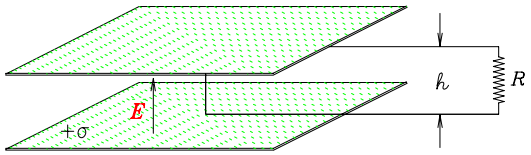
The University of British Columbia

Physics 401 Assignment # 2:
REVIEW of ELECTRODYNAMICS

Wed. 11 Jan. 2006 — finish by Wed. 18 Jan.

Please review Chapter 7. Numbered problems are (as usual) taken from the course textbook: David J. Griffiths, *"Introduction to Electrodynamics"*, 3rd Edition.

1. p. 293, Problem 7.6 — **UNDERSTANDING EMF:** A rectangular loop of wire is situated so that one end (height h) is between the plates of a parallel-plate capacitor (see figure), oriented parallel to the field $\vec{\boldsymbol{E}}$. The other end is 'way outside, where the field is essentially zero. What is the emf around this loop? If the total resistance is R, what current flows? *Explain.* [*Warning:* this is a trick question, so be careful. If you have invented a perpetual motion machine, there's probably something wrong with it.]



2. p. 300, Problem 7.8 — **MOTIONAL INDUCTION:** A square loop of wire of side a is near a long straight wire which is carrying a current I, as shown in the figure.

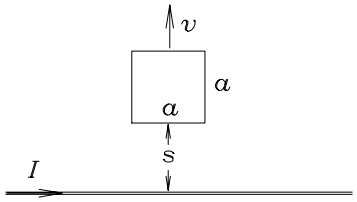
(a) Find the magnetic field due to the current carrying wire.

(b) Find the flux of $\vec{\boldsymbol{B}}$ through the loop.

(c) If the loop is pulled directly away from the wire (upwards in the diagram) at speed v, what is the emf generated?

(d) Does the induced current flow clockwise or counter-clockwise in the loop?

(e) What is the induced current in the loop if the loop is pulled directly to the *right*, instead of upwards?



3. p. 305, Problem 7.14 — **MAGNET FALLING IN COPPER PIPE:** As a lecture demonstration, a short cylindrical bar magnet is dropped down a vertical copper tube of slightly larger diameter. It takes several seconds to emerge at the bottom, whereas an otherwise identical piece of *nonmagnetic* iron makes the trip in a fraction of a second. [You have seen this demo at least once.] *Explain why the magnet falls more slowly.* Please don't be glib. Include a diagram of the tube and magnet in your answer/explanation, clearly indicating the directions of any fields, currents or forces.

4. p. 328, Problem 7.35 — **COULOMB'S LAW FOR MAGNETIC CHARGES:** Assuming that "Coulomb's Law" for magnetic charges (q_m) reads:

$$\vec{\boldsymbol{F}} = \frac{\mu_0}{4\pi}\frac{q_{m_1} q_{m_2}}{\mathcal{R}^2}\,\hat{\boldsymbol{\mathcal{R}}} \qquad \left(\text{where} \quad \vec{\boldsymbol{\mathcal{R}}} \equiv \vec{\boldsymbol{r}} - \vec{\boldsymbol{r}}'\right),$$

work out the analogue of the Lorentz force on a magnetic monopole moving at velocity $\vec{\boldsymbol{v}}$ through electric and magnetic fields $\vec{\boldsymbol{E}}$ and $\vec{\boldsymbol{B}}$. [For an interesting commentary, see W. Rindler, *Am. J. Phys.* **57**, 993 (1989).]

5. p. 328, Problem 7.36 — **MONOPOLE THROUGH LOOP:** Suppose a magnetic monopole q_m passes through a resistanceless loop of wire with self-inductance L. *What current is induced in the loop?* [This is one of the methods used to search for magnetic monopoles in the laboratory; see B. Cabrera, *Phys. Rev. Lett.* **48**, 1378 (1982).]

6. **SEMINAR TOPIC:** *Write down your proposed seminar topic.*

The student seminar is a chance for you to investigate and share with your classmates an E&M topic of your choice. Check out Janis' list of Suggested Seminar Subjects linked into the course Website (see http://musr.physics.ubc.ca/~jess/p401/) if you are looking for ideas. You may select any electromagnetism topic of your choice; there are many cool/interesting ones that aren't on the list, provided the professor (that's me) agrees that your choice is appropriate. I just want to make sure that the topic you pick indeed has some E&M in it. I also recommend the UBC Library's free Research Skills Workshop (offered several times per term, next offered January 19 and February 21) to learn how to approach a general research problem and familiarize yourself with many of the 'standard' online e-tools, including the Web of Science, the science citation index, how to get the most out of online databases, accessing electronic journals and e-books.

The oral report will be a short 8-minute seminar-type presentation to the class, followed by 3-4 minutes of discussion and questions. All students will participate in evaluations (marks) for all presentations except his/her own. The essay/write-up will be a short 3-6 page paper based on your presentation. There will be 1 or 2 oral presentations per class, during the last 15 to 25 minutes of each class beginning the February 20, just after Spring Break. (Current registration in this class is 20; there are 18 classes after Spring Break, so most classes will have one presentation, but two will have two.) Your report is due Friday 07 April 2006 at the latest. If you hand it in earlier, I will mark and return it to you within a week.

Hopefully everyone gets their first choice topic; however, if two or more people choose very similar topics, we'll resolve it: most topics are sufficiently enormous that two or three presentations on different aspects/features of the same topic can be made, with very little overlapping content.

A list of presentation dates will be distributed in class and put on the course Web page before the end of January. If you have **real** date restrictions, please specify them. The first presentation will be on February 21. Also state if you'd prefer your presentation date to be early (in February), middle (first part of March) or later (end of March, beginning of April).