HW solution chapter 33 Phy 201
Term 112

33.2

$$d = ct = 3\times10^{8} \times 1\times10^{-9} = \underline{0.3\ m}$$

33.6

$$\lambda = \frac{c}{f} \quad \text{but} \quad f = \frac{1}{2\pi\sqrt{LC}}$$

$$\Rightarrow \lambda = 2\pi c\sqrt{LC} = 2\times\pi\times3\times10^{8}\sqrt{0.253\times10^{-6}\times25\times10^{-12}}$$

$$= \underline{4.7\ m}$$

33.10

a) $B_m = \dfrac{E_m}{c} = \dfrac{5}{3\times10^{8}} = 1.7\times10^{-8}\ T$

b) $I = \dfrac{E_m^2}{2\mu_0 c} = \dfrac{5^2}{2\times4\pi\times10^{-7}\times3\times10^{8}} = \underline{3.3\times10^{-2}\ W/m^2}$

33.18

$\lambda = 500\ nm \quad P = 200\ W \quad r = 400\ m$

$$B = B_m \sin(kx - \omega t)$$

$$\frac{\partial B}{\partial t} = -\omega B_m \cos(kx-\omega t) = -\left(\frac{\partial B}{\partial t}\right)_{max} \cos(kx-\omega t)$$

$$\Rightarrow \left.\frac{\partial B}{\partial t}\right)_{max} = \omega B_m *$$

$$I = \frac{P}{4\pi r^2} \qquad B_m = \frac{E_m}{c} =$$

$$I = \frac{E_m^2}{2\mu_0 c} = \frac{P}{4\pi r^2} \Rightarrow E_m = \sqrt{\frac{2\mu_0 P c}{4\pi r^2}}$$

$$B_m = \sqrt{\frac{2\mu_0 P}{4\pi r^2 c}}$$

$$c = \frac{\omega}{k} \Rightarrow \omega = ck = \frac{c\,2\pi}{\lambda}$$

$$\Rightarrow \left.\frac{\partial B}{\partial t}\right)_{max} = \sqrt{\frac{2\mu_0 P}{4\pi r^2 c}}\ \frac{c\,2\pi}{\lambda} = \sqrt{\frac{2\mu_0 P c}{4\pi r^2}}\ \frac{2\pi}{\lambda}$$

$$= \sqrt{\frac{2\times \cancel{4\pi}\times 10^{-7} \times 200 \times 3\times 10^{8}}{\cancel{4\pi} \times (400)^2}}\ \frac{2\pi}{500\times 10^{-9}}$$

$$= \underline{3.4\times 10^{6}\ T/s}$$

33. 22

$I = 1.4\ kW/m^2$

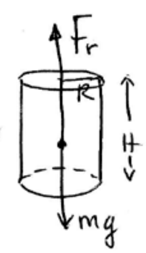
a) The radiation pressure $p_r = \frac{I}{c} \Rightarrow F_r = p_r \times \text{Area} = \frac{I}{c}\pi R^2$

$$F_r = \frac{1.4\times 10^{3}}{3\times 10^{8}} \times \pi \times (6.37\times 10)^2 = \underline{6\times 10^{8}\ N}$$

b) $$F_g = \frac{GMm}{R^2} = \frac{6.67\times 10^{-11} \times 2\times 10^{30} \times 5.98\times 10^{24}}{(1.5\times 10^{11})^2} = \underline{3.6\times 10^{22}\ N}$$

$$F_g \gg F_r$$

33.28



$$F_r = p_r A = \frac{2I}{c}\pi R^2$$

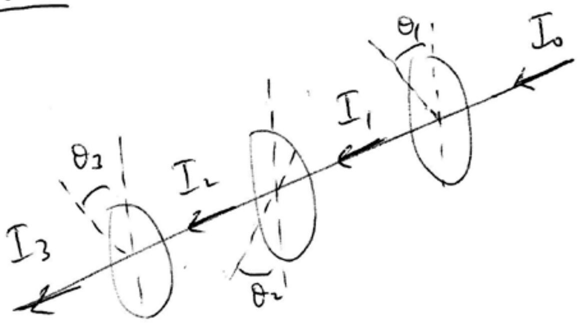
At equilibrium $F_r = mg$

$$\frac{2I}{c}\cancel{\pi R^2} = \rho \cancel{\pi R^2} H g \qquad \text{but } I = \frac{P}{\pi R^2}$$

$$H = \frac{2I}{\rho g c} = \frac{2P}{\pi R^2 \rho g c} = \underline{4.9\times 10^{-7}\ m}$$

$$= \frac{2\times 4.6}{\pi \times (1.3\times 10^{-3})^2 \times 1200 \times 9.8 \times 3\times 10^{8}}$$

33.34



$\theta_1 = \theta_2 = \theta_3 = 50^\circ$

I_0 is unpolarized

$$I_1 = \frac{1}{2} I_0$$

$$I_2 = I_1 \cos^2 100$$

$$I_3 = I_2 \cos^2 100$$

$$I_3 = \frac{1}{2} I_0 \cos^2 100 \cos^2 100 \Rightarrow$$

$$\frac{I_3}{I_0} = \frac{1}{2} \cos^2 100 \cos^2 100 = 4.5 \times 10^{-4}$$

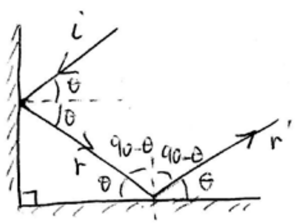
33.37

a) $I_1 = \frac{1}{2} I_0 = \frac{10}{2} = 5 \ mW/m^2 = \frac{E_m^2}{2\mu_0 c} \Rightarrow E_m = \sqrt{2\mu_0 c I_1}$

$= \underline{1.9 \ V/m}$

b) $p_r = \frac{I}{c} = \frac{5 \times 10^{-3}}{3 \times 10^8} = \underline{1.7 \times 10^{-11} \ Pa}$

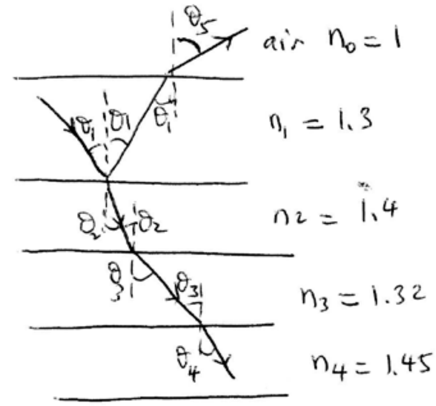
33.47



the outgoing ray is parallel to the incoming ray.

33.53

$\theta_1 = 40.1°$



a) $n_1 \sin\theta_1 = n_0 \sin\theta_5$

$\sin\theta_5 = \frac{n_1}{n_0} \sin\theta_1$

$= \frac{1.3}{1} \sin 40.1°$

$\underline{\theta_5 = 56.9°}$

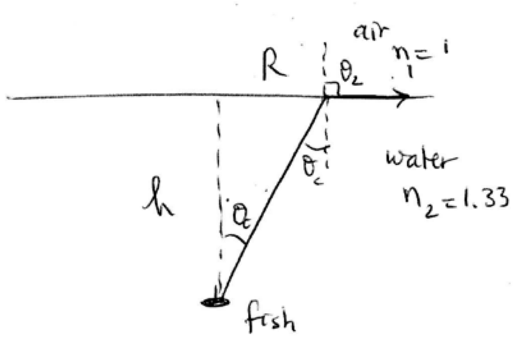
b) $n_1 \sin\theta_1 = n_2 \sin\theta_2 = n_3 \sin\theta_3 = n_4 \sin\theta_4$

$n_1 \sin\theta_1 = n_4 \sin\theta_4$

$\sin\theta_4 = \frac{n_1}{n_4} \sin\theta_1 = \frac{1.3}{1.45} \sin 40.1°$

$\underline{\theta_4 = 35.2°}$

33.60



$n_2 \sin\theta_c = n_1 \sin 90°$

$\sin\theta_c = \frac{n_1}{n_2} = \frac{1}{1.33}$

$\theta_c = 48.8°$

$\tan\theta_c = \frac{R}{h} \Rightarrow R = h \tan\theta_c$

$R = 2 \tan 48.8 = 2.28$

diameter $= 2R = \underline{4.56 m}$