8.02 ESG Independent Study

Unit 11: Faraday's Law

By now, you should be convinced that a charge moving in a magnetic field experiences a force (alright, unless $\vec{V} \times \vec{B} = \vec{0}$). Suppose that an observer moving with the charges says "Nuts![1] This charge isn't moving, but there's still a force." Can a *moving* B field produce a force? How does a field move? If these questions seem esoteric, remember that Einstein's first paper on relativity was titled "On the Electrodynamics of Moving Bodies."

As in the two previous units, UP treats the phenomenon of induction as experimental, while Purcell regards the effects as a consequence of relativity. Purcell does, however, include a recreation of Faraday's experiments in section one of chapter seven.

Objectives: After completing this unit, you should be able to use Faraday's law to explain and calculate the induced electric fields which arise from both the motion through a magnetic field and a time-varying magnetic field.

Suggested Procedure: As in unit nine, the suggested problems are extensive; again this should be taken as indicative of the importance of Faraday's law.

1. Read chapter 29 in UP11. Be sure you understand the right hand rule and Lenz's Law. Figure 29.5 may help. Suggested problems are 3a, 16, 22abc, 25, 29, 54, 65 (for those taking 18.03), 76.

   or

2. Read chapter seven in Purcell, sections 1–5. Suggested problems include pp. 286–291, #s 2, 4, 6, 12, 14, 15, 16, 22.

3. Take a unit test.

[1] Attributed to Gen. D. MacAuliffe as a response to a German request for his surrender, during the successful defense of the city of Bastogne, Christmas Day, 1944.