EE2190 Quiz 3, Spring 2005

Show your work for full credit. Express ALL answers in MKS (meters, kilograms, seconds).

1. What is the force due to radiation pressure on a perfectly reflecting surface of 1m² oriented normal to the incoming sun's rays, situated at the earth's surface where the sun's irradiance is approximately 1400 W/m²?

\[
\text{Force} = \frac{dp}{dt} = \left(\frac{\text{# photons}}{\text{sec}}\right) \frac{h}{\lambda}
\]

\[
\frac{\text{# photons}}{\text{sec}} = \frac{\text{Irradiance} [\text{W/m}^2]}{(hc/\lambda) [\text{m}]} \times \text{(Area)}
\]

\[
\text{Force} = 1400 [\text{W/m}^2] \left[\frac{\text{W}}{\text{m}^2}\right] \frac{(h/\lambda)}{\text{m}}
\]

\[
= \frac{14000 [\text{W/m}^2]}{3.8 \times 10^8 [\text{m/s}]} = 3.7 \times 10^{-6} \text{ [N/m²]}
\]

Now because this is a reflecting surface, must multiply by factor of \( \frac{1}{2} \)

So total Force = \( 9.3 \times 10^{-6} \text{ N} \)

2. How many photons per second are emitted from a 100 W source with \( \lambda = 550 \text{ nm} \)?

\[
\frac{\text{# photons}}{\text{sec}} = \frac{\text{Power} [\text{W}]}{\text{Energy} [\text{J}]} = \frac{100 \left[\frac{\text{J}}{\text{s}}\right]}{\text{h}c/\lambda [\text{J}]} [\text{sec}]
\]

\[
= \frac{100 \times 550 \times 10^{-9}}{6.626 \times 10^{-34} \times (3 \times 10^8)} [\text{sec}]
\]

\[
= 2.8 \times 10^{20} \frac{\text{sec}}{\text{sec}}
\]