Oberlin College Physics 111, Spring 2024

Assignment 4

Monday, 26 February

Reading: We move on from electrostatics to electric current. By Friday, read LSM chapter 9 ("Current and Resistance"). Section 9.6 on superconductivity is fun and fascinating but not essential to this course. Also read chapter 10 ("Direct-Current Circuits"), with special emphasis on sections 10.2 and 10.3

Laboratory: This week, "Mapping Electric Field".

Guest Lecture: On Tuesday, 27 February, at 4:35 pm, Dave Lengyel will speak on "Total Solar Eclipses, Past and Future" in Wright 201 (our classroom). As mentioned in the syllabus, if you attend this guest lecture and submit to me a one-paragraph description (on paper, on Wednesday, 28 February), you will be awarded 20 extra-credit problem-set points. (Hand in a different sheet of paper for this description and for your problem assignment due the same day.)

Problems: There are *no* assigned problems this week. Instead, there will be an exam on Wednesday, 6 March. Be sure to look at the sample exam overpage.

Exam: On Wednesday, 6 March. You may use a calculator and one $8\frac{1}{2}$ by 11 inch page of notes, but not your lab notebook, lab instructions, or any other material. No collaboration is permitted. Exam topics are:

Coulomb's law and electrostatics (laboratory as well as classroom)
Electric field and electric field mapping (laboratory and classroom)
Flux and Gauss's law
Use of Gauss's law to find electric field in situations of high symmetry
Electric potential
Conductors in electrostatic equilibrium
Capacitance
Electric potential energy

There will be no exam questions concerning:

The derivation of Gauss's law from Coulomb's law
The proof that electric potential exists
Current

Exam tips:

1. We've introduced a number of new concepts in the first weeks of this course: electric charge, electric field, electric flux, and electric potential. It's easy to mix them up. Look at problem 23 to review these concepts.

2. To find the global character of the total electric field at all points, draw electric field lines. To find the total electric field at a single point, don't draw field lines but instead sum the contribution from each individual source charge. Remember that this must be a *vector* sum, not a scalar sum.

Sample exam: In order to give you an idea of what to expect, here is a sample exam made up of exam problems I've given previously.

- 22: *Three charges*
  [*Answers:* a) $(1/4\pi\epsilon_0)(-2q/a)$ b) $(1/4\pi\epsilon_0)(2q/a^2)$; downward.]

- 18: *Electric field near two conductors*
  [Correct answer is d.]

- Problem: A point charge Q is placed at the very center of a cube with edge length a. What is the flux $\int \vec{E}(\vec{r}) \cdot \hat{\mathbf{n}}(\vec{r})\, dA$ through the top face? Explain your reasoning.
  [*Answer:* From Gauss's Law, the total flux is Q/ϵ_0. From symmetry, the flux is the same through each of the six faces. Hence the flux through the top face is $Q/(6\epsilon_0)$.]

- 7: *Card of charge*
  [*Answer:* The first candidate gives the wrong result in the special case $a = 0$, $b = 0$; the second candidate permits a divide by zero; the third lacks symmetry when a and b are interchanged; the fourth is dimensionally inconsistent.]