FREQUENTLY ASKED QUESTIONS

February 13, 2003

Administrative Questions

Where are your office hours?

In 4-338, one of the physics tutoring rooms. My office is far away and in a locked building so I prefer to have office hours in a more central location.

Can we ask questions about CyberTutor during office hours?

Absolutely. Since there are no terminals in the tutoring rooms, it's best to bring with you a printout of the problem you have a question about.

Do we need to do CyberTutor problems labeled "practice"?

No, they are just there for your practice and it's optional to do them. Some of this week's practice problems were difficult because they cover material we haven't gotten to yet. You might want to go back to them later.

Content Questions

In the last how-to for superposition, how do you decompose force magnitude into components?

Draw the force vector, and determine the angle between the force vector and the axes of your coordinate system. For instance, if there is an angle θ between your vector $\vec{F}$ and the x-axis, then the x-component is $F\cos\theta$ and the y-component is $F\sin\theta$.

I didn't understand the demo in class with the three spheres.

I think the point of this demo was to demonstrate induction and charge transfer. There were 2 conducting spheres, and a ping pong ball between. When one sphere was approached with a charged rod, by induction the nearest sphere's charge was separated. Also by induction the ping pong ball was attracted to the concentration of charge on the opposite side of the sphere to the rod. The ball swung over, and when it touched, it got some charge, and then was repelled since its charge was of the same sign as the sphere's local charge excess. The ping pong ball then swung over to the opposite sphere, and touched it; charge was then transferred to that sphere. Then it was repelled by that sphere, and it went back to the original one, touched it, got some more charge, and so on, until eventually there was no more charge to pick up, and the process stopped.

Then the rod was removed. The system was globally neutral, but one large sphere was negative and the other positive... there had been a separation of charge. The ping pong ball in the center was in an unstable equilibrium... by induction it was attracted to both spheres. Moving just a little in one direction caused it to be more attracted in that direction. When nudged a bit, it swung over, picked up some charge, was repelled, hit the opposite sphere, transferred charge there, was repelled, went back and picked up more charge, and so on... until finally all the charge was transferred and the large spheres were each individually neutral again. Wow, a lot of bustle and just neutral again in the end...

I think Prof. Roland's notes on this should be on the web soon.

Why do we bother drawing field lines? Are they really useful?

Yes, they are very useful for *visualizing* electric fields, which are a rather abstract thing. They make clear many properties of fields, and let you really "see what is happening" in many physical situations. We'll see lots of examples.

What, physically, is an electric field? A field line?

Both of these are abstractions which help us understand behavior of electromagnetic phenomena. An electric field is analogous to a gravitational field, so it may be helpful to think in analogy to gravitation. An electric field is a *property of space* corresponding to a given distribution of charges. It tells you what will happen if you drop a test charge in the field. Field lines are another device to help us visualize what is going on.

Why can't electric field lines cross?

The field line is, by definition, tangent to the direction of the electric field at any point. If you have two field lines crossing at a point, then the electric field line has two directions, which does not make sense. The electric field is a vector and a vector can only have one direction at any point.

Where did the $4\pi r^2$ come from in the expression for density of field lines?

The area of the imaginary sphere at distance r from a point charge is $4\pi r^2$. The density of lines per area is then no. of lines divided by $4\pi r^2$.

Why is electric field strength proportional to density of field lines?

The density of lines is $\frac{\text{No. of lines}}{4\pi r^2}$. The electric field from a point charge is also proportional to $\frac{1}{4\pi r^2}$. So electric field must be proportional to density of lines.

Why can't you have electric field lines in loops?

Electric field lines must always start on positive charges and end on negative charges. So you can't have loops, because you would have to start and end in the same place... and a charge can't be positive and negative at the same time.

What happens to electric field lines when there is more than one charge?

We'll see some examples. For instance, in a dipole, lines start on one charge and end on another. See Fig. 21-33 in your text, for example.

In the tutorial, why was the field the same when the test charge sign changed?

The electric field is *defined* to be $\frac{\vec{F}}{q_{test}}$ for a *positive* charge q_{test}.

When charge is negative, does that give it a sign in the Coulomb's

Law equation? How do you know when force is negative? What about the sign of the electric field?

Whether a component of force is positive or negative depends on the coordinate system you have chosen. To decide what the sign of a force is, look at the pair of charges and decide if the force is 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. Don't put extra negatives in when the charges are negative; just look at the geometry.

The direction of $\vec{E}$ is the direction a positive test charge would feel a force in: *away* from positive charges, *towards* negative charges.

Are electric fields always circular or spherical, as we saw today?

No, not at all; electric fields can have all sorts of shapes. They are spherical (in 3D; circular in 2D) for a point charge. We'll see lots of examples where they are not, e.g. parallel plates.

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

Here are some hints for the problem set:

- For problem # 1:

  This is a superposition problem, and can be done according to the mini-howto method (see last FAQ). Be careful with signs and components.

- For problem # 2: You will get a quadratic equation. Think about force directions: if you put a charge *between* q_1 and q_2, what are the directions of the forces?

- For problem # 3: Note that $\vec{E}$ field direction is towards a negative charge and away from a positive one.

- For problem # 4: First, find the number of electrons in 3 g of copper (you can use your basic chemistry knowledge: how many moles of atoms is that? How many electrons per atom?). Then, find the number of electrons in $5.5\mu C$, given that 1 electron has $1.6 \times 10^{-19} C$ of charge.

I have no idea how to start some of the CyberTutor practice problems which involve integrals.

We haven't yet covered this material in any detail; we will go through problems like this soon. So don't worry if you find these problems difficult. You might want to go back to them later after we've seen some similar examples.

Other

How's your neutrino research in Japan?

Great! The Super-K detector is back up and running, since the beginning of January, and we are detecting neutrinos from the beam 250 km away. Here are links for those interested: `http://www-lns.mit.edu/ schol/mitnu.html`

The other project I work on, the Alpha Magnetic Spectrometer (`http://ams.cern.ch/AMS/ams_homepage.html`) to go on the International Space Station, is not doing so well due to the recent Columbia tragedy. The launch date was supposed to be 2005, but now we do not know what will happen with the shuttle program.

Tidbits

Best joke from today's questionnaires:

Two cows are standing around in a field talking. "This mad cow disease thing sounds pretty terrible, doesn't it?" says one. "What do I care, I'm a helicopter!" says the other.