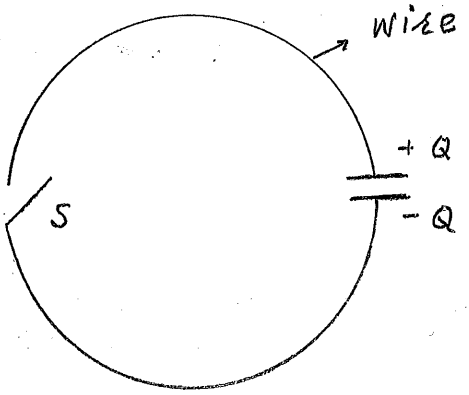
Problems: Week 11

11-1. Show that $\frac{EB}{\mu_0}$ has the same dimensions as $\frac{Energy}{Area - Time}$.

11-2. The great Nebula in Andromeda is one of our closest galactic neighbors. It is 2×10^6 light years away. How far is that in kilometers?

11-3. The capacitor is charged to $\pm Q$ Coulombs. Show that when you close the switch S the conduction current in the wire is equal to the displacement current between the capacitor plates.



11-4. What is light?

11-5. Sound and light are both waves. List five (or more) notable differences between them.

11-6. What is radiation? How would you distinguish among: (i) heat radiation (ii) FM radio waves (iii) x-rays and (iv) γ (gamma)-rays?

11-7. The energy densities of $\underset{\rightarrow}{E}$ and $\underset{\rightarrow}{B}$ fields are given by

$$\eta_E = \frac{1}{2}\varepsilon_0 E^2$$

$$\eta_B = \frac{B^2}{2\mu_0}, \text{ respectively}$$

What is the relationship between η_E and η_B if E=cB where $c=\frac{1}{\sqrt{\mu_0\varepsilon_0}}$.

11-8. You are standing near a window and see a lightning flash and note that you hear the thunder 5sec later. If the speed of sound is 330m/s, how far was the flash? Why?

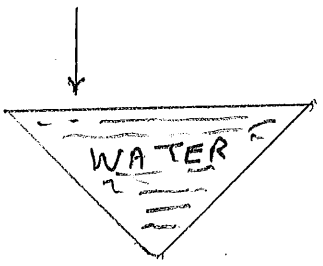
11-9. Show that $\frac{1}{\sqrt{\mu_0\varepsilon_0}}$ has the dimensions of velocity (LT^{-1}). $\varepsilon_0 = 9\times10^{-12}$ F/m, $\mu_0 = 4\pi\times10^{-7}$ H/m.

11-10. The intensity of em waves from the sun is $1.4 kilowatt/m^2$ just above the Earth's atmosphere. What is the amplitude of the $\underset{\rightarrow}{E}$-field in these waves?

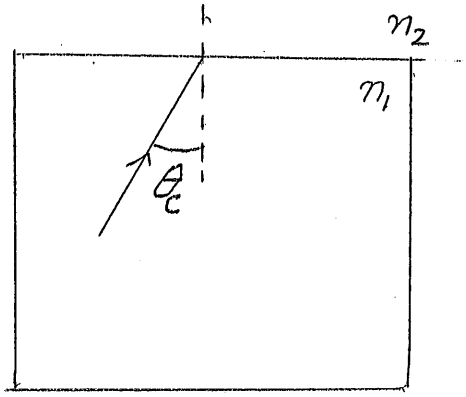
11-11. In a microwave oven electromagnetic waves of frequency 2.45GHz form standing waves with antinodes (burn marks on stationary food) which are about 6cm apart. What must be the velocity of the waves to produce such a pattern? Why?

11-12. The wavelength of red laser light is 632nm in air/vacuum. What is its frequency? If the light enters glass what happens to (i) the frequency (ii) the wavelength if the refractive index is n = 1.457.

11-13. Two perpendicular mirrors form a vessel filled with water (as shown). Alight ray is incident perpendicular to the water surface. Locate the path of light after reflection from both the mirrors.

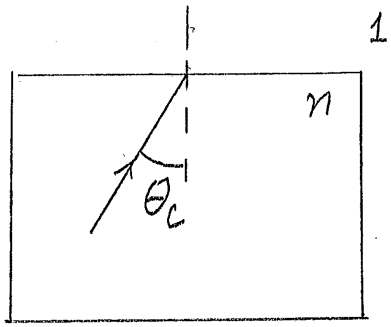


11-14. In the picture shown we are told that light is incident on the upper face at the critical angle. (i) What does it tell you about the relative values of n_1 and n_2? (ii) Locate the refracted ray.



11-15. Show that for the picture shown, the critical angle satisfies the equation

$$\sin\Theta_c = \frac{1}{n}$$



11-16. A point source is located 50cm below the surface of water. Calculate the diameter of the largest circle through which light can emerge from the surface. The refractive index of water is 1.33.