Physics 24 Problem Set 3

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due Monday, Jan. 30 at 5pm

Course Announcements:
Read Chapter 6 of Purcell, sections 6.5-6.7, 7.1, 7.2. Note Problem 6.33 was added.

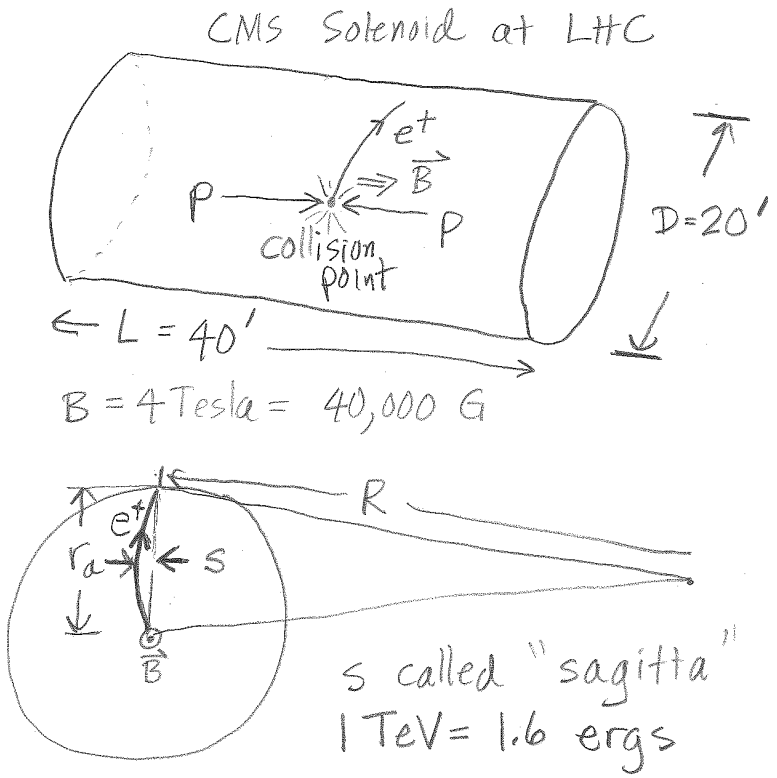

Figure 1: Problem 5b. The top figure shows the dimesions of the CMS solenoid at CERN, which has a central magnetic field of 4 Tesla or 40,000 Gauss. The bottom figure shows what actually gets measured: the *sagitta* of the curved track from a straight line.

1. Purcell 6.13. Please consider this problem *qualitatively*, that is, imagine what the magnetic field as a function of distance along the common axis of the rings looks like when the rings are very close, and very far away. Think hard about the first and second derivatives of the field at the point halfway between the rings; you can qualitatively reason out most of the answer to this problem with very little algebra.

2. Purcell 6.14

3. Purcell 6.17

4. Purcell 6.19

5. (a) Purcell 6.27.

   (b) This problem is really important for understanding how the detectors at the CERN accelerator known as the LHC function. Take a look at Fig. 1. Derive an equation for the sagitta s in terms of r_d and R, using the approximation $r_d \ll R$. This is a good approximation for the interesting case, for example, of very energetic positrons e^+ that go perpendicular to the magnetic field.

   (c) For that type of positron, $cp = 1\,\text{TeV} = 1.6\,\text{ergs}$. What is the value of the sagitta s for the positron?

   (d) For the CMS solenoid, what is the value of In, where I is the current, and n the turns/cm. Put your numerical answer in Amperes/cm.

6. Purcell 6.30

7. Purcell 6.33
