FREQUENTLY ASKED QUESTIONS

February 11, 2003

Administrative Questions

CyberTutor is flaky... why did a question disappear? Also, I think there might be mistakes in some of the problems.

Please note that this is the first semester that CyberTutor is being used for this course, so the problems are mostly brand-new and untested by students. So there might be a higher rate of errors and weirdness. Several things were changed/fixed for this last assignment. Please report anything funny you notice to the CyberTutor folks so that they can fix it! (by which I mean funny peculiar, not funny ha-ha.)

Can we have answers to pset problems, so that we can check our work?

I don't want to do this globally if it is not a course policy: please ask Prof. Roland. If you're uncertain of your method or answer, you can ask me personally during class or office hours.

Content Questions

I didn't understand the demo in class on Monday.

I missed class, but I'm told it was a demonstration of Coulomb's Law, i.e. electric force vs. distance. Prof. Roland said he would complete the analysis tomorrow.

What exactly *is* charge?

Perhaps the easiest way to think of it is as the analog of mass for electromagnetism ("charge is to electrostatics as mass is to gravitation"). Unlike for charge, you have an intuitive feeling for mass, but what *is* mass exactly? It's what gravity acts on. Similarly, charge is what the electrostatic force acts on. Mathematically, Coulomb's Law, $F_e = kq_1q_2/r_{12}^2$ is identical to Newton's

Universal Law of Gravitation, $F_g = Gm_1m_2/r_{12}^2$, where q plays the role of m.

How can you use Newton's 3rd law for electrostatic forces?

Newton's 3rd law applies generally to *any* forces. If particle 1 applies a *blank* force to particle 2, particle 2 applies an equal and opposite *blank* force to particle 1. You can fill in the *blank* with "gravitational", "electrostatic", "contact", whatever.

I'm unclear about superposition, especially for the continuous charge distribution.

The principle of superposition is a fabulous thing it and makes your life simple. What it says is: *The force between any two charges is **independent** of the presence of any other charges.* What this implies is that when you have a bunch of charges, and you want to find the total force on charge Q, you can just calculate all the forces between Q and each other charge separately (as if only the two charges under consideration existed), and *just add them.* Remember that force is a vector and the addition is a *vector* sum!

Here is a "mini howto" on superposition problems with Coulomb forces:

1. Identify the charge you want to find the force on; call it Q.
2. For another charge q_i, draw the force vector $\vec{F}_{Q,i}$ on Q due to q_i, taking into account whether it is attraction or repulsion. When considering Q and q_i, ignore the presence of any other charges.
3. Find the magnitude of this force: $F_{Q,i} = kQq_i/r_i^2$, where r_i is the distance between them.
4. Decompose the force into components in your chosen coordinate system.
5. Repeat for every other charge in the problem.
6. Now add the forces $\vec{F}_{Q,i}$ vectorially, i.e. add up the $\hat{\imath}$, $\hat{\jmath}$ and $\hat{k}$ components. The resultant vector is the total force.

For a continuous distribution of charge, it's really the same thing as for point charges, except that you treat the continuous distribution as if it is a bunch of infinitesimally small point charges added together. So the total force on Q, which is the sum of forces due to each piece Δq_i, $F_{tot} = \sum_{i=1}^{n} \frac{kQ\Delta q_i}{r_i^2}$, becomes an integral $F_{tot} = \int \frac{kQdq}{r^2}$. (We'll see lots of examples of this.)

Is adding up Coulomb forces like adding up gravitational forces? Is there such a thing as "center of charge"?

Yes, it is, exactly. Yes, you can define a "center of charge" which is the analog of the "center of mass"; but we won't use this commonly in this course.

What does $\hat{r}_{12}$ mean?

This means a unit vector in the direction of $\vec{r}_{12}$ (where $\vec{r}_{12}$ is the vector along the line between charges 1 and 2). This is just means a vector of unit length along that direction.

I'm having trouble with the CyberTutor problems...

Note that some of the problems assigned at one time were taken away since we haven't covered the material yet.

Here are a couple of hints on the harder CyberTutor problems:

- For the Coulomb tutorial problem: what is the distance beween q3 and q0? What is the magnitude of the force? Don't forget to decompose into components.
- For the Mystery Charge problem: do the vector components carefully! This is a superposition problem.

Why aren't we talking about $k = 1/4\pi\epsilon_0$?

That is another way to write the Coulomb constant k. You can write it that way if you prefer.

When finding components of a force, do you find the magnitude of the whole force first, then break it into components?

Yes... see the mini-how-to above.

In the practice problem, did q_1 and q_2 have any effect on each other? Why did it matter whether the charges were attached to the floor?

Yes, q_1 and q_2 did exert electrostatic forces on each other... *but this interaction had no effect on the forces they exerted on Q.* That's the point of superposition! The problem stated that the charges were fixed to the floor because if not, they would have been accelerated (repelling each other, they would shoot apart!)

In the experiment, what is the effect of the multimeter on the current of the circuit?

This depends what you are trying to do and what setting you are on. We will talk about this later in some detail when we do circuits and the discussion in your experiment writeup will make more sense then. For the moment, just be aware that your multimeter may affect the circuit you are measuring.

In the second multiple choice problem, how can the forces be equal when the charges aren't equal?

The force of charges on each other *must* be equal by Newton's third law. If you don't believe it, take two nonequal charges, and calculate the force on one due to the other using Coulomb's Law. Then calculate the force the other way around. Are they equal or not?

When charge is negative, does that give it a sign in the Coulomb's Law equation? How do you deal with the sign?

The best way to deal with the sign is to look at the pair of charges and decide if it's attractive or repulsive, and draw the vector arrow. Then whether it is positive or negative in direction (according to your chosen coordinate system) should be clear.

Other

Why is this material not being taught in lecture?

Most of it will eventually be covered in lecture. Most of the time, I will review material that's been seen already, but sometimes (such as this week) I will jump ahead a bit and introduce some concepts before you see then in lecture. This will usually only be when the concepts are needed for getting started on the homework.

Do we have to leave our pset answers in vector form?

I am not sure how the grader will decide to grade it. If asked for force, make sure it is specified as a vector, *e.g.* in notation $\vec{A} = A_x\hat{\imath} + A_y\hat{\jmath}$. If asked specifically for magnitude and/or direction, give magnitude and you may want to indicate direction as an angle (preferably making a diagram showing which angle you mean.) Don't forget units!!

Tidbits

Animation of Coulomb's Law
`http://webphysics.davidson.edu/Applets/efield4/prb2.html`