Interactive Problem Set 3, SP212 Spring 2013

Topic: 22.1 - 22.5 The Electric Field

IPS 3.1 (in-class) A charge $q = +100$ nC sits on the origin. An identical charge sits on the x axis at $x = +0.04$ m. What is the electric field produced by these two charges at the point $(0, +0.07)$ m? Report your answer by giving the values for the components E_x and E_y.

IPS 3.2 (in-class) Continuing with the problem above, if I placed an electron at this location, what would be the acceleration of this electron? Report your answer by giving the components a_x and a_y.

IPS 3.3 (in-class) An *electric dipole* consists of two charges of equal magnitude q but opposite sign, and separated by a distance d. Consider such an arrangement on the z axis with $-q$ at $z = -d/2$ and $+q$ at $z = +d/2$. Find a general expression for the electric field at any point on the $+z$ axis $E(z)$ where $z > d/2$.

IPS 3.4 (in-class) Continuing with the previous problem. Take the limit of your answer for the case where $z \gg d$.

Note: The quantity qd should pop out as an overall important factor in your result. This quantity is called the electric dipole moment and is *the* fundamental property associated with the arrangement of charges, it is usually denoted $p = qd$. As a vector, $\vec{p}$ points from the $-$ charge to the $+$ charge.

When we speak of a water molecule as having an electric dipole moment, we are referring to the fact that while it is neutral overall the electrons that we might think of as coming from the hydrogen atoms hang out to some degree with the oxygen atom giving an effective separation of $+$ and $-$ charge.

IPS 3.5 (homework) Let's continue with the same electric dipole described above. Calculate the electric field to the right of the dipole for some generic point on the $+x$ axis, $(x, 0, 0)$. Verify that the direction of your electric field vector agrees with the direction implied by the field lines shown in figure 22-5 (page 582) in your book, also shown at the top of page 90 in the WPC.

Notebook documentation tip: I would somewhat carefully sketch figure 22-5 in your problem solution and then add in coordinate axes and a sketch of your electric field vector for a point on the $+x$ axis.

IPS 3.6 (homework) Take the limit for the case that $x \gg d$ and show that while the answer is different, that same factor $p = qd$ is an overall important quantity in your answer.

Reading for next class: Reread chapters 21 and 22 of the WPC. Next class we will tackle continuous charge distributions, sections 22.6 - 22.7 in the text.