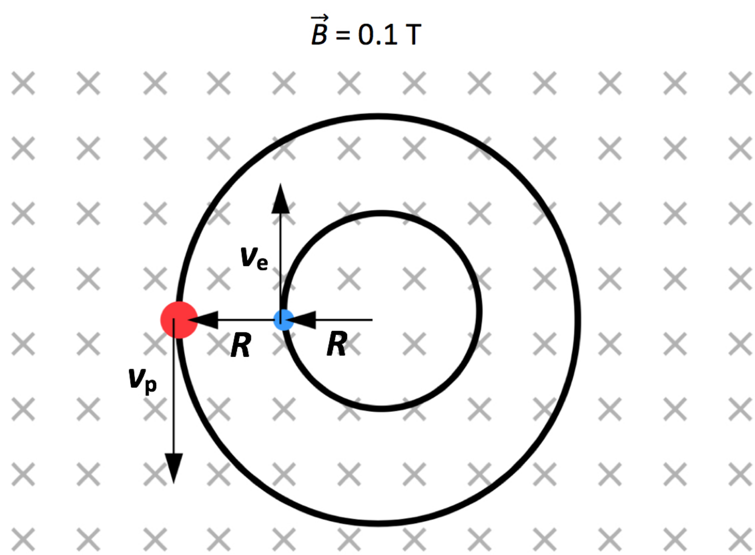
Problem Set No. 1

UBC Metro Vancouver Physics Circle 2018

March 1, 2018

Problem 1

An electron is moving in a circular path under the influence of an external magnetic field, $\vec{B} = 0.1$ T, maintaining a radius of R. Just outside this electron is a proton, that is also moving in a circular path under the influence of the same external magnetic field, always maintaining a radial distance of R from the electron's orbit.



In this moment of time as the particles align, what is the minimum value of R such that the electron can have a stable circular motion?

Problem 2

A physicist is standing at the edge of a cliff, facing the ocean. He throws a large rock with velocity $\mathbf{v_0}$, aimed at an angle θ above the horizontal. The rock travels in a projectile motion, displacing a vertical height of h when it hits the water. For this problem, let's assume air resistance is negligible. Upon hitting the water, the rock makes a *splash* sound. If the expression for the total time it takes for the physicist to hear the sound is equivalent to

$$t_{\text{total}} = k_1 \left(\beta + \sqrt{\beta^2 + 2\gamma}\right) + k_2 \left(\sqrt{2\alpha^2 \left(\beta^2 + \beta\sqrt{\beta^2 + 2\gamma} + \gamma\right) + \gamma^2}\right)$$

what are $\alpha(v_0, \theta)$, $\beta(v_0, \theta)$, and $\gamma(h)$? What are the values of the constants k_1 and k_2? Assume, in this perfect universe, there is no drop in sound intensity.

Problem 3

A positively charged particle of mass m is shot horizontally into an apparatus with speed v. The apparatus is made up of uniform and adjacent electric and magnetic fields, $\vec{E}$ and $\vec{B}$, respectively. Since the particle has a positive charge of q, its path will deviate before it hits the detection screen at the very end. If

(1) the particle is initially aimed perfectly at the origin of the detection screen,
(2) the parallel plates each have a length l_E and width $\gg l_E$,
(3) the electric and magnetic fields are separated by distance d_1,
(4) the magnets each have a length of l_B and width $\gg l_B$, and
(5) the magnetic field and detection screen are separated by distance d_2,

determine the exact (theoretical) x and y coordinates where this particle will hit the detection screen based on the parameters mentioned above. The figure below depicts the situation described.