 2.909A$

3) 

$L = 4m$

$v_{sound} = 335\ m/s$

$I = 6W/m^2$

3. $\delta\varphi$ (phase diff) gives the phase of individual wave @ observer

$\varphi = \frac{2\pi}{\lambda} r_2 - \frac{2\pi}{\lambda} r_1$

2. $f = 30\ Hz$ $\quad v = \lambda f$

$\lambda = ?$ $\quad \lambda = v/f$ $\quad \approx 0.932$ rad

$\approx \boxed{11.167m}$ $\quad \varphi \approx \boxed{53°}$