8.02 ESG Independent Study

Unit 9: Magnetism

Magnetism, the "M" in E&M, as presented in 8.02, is another field which exerts a force on a charge, but in a perhaps unfamiliar way. The common phenomenon of magnetism, as seen in compass needles and horseshoe magnets, is only one manifestation of magnetic interaction.

The study of magnetic fields and forces is the point at which the treatments given in University Physics and in Purcell diverge. UP presents the magnetic force on a moving charge phenomenologically, and apply the observed relations between velocity and magnetic field to dynamic questions. Purcell, in chapter five, considers the forces between moving charges using special relativity, and in chapter six regards the magnetic field as a convenient way of representing a relativistic effect.

Each presentation has its advantages. If, for example, special relativity is unfamiliar or unappetizing, UP's approach is convenient in learning how to find magnetic effects given a magnetic field (calculation of magnetic fields comes in Unit 10), but the magnetic force and field are given as experimental observations. When all of Maxwell's equations are developed, the relativistic invariance is discussed as a special topic, if at all.

Purcell instead derives effects identified as magnetic from only Coulomb's law and special relativity; magnetic effects *must* exist, and since they do, relativity is again vindicated. The invariance of Maxwell's equations are built into the equations as they are developed.

Either treatment is adequate for 8.02. Prospective physics majors should at least look at chapter five in Purcell to get an idea of how the electric field of a moving charge depends on the motion. Most other texts for E&M at this level use an approach similar to Halliday & Resnick.

Suggested Procedure:

1. Read in UP11 chapter 27. Suggested problems include 1, 5, 21, 31, 34, 46, 60, 62, 76, 86 (remember your vector algebra), 91.

   or

2. Read in Purcell, chapter six, sections 1, 2, and 9. The remainder of the chapter will be used in unit ten, and it can't hurt to read ahead.

If you feel shortchanged by the length of the reading, look in chapter five, sections 1–6, 9. Suggested problems (from chapter six) include pp. 245–253, #s 1, 2, 6, 22, 23, 27, 35, 38. If you'd like to know more about special relativity, you can refer to appendix A.

3. Take a unit test.