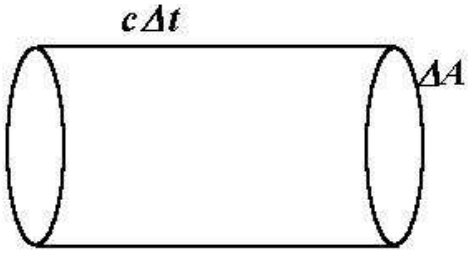
PHY 5346
Homework Set 12 Solutions – Kimel

1. 6.11

a) Consider the momentum contained in the volume



$$\Delta p = \Delta t c \Delta A g$$

$$F = \frac{\Delta p}{\Delta t} = c \Delta A g$$

$$P = \frac{F}{\Delta A} = cg$$

where I'm using the time averaged quantities. In class we found

$$cg = \frac{1}{c} S = \frac{1}{2} \varepsilon_0 |E_0|^2 = u$$

Thus

$$P = u$$

b) We are given

$$S = 1.4 \times 10^3 \mathrm{W/m^2}$$

But we know $P = u = \frac{S}{c}$. From Newton's second law

$$a = \frac{F}{m} = \frac{F/A}{m/A} = \frac{S/c}{m/A} = \frac{1.4 \times 10^3 \mathrm{W/m^2}}{3 \times 10^8 \mathrm{m/s} \times 1 \times 10^{-3} \mathrm{kg/m^2}} = 4.66 \times 10^{-3} \mathrm{m/s^2}$$

In the solar wind, there are approximately 10×10^4 protons/$(m^2 - \sec)$, with average velocity $v = 4 \times 10^5 \mathrm{m/s}$.

$$\frac{\Delta p}{\Delta t A} = P = 10 \times 10^4 \times 4 \times 10^5 \times 1.67 \times 10^{-27} = 6.68 \times 10^{-17} \mathrm{N/m^2}$$

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$$a = \frac{F}{m} = \frac{F/A}{m/A} = \frac{P}{m/A} = \frac{6.68 \times 10^{-17} \mathrm{N/m^2}}{1 \times 10^{-3} \mathrm{kg/m^2}} = 6.68 \times 10^{-14} \mathrm{\ m/s^2}$$