W.S. # 8.5 Waves Review **Key**

WS 8.5 Waves Review Name:________________________________ pd.____

- watch s.f. *- show work on all problems*

1. One of the yellow lines of the sodium spectrum has λ = 5896 Ångströms. (1Å=10^{-10}m)

3s.f.

a. Calculate the frequency of this light. Frequency = 5.088×10^{14} Hz or $\boxed{5.09 \times 10^{14}\ Hz}$

$f = c/\lambda = 3.00 \times 10^8\ m/s \,/\, 5.896 \times 10^{-7}\ m$

b. If the light above entered a piece of glass for which n = 1.50 for yellow light, then the light would be slowed to a speed of 2.00×10^8 m/s, with its frequency 5.088×10^{14} Hz, and its wavelength 3.93×10^{-7} m (Put numbers in all spaces after showing work here. Label the work)

or $\boxed{5.09 \times 10^{14}\ Hz}$ (frequency does not change)

$n = \frac{c}{v}$ $v = \frac{c}{n} = \frac{3.00 \times 10^8\ m/s}{1.50} = \boxed{2.00 \times 10^8\ m/s}$

$v = \lambda f$ $\lambda = \frac{v}{f} = \frac{2.00 \times 10^8\ m/s}{5.088 \times 10^{14}\ Hz} = \boxed{3.93 \times 10^{-7}\ m}$

2s.f.

2. If a source of periodic waves is in phase with another similar source, an interference pattern with hyperbolic nodes on a plane can be produced. If the sources are 4.00 cm apart, with λ = 1.50 cm, and the pattern is observed from 0.75 m away, find the distance to the first two nodes (*assume that $D_0=D_1=D_2$...probably not really true here...*)

x_0 = 0.14 m x_1 = 0.42 m

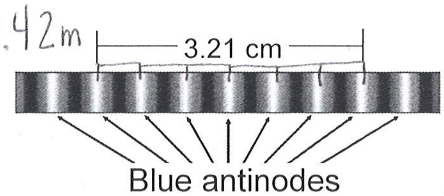
$\frac{x_n}{D_n} = \frac{(n+\frac{1}{2})\lambda}{d}$

n = 0 $x_0 = \frac{(n+\frac{1}{2})\lambda \cdot D_0}{d} = (0.5)(1.5\ cm)(0.75\ m)/4.00\ cm = 0.14\ m$

n = 1 $x_1 = (n+\frac{1}{2})\lambda \cdot D_1/d = (1.5)(1.5\ cm)(0.75\ m)/4.00\ cm = 0.42\ m$

3s.f.

3. An interference pattern is created on a screen like what we did in Young's experiment. If blue light of about 450. nm wavelength was used at a distance of 2.00m from the screen,



a. What was the slit spacing (distance between slits)?

$\Delta x = \frac{x_T}{\#\ of\ spaces} = \frac{3.21\ cm}{6} = 0.535\ cm$ or $0.00535\ m$

$\frac{x_n}{D_n} = \frac{n\lambda}{d}$ n = 1 $D_0 \approx D_1 = 2.00\ m$

$d = \frac{n\lambda \cdot D_n}{x_n} = \frac{(1)(450.\ nm) \times \left(\frac{10^{-9}\ m}{nm}\right) \times (2.00\ m)}{(0.00535\ m)}$

$\boxed{d = 1.68 \times 10^{-4}\ m}$

b. With the setup, how far is it from the center of the middle anti-node to the center of the 7th antinode? (consider the middle one to be number zero)

x_1

n = 0 1 2 3 4 5 6 7

$7 \times (x_1) = 7(0.535\ cm) = 3.745\ cm$ or $\boxed{0.0375\ m}$

$KHz = 1\times10^3 Hz$ $\quad C = 3.00\times10^8 m/s \quad \lambda = \frac{c}{f}$

$MHz = 1\times10^6 Hz$

4. Calculate wave lengths for typical radio frequency electromagnetic radiation using the following frequencies: (Show work on back if not enough room here)

AM radio $\lambda = \frac{3.00\times10^8 m/s}{1000\,KHz\left(\frac{1\times10^3 Hz}{KHz}\right)} =$ $\quad v = 1000$ kHz (f) $\quad \lambda =$ $3\times10^2\,m$ or $\Rightarrow$ $\boxed{300m}$ 1s.f.

Lower limit of "40 meter" amateur band $\quad v = 7.0$ MHz (f) $\quad \lambda =$ $42.9\,m \Rightarrow$ 2s.f. $= \boxed{43m}$

$\lambda = 3.00\times10^8 m/s \,/\, 7.0\,MHz\times\frac{1\times10^6 Hz}{MHz}$

Low are of TV broadcast $\quad v = 60$ MHz (f) $\quad \lambda =$ $\boxed{15m}$ 1s.f.

$\lambda = \frac{3.00\times10^8 m/s}{60\,MHz\times(1\times10^6 Hz/MHz)}$

Typical FM station $\quad v = 99$ MHz (f) $\quad \lambda =$ $\boxed{13.0m}$ 2s.f.

$\lambda = \frac{3.00\times10^8 m/s}{99\,MHz(1\times10^6 Hz/MHz)} =$

5. How long would it take light to cross the classroom (a distance of about 10. m)? *Answer in seconds and microseconds* 3.3×10^{-8} s = 3.3×10^{-2} μs

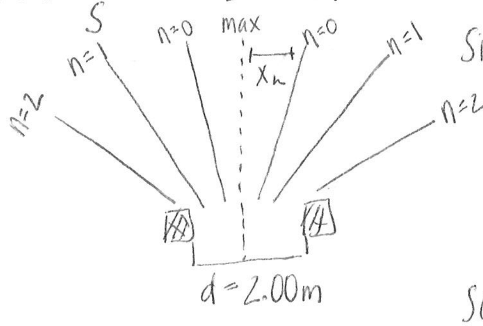
$1\,\mu s = 10^{-6} s \quad v = d/t \quad t = d/v = \frac{10m}{3.00\times10^8 m/s} = 3.3\times10^{-8} s \times \frac{1\,\mu s}{10^{-6} s} = 3.3\times10^{-2}\,\mu s$

6. A stereo set I build about 20 years ago had 2 speakers in each cabinet. (Modern speaker cabinets often have at least 3.) The smaller one, which reproduces the higher pitched sounds best, had a diameter of 3.50 inches. (Remember, 1" = 2.54 cm by legal definition - exactly). When the two speaker cabinets were placed 2.00 meters apart (center to center) and were sending out sound with a frequency of 900. Hz, where (at what angles) would you expect no sound if the speed of sound in the room were 330. m/s? (Calculate all the angles - set up the equation for the angles clearly and present your answers in a table. You do not need to re-solve the smooth form for each case, just do one thoroughly and explain briefly what you'll do to get the rest of the cases. Show why the list of solutions ends.) After the solution, make a list of all the reasons why you think we don't usually hear nodes from our stereo systems.

3s.f.

$V = \lambda f \quad f = \frac{V}{\lambda} \quad \lambda = \frac{V}{f} \quad V = 330.\frac{m}{s} \quad d = 2.00\,m$

$\lambda = \frac{330.\frac{m}{s}}{900.\,Hz} = \boxed{\lambda = 0.367m}$



destructive / nodes

$\sin\theta = \frac{X_n}{D_n} = \frac{(n+\frac{1}{2})\lambda}{d}$

$\theta = \sin^{-1}\left(\frac{(n+\frac{1}{2})\lambda}{d}\right)$

Sample calculation for n = Ø

$\theta = \sin^{-1}\left(\frac{(0.5)(0.367m)}{(2.00m)}\right)$

$\boxed{\theta = 5.26^\circ}$

Table of Angles

node#	θ
n=0	5.26°
n=1	16.0°
n=2	27.3°
n=3	40.0°
n=4	55.7°
n=5	Error → (angle is greater than 90°)

We usually don't hear nodes because the sound bounces around the room + destroys the nodes.