Key Concepts – Interference & Diffraction

1. The total phase angle of a wave is the quantity $\theta = (kx - \omega t + \phi)$

2. Two different waves, with angles θ_1 and θ_2 will interfere
   constructively if $\Delta\theta = 2\pi * m$
   destructively if $\Delta\theta = 2\pi * (m+\frac{1}{2})$ where m = any integer 0,1,2....

3. Different examples of 2-wave **interference**:

Type	Constructive Maxima	Destructive Minima
2 sources at diff. positions x (in air)	$\Delta\theta = 2\pi * m$, so $k\Delta x = 2\pi * m$ $\Delta x = \lambda\, m$	$\Delta\theta = 2\pi * (m+\frac{1}{2})$, so $k\Delta x = 2\pi * (m+\frac{1}{2})$ $\Delta x = \lambda\, (m+\frac{1}{2})$
1 source, split by 2 slits d = slit separation	approximate $\Delta x = d \sin\alpha$ ... $d \sin\alpha = \lambda\, m$	$d \sin\alpha = \lambda\, (m+\frac{1}{2})$
1 source, split by reflection from a thin film	$\Delta\theta = 2\pi * m$	$\Delta\theta = 2\pi * (m+\frac{1}{2})$
Case A: film rests on a *larger* n material (eg soap on water, oil on water)	$\Delta\theta = \Delta kx = 2\pi * m$ $k_{film} * 2t = 2\pi * m$ Convert k_{film} to get $2t = \lambda_{film}\, m$, or $n_{film} * 2t = \lambda_{air}\, m$	$\Delta\theta = \Delta kx = 2\pi * (m+\frac{1}{2})$ $k_{film} * 2t = 2\pi * (m+\frac{1}{2})$ Convert k_{film} to get $2t = \lambda_{film}\, (m+\frac{1}{2})$, or $n_{film} * 2t = \lambda_{air}\, (m+\frac{1}{2})$
Case B: film rests on a *smaller* n material (eg soap film in air, water film on ice)	now $\Delta\theta$ has an additional phase $\Delta\phi=\pi$ $\Delta\theta = \Delta(kx + \phi) = 2\pi * m$, $k_{film} * 2t - \pi = 2\pi * m$ Move π to right hand side... $k_{film} * 2t = 2\pi * (m+\frac{1}{2})$ Convert k_{film} to get $n_{film} * 2t = \lambda_{air}\, (m+\frac{1}{2})$	$\Delta\theta = \Delta(kx + \phi) = 2\pi * (m+\frac{1}{2})$ $k_{film} * 2t + \pi = 2\pi * (m+\frac{1}{2})$ Move π to right hand side... $k_{film} * 2t = 2\pi * m$ Convert k_{film} to get $n_{film} * 2t = \lambda_{air}\, m$

4. Different examples of 1-wave **diffraction**:

Type	Constructive Maxima	Destructive Minima
single slit diffraction a = slit width		approximate $\Delta x = a/2 \sin\alpha$ ... $a \sin\alpha = \lambda\, m$
multi-slit diffraction "grating" d = slit separation	approximate $\Delta x = d \sin\alpha$ ... $d \sin\alpha = \lambda\, m$	

3diffraction And Interference Review Answers

Michael J. Padilla,Ioannis Miaoulis,Martha Cyr,Jay M. Pasachoff

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