Name_____ Pd_____

We're Not Getting Any Younger

1. Light falls on a pair of slits $1.9 \cdot 10^{-3}$ cm apart. The slits are 80 cm from a screen. The first order bright spot is 1.9 cm from the central bright spot. What is the wavelength of the light? What color is this light?

$d = 1.9 \cdot 10^{-5}$ m
$L = .8$ m
$x = .019$ m
$n = 1$

$\theta = \tan^{-1}\left(\frac{.019}{.8}\right)$
$\theta = 1.36°$

$n\lambda = dx/L$
$1\lambda = 1.9 \cdot 10^{-5}(.019)/.8$
$\lambda = 451$ nm

2. A radio station broadcasts at 600 MHz from two antennas. A home is 17500 m from one antenna and 0.0195 Mm (megameters) from the other. Do they get poor reception or good reception? Remember that radio waves are a type of light–you know the speed of light, right? Explain your answer. (NOTE: The house is not necessarily on the line that connects the two antennas.)

$f = 600 \cdot 10^6$ Hz $\lambda = \frac{c}{f} = .5$m

$\Delta\delta = |17500 - 19500| = 2000$m $\Rightarrow 4000\lambda$ They are on an antinodal line

3. A lecturer is demonstrating two-slit interference with sound waves. The speakers are 4 m apart in a room at 10°C (The speed of sound is 337 m/s.). The sound has a frequency of 325 Hz. A student walks across the room parallel to a line joining the speakers 4.5 m out from the speakers. What will be the distance between consecutive "dead" or quiet spots?

$d = 4$m
$v = 337 = 325\lambda$ $\lambda = 1.037$m
$L = 4.5$
$x = ?$

$n\lambda = d\sin\theta$
$1(1.037) = 4\sin\theta$
$.2593 = \sin\theta$
$\theta = 15.03°$

$\tan 15.03 = \frac{x}{4.5}$

$\theta = 15.03°$, $L = 4.5$m, $x = 1.21$m

4. Monochromatic light of wavelength 500 nm passes through two slits and hits a screen 1.2 m away. The distance from the central to the first maximum is 0.6 cm. What is the slit separation distance, and what would be the distance to the 21st maximum from the central bright spot? (Hint: Is it 21 times the distance to the first bright spot?) What would be your percent error if you did an experiment assuming it was 21 times the distance?

$\lambda = 500 \cdot 10^{-9}$m
$L = 1.2$m
$x_1 = .006$m
$d = ?$

$500 \cdot 10^{-9} = d(.006)/1.2$

$n = 21$
$\lambda = 500 \cdot 10^{-9}$
$L = 1.2$
$x_{21} = ?$
$d = 10^{-4}$m

Approx: $x = .126$m ($\theta = 6°$ OK!)

$21x_1 = .126$

$d = 10^{-4}$m
$x_{21} = .126$m → 0% error

5. A child is bobbing two fingers up and down in sync with each other at a rate of 14 up-and-down bobs in 2.059 s on one side of a tub. Their fingers are 20 cm apart. On the other side of the tub, 45 cm away, there is a central antinode. The next nearest antinode is 15 cm away along the side of the tub. How long would it take a wave to travel straight across the tub? (Can you use $n\lambda \approx dx/L$ for this problem?)

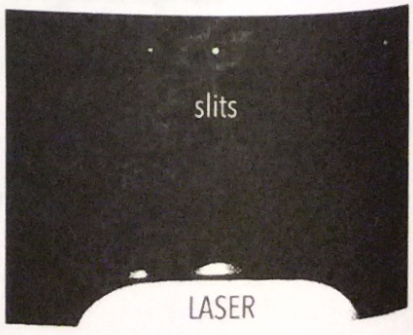
$f = \frac{14}{2.059} = 6.8$ Hz
$d = .2$m
$L = .45$m
$x = .15$m

$\tan^{-1}\left(\frac{.15}{.45}\right) = 18.4°$
No approx!!

$1 \cdot \lambda = .2\sin\theta$
$\lambda = .2\sin 18.4 = .063$m

NOPE
$v = f\lambda = 6.8(.063) = .428$ m/s

6. A laser shoots a beam of light at a diffraction grating as shown. The time period for the light waves shot from the laser is $2.27 \cdot 10^{-15}$ seconds. The speed of light in the room where the experiment was performed is $3 \cdot 10^8$ m/s. If the first bright spot on either side of the central antinodal line (CAN) is 2 cm away from the CAN, and the slits are 55 mm from the wall where the pattern is being observed, what is the distance between the slits (in micrometers)?



$T = 2.27 \cdot 10^{-15}$s
$f = \frac{1}{T} = 4.405 \cdot 10^{14}$Hz
$\lambda = \frac{c}{f} = 6.81 \cdot 10^{-7}$m

$x = .02$m
$L = .055$m
$\theta = \tan^{-1}\left(\frac{.02}{.055}\right) = 19.98°$

$n\lambda = d\sin\theta$
$1(6.81 \cdot 10^{-7}) = d(\sin 19.98)$

$d = 1.99 \cdot 10^{-6}$m