Phys 302 Photonics

Homework Solutions - Chapter 2

(2.2) $\lambda = \frac{c}{\nu}$ (a) Red light, $\lambda_{Red} = \frac{3\times10^8 \frac{m}{s}}{5\times10^{14} Hz}$

$$\lambda_{Red} = 6\times10^{-7} m = 600 nm$$

(b) If $\nu = 60 Hz$, $\lambda = 5\times10^6 m$. This is the frequency and wavelength of commerical power to your house.

(2.3) $v = \lambda\nu = (5\times10^{-5} cm)(6\times10^8 Hz) * \left(\frac{1m}{10^2 cm}\right)$

$$v = 300 \ m/s$$

(2.7) $v = \frac{\text{distance traveled}}{\text{time}} = \frac{10m}{2s} = 5 \ m/s$

$$\nu = \frac{v}{\lambda} = \frac{5 \ m/s}{0.5 \ m} = 10 \ Hz$$

(2.26) $\psi(y,t) = A\cos\pi(3\times10^6 y + 9\times10^{14} t)$

$$= A\cos(ky + \omega t)$$

Speed $v = \frac{\omega}{k}$

$$= \frac{\pi\times9\times10^{14}/s}{\pi\times3\times10^6/m}$$

$$v = 3.00\times10^8 \frac{m}{s} = c$$

(2.32) You have a traveling wave if you can write $\Psi(x,t) = f(x \mp vt)$

(a) $a^2y^2 + b^2t^2 - 2abty = (ay - bt)^2$
$= a^2(y - \frac{b}{a}t)^2$

This is of the required form of a traveling wave with: $v = b/a$ to the right of the y-axis.

(b) $az^2 - bt^2$ cannot be put into the required form, so it is not a Traveling wave.

(c) $\left(\frac{x}{a} + \frac{t}{b}\right)^2 = \frac{1}{a^2}\left(x + \frac{a}{b}t\right)^2$ is of the required form, so it is a Traveling wave with $v = a/b$ to the left of the x-axis

(d) $(t - x) = -(x - t)$ is of the required form of a traveling wave with velocity $v = 1$ to the right of the x-axis

(2.34) The phase of the wave is $\phi = kx - \omega t$
The phase difference is

$$\Delta\phi = \phi_2 - \phi_1 = (kx_2 - \omega t) - (kx_1 - \omega t)$$

$$\Delta\phi = k(x_2 - x_1) = \frac{2\pi}{\lambda}(x_2 - x_1)$$

$$\Delta\phi = 2\pi\left(\frac{\nu}{v}\right)\Delta x = 2\pi\left(\frac{1.10\,kHz}{330\,m/s}\right)(10.0\,cm)$$

$$\boxed{\Delta\phi = \frac{2\pi}{3}\text{ radians} = 120^0}$$