**Question**: Connecting Electrostatics to Dynamics/Kinematics

Work in groups of 3-4 to answer these 4 questions!

(Hint: do you remember your equations from Dynamics/Kinematics?)

An electron travelling at 2.3 x 105 m/s with a direction as shown in the drawing enters a uniform 280 N/C electric field.

(a) Analyzing the electric lines of force, what is the direction of the force acting on the particle?

(b) What is the magnitude of the force?

(c) What is the acceleration acting on the electron?

(d) If the electron travels a distance of 3.0 mm in the field, what is the distance it will be deflected from its original path?

(a) The direction of the force will be down. The arrows on the lines of force show the direction of a force acting on a positive test charge. Since the electron has a negative charge, the force will be in the opposite direction.

(b) We know the charge of an electron, so we can figure out the force acting on it.



(c) We can use the second law to find the acceleration. We’ll need the mass of the electron, but we can look that up.





(d) The electron is moving horizontally at a constant velocity. It will be accelerated downward by an electromagnetic force and also by gravity. Looking at the acceleration from the electric field, we can see that the acceleration from gravity is way way smaller, so we can ignore gravity - it is totally insignificant. (Hey, what is a lousy 9.8 m/s2 compared with 1013 m/s2?)

We need to figure out the length of time it will be accelerated. It is moving through a field – this is ***when*** it will be accelerated – a distance of 3.0 mm. We know the horizontal speed, so we can find the time to travel that distance.



Armed with the time, we can find the distance it will be displaced.



So the electron will be deflected downwards a distance of 2.1 mm as it travels through the field.

This problem looked really horrible, even though I must admit this, but it actually turned out to be quite simple. Other than the  equation, the problem dealt with a force, an acceleration, a constant velocity over a given distance, and a displacement caused by a force. All of which is stuff you’ve done before.

***Superposition Principle:***

When we have more than two charges in proximity, the forces between them get more complicated. But, please to relax, even though things seem complicated, they actually ain’t and it is fairly simple to work things out. The forces, being vectors, just have to be added up. We call this the ***superposition principle***.

Superposition Principle  The resultant force on a charge is the vector sum of the forces exerted on it by other charges.

***Let’s look at a system of three charges. The charges are arranged as shown in the drawing.*** q1 ***is 3.00 m from*** q2***.*** q2 ***is 4.00 m from the*** q3***. (We immediately spot this as one of those “345” triangle deals, so we know that*** q1 ***is 5.00 m from*** q3***). What is the net force acting on*** q3***?***



***What is the net force acting on*** q3***? Solve the following on a whiteboard, check your answer with the key and if correct record the answer from your whiteboard onto this sheet!***

***KEY:***

***q3*** is attracted to ***q2***(they have opposite charges) and repulsed by ***q1*** (they have the same charge). The two force vectors have been drawn and labeled, ***F23*** and ***F13***.



The net force on ***q3*** is ***F23***+ ***F13***.

The first step is solving the problem is to find the magnitude of the 2 forces:









The next step is to break the two vectors down into their horizontal and vertical components and add the two vectors in the ***x*** and ***y*** directions. This gives us the components of the resultant vector, ***FX***and ***FY*:**











Now we can find the resultant force:





Now we can find the direction or the resultant force:

 

Isn’t it great to solve these problems?