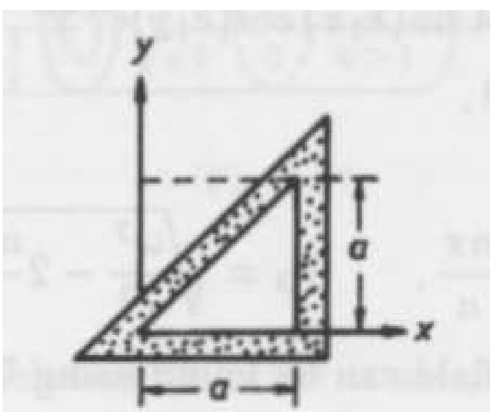
# Physics 323, Spring Quarter 2015
# Electrodynamics: Homework Assignment 6

**Turn in all problems and clearly note all constants and assumptions you use. (1-point penalty each otherwise)**

# Due 9:00 am Thursday May 14

1. A waveguide is constructed so that the cross section of the guide forms a triangle (see sketch). The walls are perfect conductors, the volume of the guide is vacuum.
a. Determine the allowed modes for waves propagating in the guide.
b. For those allowed modes, find the electric field.
c. For those allowed modes, find the cutoff frequency.
d. If some modes are not allowed, explain why.
Hint: Ponder the modes in the related square waveguide.




2. Cerenkov radiation is emitted by a high energy charged particle which moves through a medium with a particle velocity greater than the velocity of electromagnetic waves in the medium.
a. Find the relationship between the particle velocity $v=\beta c$, the index of refraction n, and the angle $\theta$ at which the Cerenkov radiation is emitted relative the line of flight of the particle. Hint: make a drawing of the emission process.

b. Hydrogen gas at one atmosphere and at 20°C has an index of refraction $n = 1 + 1.35\times10^{-4}$. What's the minimum kinetic energy (in MeV) that an electron would need in order to emit Cerenkov radiation in this gas?

3. Two point charges of charge q are located at the ends of a line of length 2L. The charges rotate about the center of the line with angular velocity $\omega/2$ about an axis perpendicular to the line.
a. Find the electric dipole and quadrupole moments.
b. What is the emission frequency?

4. In the so-called "emission theories" of relativity, electrodynamics is modified by supposing that the velocity of light is c relative to a source of emission rather than the velocity given by the special theory of relativity. The emission theories differ among themselves in predicting what happens to the velocity of light on reflection from a mirror. These emission theories divide into two main possibilities on reflection: (1) The velocity becomes c relative to the original source; (2) the velocity becomes c relative to the mirror. Consider a pulse of light moving towards a mirror with speed $\nu$. At the time the light pulse bounces off the mirror (in the mirror's rest frame), the source is a distance L from the mirror.
a. Find the round-trip elapsed time from emission-point to mirror to original-emission-point (in the mirror's rest frame) for the usual case where special relativity holds.
b. Now find this round-trip time for the unusual case of emission theories for possibilities (1) and (2).
*** c. Experiments have ruled out emission theories of this kind. In view of your answers to (a) and (b), which of the two emission theory possibilities (1 or 2) was more difficult to rule out and why?

*** Denotes a conceptually tricky problem.

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