Problem I

1. A proton moves through a region containing a uniform electric field given by $\vec{E} = 50.0\hat{\mathbf{j}}$ V/m and a uniform magnetic field $\vec{B} = \left(0.200\hat{\mathbf{i}} + 0.300\hat{\mathbf{j}} + 0.400\hat{\mathbf{k}}\right) T$. Determine the acceleration of the proton when it has a velocity of $\vec{v} = 200\hat{\mathbf{i}}$ m/s.

Problem II

The distance to the North Star, Polaris, is approximately 6.44×10^{18} m.

(a) If Polaris were to burn out today, how many years from now would we see it disappear?

(b) What time interval is required for sunlight to reach Earth?

(c) What time interval is required for a microwave signal to travel from the Earth to the Moon and back?

Your answer to the latter question may vary depending on your value for the distance from the moon, but should be generally around 3 seconds.

Problem III

2. The red light emitted by a helium-neon laser has a wave-length of $\left(632.8 \times 10^{-9}\right)$ m. What is the frequency of the light in waves?

Problem IV

3. A plane electromagnetic sinusoidal wave propagates in the x direction. The wavelength is 50.0 and the electric field vibrates in the xy plane with an amplitude of 22.0V/m.

(a) What is the waves frequency?

(b) What is the magnetic field $\vec{B}$ when the electric field has its maximum value in the negative y direction.

(c) Write an expression for $\vec{B}$ with the correct unit vector, with numerical values for B_{max}, k, and ω, and with its magnitude in the form $B = B_{\max} \cos(kx - \omega t)$.

Problem V

4. If the intensity of sunlight at the Earth's surface under a fairly clear sky is 1000 W/m^2, how much electromagnetic energy per cubic meter is contained in sunlight?

Problem VI

5. What is the average magnitude of the Poynting vector 5.00 miles from a radio transmitter broadcasting isotropically with an average power of 250kW?

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Problem VII

6. High-power lasers in factories are used to cut through cloth and metal. One such laser has a beam diameter of 1.00 mm and generates an electric field having an amplitude of 0.700 MV/m at the target.
   (a) What is the amplitude of the magnetic field produced?
   (b) What is the intensity of the laser?
   (c) What is the power delivered by the laser?

Problem VIII

7. Consider a bright star 20.0 light-years from Earth with a power output of $\left(4.00 \times 10^{28}\ \text{W}\right)$ (nearly 100 times as much as our star).
   (a) Find the intensity of the starlight on Earth.
   (b) Find the power of the starlight that the Earth intercepts.

Problem IX

8. ELF waves that can penetrate the oceans are the only practical means of communicating with distance submarines.
   (a) Calculate the length of a quarter-wavelength antenna for a transmitter generating ELF waves of frequency 75.0 Hz into air.
   (b) How practical is this means of communication?

Problem XI

Twelve VHF channels lie in the range of frequencies between 54 MHz and 216 MHz. Each channel is assigned a width of 6.00 MHz, with the tow ranges 72-76 MHz and 88-174 MHz reserved for non-TV purposes. Calculate the broadcast wavelength for channel 4, 6, and 8.