

Name:

Physics 51
Homework #17
November 7, 2016

38-E25, 38-E28, 38-P13*, 38-P14

38-E25 The intensity of direct solar radiation not absorbed by the atmosphere on a particular summer day is 130 W/m^2 . How close would you have to stand to a 1.0-kW electric heater to feel the same intensity? Assume that the heater radiates uniformly in all directions.

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38-E28 Sunlight strikes the Earth, just outside its atmosphere, with an intensity of 1.38 kW/m^2 . Calculate

(a) E_m and

(b) B_m for sunlight,

assuming it to be plane wave.

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38-P13* A plane electromagnetic wave, with wavelength 3.18 m, travels in free space in the $+x$ direction with its electric field vector \vec{E} , of amplitude 288 V/m, directed along the y axis.

- (a) What is the frequency of the wave?
- (b) What is the direction and amplitude of the magnetic field associated with the wave?
- (c) If $E = E_m \sin(kx - \omega t)$, what are the values of k and ω ?
- (d) Find the intensity of the wave.
- (e) If the wave falls on a perfectly absorbing sheet of area 1.85 m^2 , at what rate would momentum be delivered to the sheet and what is the radiation pressure exerted on the sheet?

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38-P14 Figure 38-30 shows a parallel-plate capacitor being charged.

- Show that the Poynting vector \vec{S} points everywhere radially into the cylindrical volume.
- Show that the rate at which energy flows into this volume, calculated by integrating the Poynting vector over the cylindrical boundary of this volume, is equal to the rate at which the stored electrostatic energy increases; that is,

$$\int \vec{S} \cdot d\vec{A} = Ad \frac{d}{dt} \left(\frac{1}{2} \epsilon_0 E^2 \right),$$

where Ad is the volume of the capacitor and $\frac{1}{2} \epsilon_0 E^2$ is the energy density for all points within that volume. This analysis shows that, according to the Poynting vector point of view, the energy stored in a capacitor does not enter it through the wires but through the space around the wires and the plates. (Hint: To find \vec{S} we must first find \vec{B} , which is the magnetic field set up by the displacement current during the charging process; see Fig. 38-2. Ignore fringing of the lines of \vec{E} .)

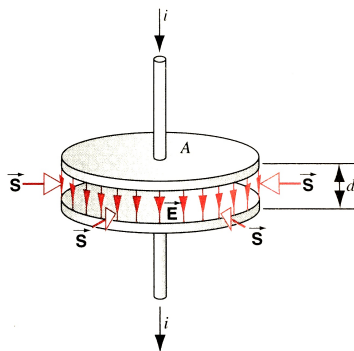


FIGURE 38-30. Problem 14.

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