Physics 114 - Spring 2015 – Module 10

1. When a mariner's compass is installed aboard an iron ship, it must be "adjusted" by placing several small permanent "correcting" magnets in its vicinity. What is the purpose of these magnets?

2. By measuring the electric and magnetic fields at a point in space where there is an electromagnetic wave, can you determine the direction from which the wave came? Explain.

3. An electromagnetic wave has a magnetic field given by $B(y,t) = (4.38 \times 10^{-8}\ T)\sin[\omega t + (7.45 \times 10^{4}\ rad/m)y]$ in the positive x direction. The wave is traveling the the -y-direction in vacuum.
   a) What is the frequency f of the wave?
   b) Write the vector equation for E(y,t).

4. The light beam from a searchlight may have an electric-field magnitude of 1000 V/m, corresponding to a potential difference of 1500 V between the head and feet of a 1.5-m-tall person on whom the light is shone. Does this cause the person to feel a strong electric shock? Why or why not?

5. It turns out that electromagnetic radiation is emitted by accelerating charges. The rate at which energy is emitted from an accelerating charge that has charge q and acceleration a is given by

$$\frac{dE}{dt} = \frac{q^2 a^2}{6\pi\varepsilon_o c^3}$$

   where c is the speed of light. Verify this equation is dimensionally correct.
   Consider the classical hydrogen atom … The electron in a hydrogen atom can be considered to be in a circular orbit with a radius of 0.0529 nm and a kinetic energy of 13.6 eV. If the electron behaved classically, how much energy would it radiate per second? What does this tell you about the usefulness of classical physics to describe atoms?

6. The energy flow to the earth associated with sunlight is about 1.4 kW/m^2. a) find the maximum values of E and B for a sinusoidal wave with this intensity. b) The distance from the earth to the sun is about 1.5×10^{11} m. Find the total power radiated by the sun.

7. The radiation pressure from a laser beam supports a particle against the force of gravity. What power 654-nm laser is necessary to support a perfectly reflecting spherical particle having a diameter of 10 μm and a density of 0.2 g/cm^3?