3-27

Momentum of 10^{19} Hz X-ray photon?

$$\nu = 10^{19}\ \text{Hz}$$

$$\vec{p} = \hbar\vec{k}$$

or, easier $p = \frac{h}{\lambda}$ (magnitude)

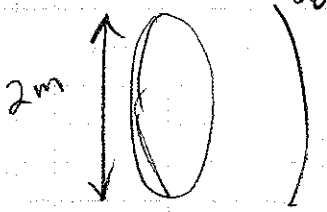
$$c = \lambda\nu \Rightarrow \frac{1}{\lambda} = \frac{h\nu}{c}$$

which is also $\frac{\mathcal{E}}{c}$ where $\mathcal{E}$ is the energy

$$p = \frac{h\nu}{c} = \frac{(6.63\times10^{-34}\ \text{J.s})(10^{19}\ \text{Hz})}{3\times10^{8}\ \text{m/s}}$$

$$\boxed{p = 2.21\times10^{-23}\ \text{N.s}}$$

3-35



200 kW pulses

In each pulse $I = \frac{2\times10^{5}\ \text{W}}{\pi(2\text{m})^2}$

$= \frac{10^{5}\ \text{W}}{2\pi\ \text{m}^2} = \frac{10\cdot10^{4}}{6.28}$

$= 1.58\times10^{4}\ \text{W/m}^2$ (during pulse)

$F = PA$

pressure $P = \frac{I}{c} = F = \frac{I}{c}A$

$F = \frac{2\times10^{5}\ \text{W}}{A}\,\frac{A}{c}$

but only on a fraction $\frac{500\times2\,\mu\text{s}}{5} = \frac{1}{1000}$ of time

$= \frac{2\times10^{5}\ \text{W}}{3\times10^{8}\ \text{m/s}} = 6.67\times10^{-4}\ \text{N}$ (during pulse)

$\overline{F_{avg} = 6.67\times10^{-7}\ \text{N}}$

206 1839

3-14 Irradiance 1m away from 20 W light bulb.

20W gets distributed into $4\pi r^2$ area

$$A = 4\pi(1)^2 = 4\pi\ m^2$$

$$I = \frac{20W}{4\pi\ m^2} = 1.59\ \frac{W}{m^2}$$

This would be the integrated or bolometric luminosity.

3-16 $L = 3.9 \times 10^{26}\ W$ $r = 1.5 \times 10^{11}\ m$

We are going to use

$$I = \langle S \rangle_T = \frac{c\,\epsilon_0\,E_0^2}{2}$$

to estimate E_0, first we need

$$I = \frac{3.9\times10^{26}W}{4\pi(1.5\times10^{11}m)^2} = \frac{39\times10^{25}W}{4\pi\times2.25\times10^{22}m^2}$$

$$= 1.38\times10^3\ \frac{W}{m^2}$$

$$E_0 = \sqrt{\frac{2I}{c\epsilon_0}} = \sqrt{\frac{2\times1.38\times10^3}{(3\times10^8)(8.85\times10^{-12})}}$$

$$= \sqrt{\frac{2760}{3\times8.85}\times10^9}$$

$$= \sqrt{\frac{920}{8.85}\times}$$

$$\sqrt{100.4\times10^4} \approx \sqrt{10^6}$$

$$\approx 1000\ \frac{V}{m}$$