PHY 102: Homework #1 Solution

1. From the formula $\lambda = v.T = \frac{v}{f}$, one obtain :

(a) For $\lambda = 0.1\text{m}$, $v_s = 340\text{m/s}$: $f = \frac{340\text{m/s}}{1.0\text{m}} = 340\text{Hz}$.

(b) For the electromagnetic wave $v_s = C = 3\times10^8\,\text{m/s}$, therefore $f = 3\times10^8\,\text{Hz}$

2. The wave length interval is $4\times10^{-7}\,m \quad to \quad 7\times10^{-7}\,m$. From the same formula as in the above, one found :

- $\lambda = \frac{3\times10^8\,m/s}{4\times10^{-7}\,m} = 0.75\times10^{15}\,Hz$
- $\lambda = \frac{3\times10^8\,m/s}{7\times10^{-7}\,m} = 0.42\times10^{15}\,Hz$

Thus the frequencies of the electromagnetic waves are $0.42\times10^{15}\,Hz$ to $0.75\times10^{15}\,Hz$

3. The wave string equation being

$$y(x,t) = 4.00\times\sin(\omega t - kx),$$

With $\omega = 6.0\times10^2\,\text{rad/sec}$ and $k = 6.0\,\text{rad/m}$

(a) The amplitude : A=4.0mm

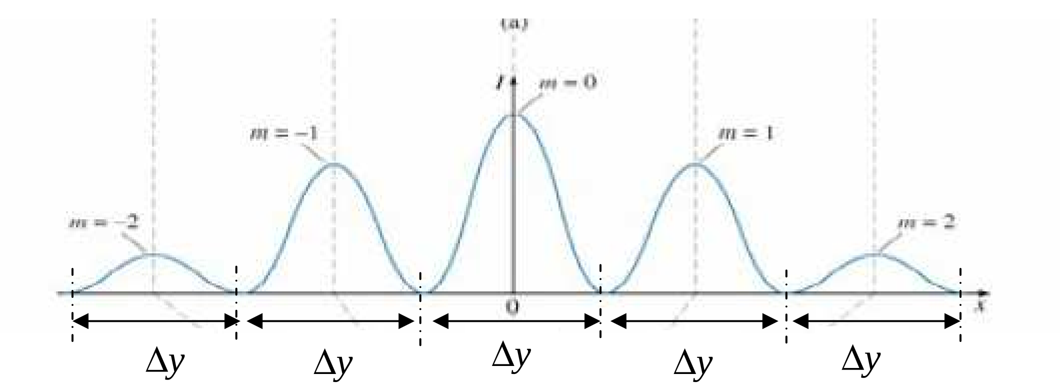
(b) The wavelength : $\lambda = \frac{2\pi}{k} = \frac{2\times3.14\text{rad}}{6.0\text{rad/m}} = 1.04\,\text{m}$

(c) The period : $T = \frac{2\pi}{\omega} = \frac{2\times3.14\text{rad}}{6.0\times10^2\,\text{rad/s}} = 1.04\times10^{-2}\,\text{s}$

(d) Wave speed : $v = \frac{\lambda}{T} = \frac{1.04\text{m}}{1.04\times10^{-2}\,\text{s}} = 100\,\text{m/s}$

(e) The wave is traveling in the positive direction of x.

4. This is a Bonus question. Clever students should not hesitate to attack this problem.



One must show that Δy, the distance between two adjacent fringes, are equals. Recall that:

$$y_m = m\frac{\lambda L}{d}$$

Δy is given by

$$\Delta y_m = y_{m+1} - y_m$$

One has,

$$\Delta y_1 = y_2 - y_1 = 2\frac{\lambda L}{d} - \frac{\lambda L}{d} = (2-1)\frac{\lambda L}{d} = \frac{\lambda L}{d}$$

$$\Delta y_2 = y_3 - y_2 = 3\frac{\lambda L}{d} - 2\frac{\lambda L}{d} = (3-2)\frac{\lambda L}{d} = \frac{\lambda L}{d}$$

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$$\Delta y_m = y_{m+1} - y_m = (m+1)\frac{\lambda L}{d} - (m)\frac{\lambda L}{d} = (m+1-m)\frac{\lambda L}{d} = \frac{\lambda L}{d}$$

Therefore, it's clear that the fringes are equally distant.

5. The distance slit screen : $D = L = 36.8\,cm = 368\,mm$
   Distance between slits: $d = 0.120\ mm$
   Wavelength: $\lambda = 474\,nm$
   From the formula

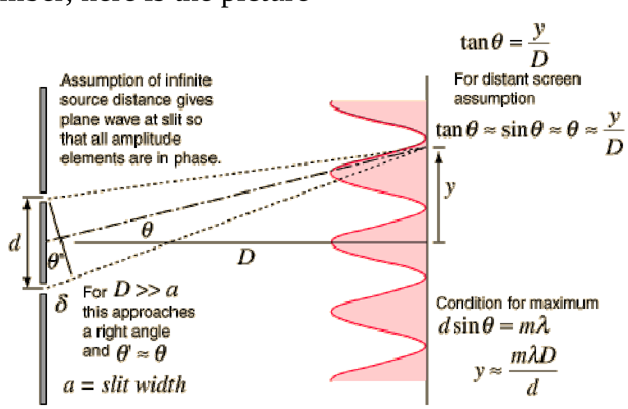
$$y = m\frac{\lambda L}{d}$$

   And $m = 1$ for adjacent fringes, we get

$$y = \frac{\lambda L}{d} = 475\,nm \times \frac{368\,mm}{0.120\,mm} = 1.456\times 10^{-15}\ m = 1.456\,fm$$

   Where $1\,fm = 10^{-15}\ cm$, is called the centimeter.

If you don't remember, here is the picture



6. The distance slit screen : $D = L = 250\,cm$

Distance between slits: $d = 0.0150\,\text{cm}$

Distance between bright fringes: $y = 0.76\,\text{cm}$

Since

$$y = m\frac{\lambda L}{d}$$

For two adjacent fringes $m = 1$, the wavelength is therefore given by

$$\lambda = \frac{y.d}{L} = 0.76\,\text{cm} \times \frac{0.0150\,\text{cm}}{250\,\text{cm}} = 456 \times 10^{-9}\,\text{cm} = 456\,\text{nm}$$