32-41.

$$S_{\text{av}} = \frac{\text{Power}}{\text{Area}} = \frac{3.2 \times 10^{-3}}{\pi \left(1.25 \times 10^{-3}\right)^2} = 652 \text{ W/m}^2$$

(a)

$$\begin{aligned} S_{\text{av}} &= \frac{1}{2}\epsilon_0 c E_m^2 \Rightarrow E_m = \sqrt{\frac{2S_{\text{av}}}{c\epsilon_0}} = 701 \text{ V/m} \\ S_{\text{av}} &= \frac{1}{2\mu_0} c B_m^2 \Rightarrow B_m = \sqrt{\frac{2\mu_0 S_{\text{av}}}{c}} = 2.34 \times 10^{-6} \text{ T} \end{aligned}$$

(b) Note that the average of E^2 is $\frac{1}{2}E_m^2$.

$$\begin{aligned} u_{\text{E,av}} &= \frac{1}{2}\epsilon_0 \left(\frac{1}{2}E_m^2\right) = \frac{S_{\text{av}}}{2c} = 1.09 \times 10^{-6} \text{ J/m}^3 \\ u_{\text{B,av}} &= \frac{1}{2\mu_0}\left(\frac{1}{2}B_m^2\right) = \frac{S_{\text{av}}}{2c} \end{aligned}$$

(c)

$$U = u \cdot \text{Beam Volume} = \frac{S_{\text{av}}}{c} \cdot \text{Area} \times \ell = \text{Power } \frac{\ell}{c} = 3.2 \times 10^{-3} \ \frac{1}{3 \times 10^8} = 1.07 \times 10^{-11} \text{ J}$$

32-44.

$$\begin{aligned} S_{\text{av}} = \frac{1}{2}\epsilon_0 c E_m^2 &= \frac{\text{Power}}{\text{Area}} \\ E_m &= \sqrt{\frac{2\text{Power}}{\epsilon_0 c \text{Area}}} = 242 \text{ V/m} \end{aligned}$$

32-49. Find S_{av} at 2.5 km from antenna:

$$S_{\text{av}} = \frac{\text{Power}}{4\pi r^2} = \frac{55 \times 10^3}{4\pi \cdot (2.5 \times 10^3)^2} = 7.003 \times 10^{-4} \text{ W/m}^2$$

Find B_m from S_{av}:

$$S_{\text{av}} = \frac{1}{2\mu_0} c B_m^2 \Rightarrow B_m = \sqrt{\frac{2\mu_0 S_{\text{av}}}{c}} = 2.423 \times 10^{-9} \text{ T}$$

The magnetic flux is then: $\Phi_B = B_m \cos(\omega t) \cdot \pi r^2$, and the induced emf is: $\mathcal{E} = -d\Phi_B/dt = B_m \omega \sin(\omega t) \cdot \pi r^2$, so the maximum emf is:

$$\mathcal{E}_m = B_m \omega \cdot \pi r^2 = 2.423 \times 10^{-9} \cdot 2\pi \ 95 \times 10^6 \cdot \pi \ .09^2 = 0.0368 \text{ V}$$

32-51. The expelled momentum in the light beam (a force) is:

$$F = \frac{S\text{Area}}{c} = \frac{\text{Power}}{c} = \frac{200}{c} = 6.671 \times 10^{-7} \text{ N}$$

Starting with zero velocity we seek the time it takes to go 16 m: $t = \sqrt{2x/a}$ where the acceleration $a = F/m$:

$$t = \sqrt{\frac{2xm}{F}} = \sqrt{\frac{2 \cdot 16 \cdot 150}{6.671 \times 10^{-7}}} = 8.48 \times 10^4 \text{ s} = 23.5 \text{ hours}$$

Throwing the flashlight (in the opposite direction as the spaceship) will provide more expelled momentum faster.