University Physics II

Homework Set 2

1. A uniformly charged disk of radius 35.0 *cm* has a charge density of 7.90×10^{-3} C/m^2. Calculate the magnitude of the electric field along the central axis from the center of the disk at:
   a. 5.00 *cm*
   b. 10.0 *cm*
   c. 50.0 *cm*
   d. 200 *cm*

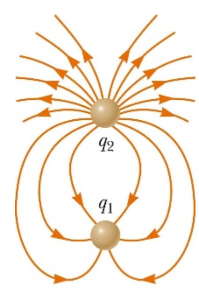
2. A uniformly charged ring of radius 10.0 *cm* has a total charge of 75.0 μC. Find the magnitude of the electric field along the central axis from the center of the ring at:
   a. 1.00 *cm*
   b. 5.00 *cm*
   c. 30.0 *cm*
   d. 100 *cm*

3. A continuous line of charge lies along the x axis, extending from $x = +x_o$ to positive infinity. The line carries positive charge with a uniform linear charge density λ_o. What is the magnitude and direction of the electric field at the origin?

4. A continuous line of charge lies along the x axis, extending from $x = +x_o$ to positive infinity. The line carries positive charge with a non-uniform linear charge density $\lambda = \lambda_o x_o / x$, where λ_o is constant. What is the magnitude and direction of the electric field at the origin?

5. The earth has a net electric charge that produces an electric field near its surface equal to 150 N/C directed toward its center.
   a. What magnitude and sign of charge would a 60 *kg* human have to have in order to balance his or her weight due to the force exerted on them by this electric field?
   b. Are you surprised by the answer? Explain.

6. The figure are right shows the electric field lines for two charged particles separated by a small distance.
   a. Determine the ratio q_1/q_2 from the number of drawn **E** field lines.
   b. What are the signs of q_1 and q_2?

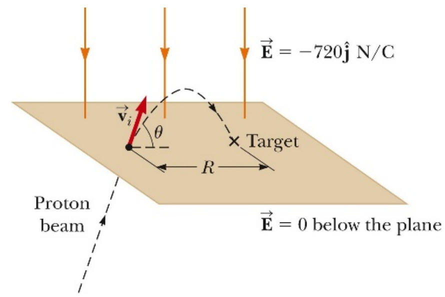


7. An electron and a proton are each placed at rest in a uniform electric field of magnitude 520 N/C. Calculate the speed of each particle 48.0 *ns* after being released.

8. A proton accelerates from rest in a uniform electric field of 640 N/C. At one later moment, its speed is 1.2×10^6 *m/s* (*this is a non-relativistic speed since* $v << c$).
   a. Find the acceleration of the proton
   b. How long does it take the proton to reach this speed?
   c. How far does it move during this time interval?
   d. What is its kinetic energy at the end of this time interval?

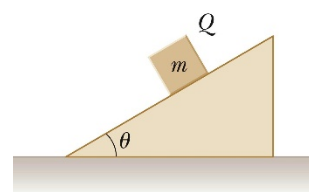
9. At $t = 0$, a proton is projected in the positive x direction into a region of a uniform electric field such that $\mathbf{E} = (-6.00 \, x \, 10^5)$ N/C $\hat{\boldsymbol{x}}$. The proton travels 7.00 *cm* before coming to rest. Determine:
   a. The acceleration of the proton
   b. The initial speed of the proton
   c. The time it takes to come to rest.

10. Protons are projected with an initial speed of $v_i = 9.55$ *km*/*s* from a field-free region through a hole in a plane into a region where a uniform electric field $\mathbf{E} = -\,720$ N/C $\hat{\boldsymbol{z}}$ is present above the plane as shown in the figure at right. The initial velocity vector of the protons makes an angle θ with the plane. The protons are to hit a target that lies at a horizontal distance of $R = 1.27$ *mm* from the point of entry into the region containing the electric field. We wish to determine the angle θ the protons must enter the electric field with in order to strike the target.

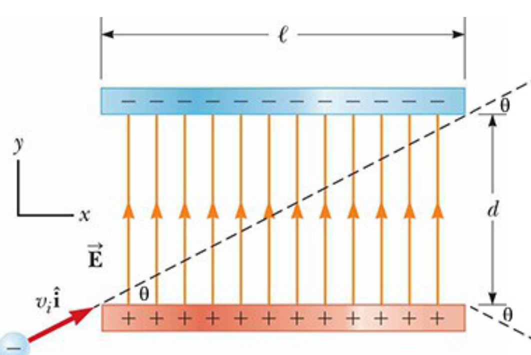


   a. Use the range equation in order to find a relationship for R involving v_i, E, the charge of the proton (q), the mass of the proton (m_p) and θ.
   b. Find the two angles that will solve the expression found in (*a*) under our conditions.
   c. What is the time of flight of the proton for each θ?

11. A small block of mass $m = 5.40$ *g* and charge $Q = -7.00$ μC is placed on an insulted, frictionless, inclined plane of angle $\theta = 25^{\circ}$ as shown in the figure at right. An electric field is applied parallel to the incline. Determine the magnitude and direction of the electric field that enables the block to remain at rest on the incline.

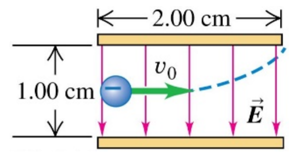


12. You are working on a research project in which you must control the direction of travel of electrons using deflection plates. You have devised the apparatus shown at right. The plates are of length $l = 0.500$ *m* and are separated by a distance $d = 3.00$ *cm*. Electrons are fired at $v_i = 5.00 \, x \, 10^6$ *m*/*s* into a uniform electric field from the left edge of the lower, positive plate and aimed at the upper right edge of the negative plate. Thus, if there is no electric field, the electrons will follow the broken line path as shown in the figure. With an electric field existing between the plates, the electrons will follow a curved path, bending downward. You need to determine:



   a. The range of angles (±θ) over which the electron can leave the apparatus without hitting the plates.
   b. The electric field required to give the maximum possible deviation angle.
      Hint: Use θ_{max} in the equation everyone forgets and solve for E

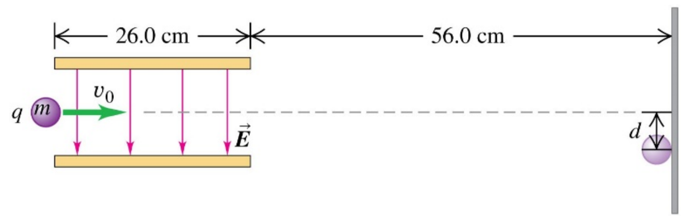
13. An electron is projected with an initial speed $v_o = 1.60 \times 10^6\ m/s$ into a uniform field between two parallel plates as shown at right. Assume the field outside the plates is zero. The electron enters the field at a point midway between the plates.



   a. If the electron just misses the field upper plate as it emerges from the field, find the magnitude of the electric field.

   b. Suppose the electron were replaced by a proton with the same v_o. Would the proton hit one of the plates? If not, what would its velocity ($\vec{\mathbf{v}}$) be as it emerged from the plates?

14. A small object with mass m, charge q, and initial speed $v_o = 5.00 \times 10^3\ m/s$ is projected into a uniform electric field between two parallel plates of length 26.0 cm. The electric field between the plates is directed downward and has a magnitude of $E = 800$ N/C. Assume that the field is zero outside the region between the plates. The separation distance between the plates is large enough for the object to pass between the plates without hitting the lower plate. After passing through the field region, the object is deflected downward a vertical distance $d = 1.25\ cm$ from its original direction of motion and reaches a collecting plate that is 56.0 cm from the edge of the parallel plates. Ignore gravity and air resistance.



   a. Is the charge on the object positive or negative?

   b. Calculate the objects charge-to-mass ration q/m.

   Hint: Determine the change in y in terms of q/m when q is between the plates (Δy_1) and between the plates and the detector (Δy_2). q/m can be found using $d = \Delta y_1 + \Delta y_2$.

15. ** Positive charge Q is distributed uniformly around a very thin conducting ring of radius a. You measure the electric field E at points x along the central axis of the ring over a wide range of values.

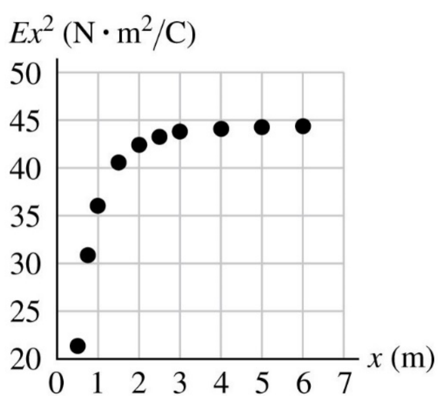
   a. Your results for the larger values of x are plotted as E times x^2 versus x in figure (a) below. Explain why the quantity Ex^2 approaches a constant value as x gets very large.

   b. Use figure (a) to determine the net charge Q on the ring.

   c. Your results for smaller values of x are plotted as E divided by x in figure (b) below. Explain why E/x approaches a constant value as x approaches zero.

   d. Use figure (b) to determine a (*in m*), the radius of the ring.

(a)



(b)