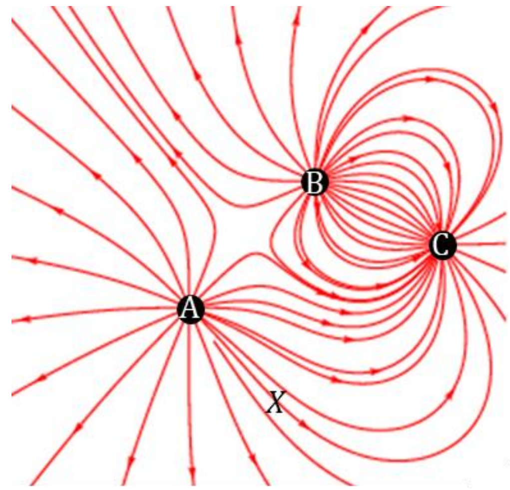
APPC, E & M: Unit A HW 3

Name: ____________________________
Hr: ____ Due at beg of hr on: ____________

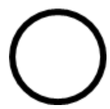
UA, HW3, P1
Reference Video: "Review of Electrostatics (Part II)"
YouTube, lasseviren1, ELECTROSTATICS playlist

A. Based on the ***E*** field lines shown, what are the signs of Charges…

…A? …B? …C?



B. State how you knew the answers to Part A.

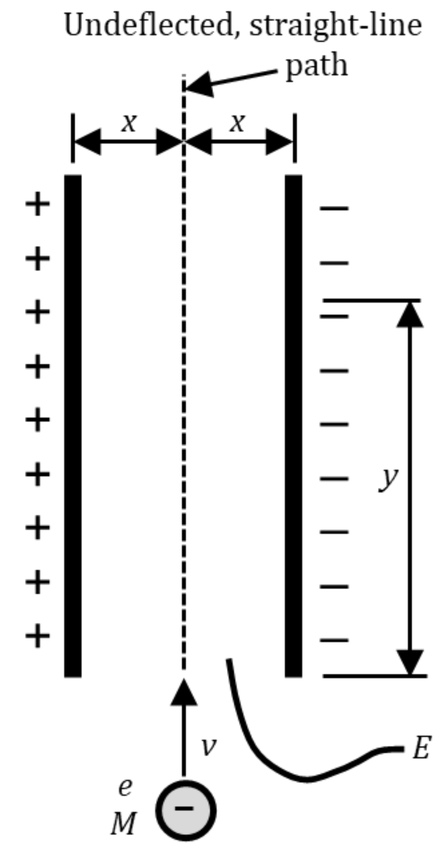
C. Locate Point *X* in the figure. Draw a circle this big →  into the figure, on and centered at Point *X*. This circle represents a neutral metal sphere of that relative size that has been inserted at the location of Point *X* in the field.

D. Draw several (+) and (−) signs on the circle in the figure to correctly show the internal charge distribution within the metal sphere, due to the ***E*** field shown.

E. Is there a net electric force on the metal sphere? (circle) YES NO If so, in which direction?

UA, HW3, P2
Reference Video: "Review of Electrostatics (Part III)"
YouTube, lasseviren1, ELECTROSTATICS playlist

An electron of mass M, charge magnitude e, and initial velocity v enters a region between two oppositely-charged plates, equidistant from each plate by a distance x. The electron is subject to a force by the E field (of unknown magnitude) that exists between the plates, and so its trajectory deviates from the original straight-line path. The electron does not emerge from the plates; instead, it collides with one of the plates at a distance y from the entry point. (See the figure.)

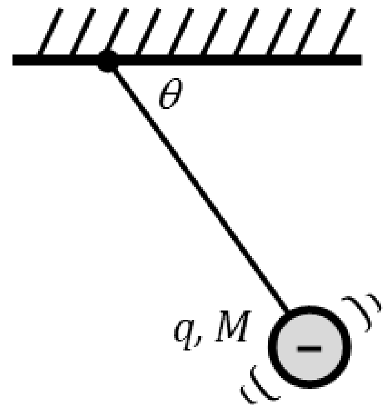


A. In the figure, draw electric field lines between the plates.

B. Draw the trajectory of the electron, which ends at a distance y from the entry point. (Yes, you must figure out which plate it will collide with.)

C. Use Newton's 2nd law, in conjunction with one or more kinematics equations, to obtain an expression for the electric field $\boldsymbol{E}$ between the plates, in terms of the known quantities.

UA, HW3, P3
Reference Video: "Review of Electrostatics (Part III)"
YouTube, lasseviren1, ELECTROSTATICS playlist



A negatively-charged object with total charge q and mass M is suspended in a gravitational field by a nonconductive string from a horizontal surface. There is a uniform electric field E in the region that acts in the horizontal direction. The mass remains motionless, with the string making an angle θ with the horizontal, as shown.

A. In which direction does the electric field E point? Briefly explain your answer.

B. At right, draw a free-body diagram of the forces (not components) acting on the object.

C. Use your FBD and Newton's 2nd law to derive an expression for E, in terms of q, M, θ, and g.

D. Use your FBD to derive an expression for the tension T in the string, in terms of M, g, and θ.

UA, HW3, P4
Reference Video: "Electric Flux (Part I)"
YouTube, lasseviren1, GAUSS'S LAW playlist

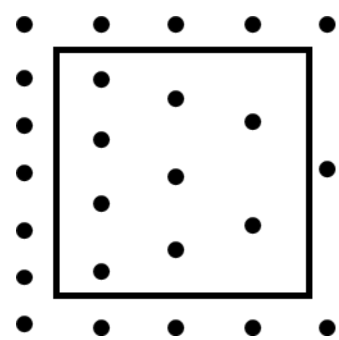
Electric flux Φ_E is a measure of the number of electric field lines that pass through a given surface area. Two ways that electric flux Φ_E can be represented are:

(1) $\varphi_E = \vec{E} \cdot \vec{A} = |\vec{E}||\vec{A}|\cos\theta$ AND (2) $\varphi_E = \int \vec{E} \cdot \overrightarrow{dA}$

A. The area vector $\vec{A}$ (or the differential area vector $\overrightarrow{dA}$) has a direction, because it is a vector. What direction is this, relative to the surface (or surface element)?

B. Describe the scenario when it is appropriate to use Equation (1) above, i.e., describe what must be true, in order to use that form of the electric flux equation.

C. Shown at right is a window-like surface; there is an electric field ***E*** – indicated by the dots – directed out of the page. If you wanted to calculate the electric flux Φ_E through the surface, which equation above – (1) or (2) – would you have to use, and why?



D. If you were to calculate the electric flux Φ_E as you mentioned in your answer to Part C, would you need to take into account all of the dots shown in the above figure? State YES or NO, and then explain briefly.

UA, HW3, P5
Reference Video: "Electric Flux (Part II)"
YouTube, lasseviren1, GAUSS'S LAW playlist

A. What is the one thing that determines the amount of electric flux Φ_E that passes through a CLOSED surface?

B. Does the size of the CLOSED surface affect the amount of flux Φ_E that passes through it?

C. Does the shape of the CLOSED surface affect the amount of flux Φ_E that passes through it?

D. We have already learned that two equations for flux are $\varphi_E = \vec{E} \cdot \vec{A} = |\vec{E}||\vec{A}| \cos\theta$ and $\varphi_E = \int \vec{E} \cdot \overrightarrow{dA}$. But there is also a different form that is given in this video and that is closely connected to your answer to Part A. Write that equation here.

E. Using the equation from your answer to Part D as a starting point, write equations for the electric flux Φ_I, Φ_{II}, Φ_{III}, and Φ_{IV} through the closed surfaces I, II, III, and IV, as shown in the figure. (You need to imagine the four surfaces as being three-dimensional and closed.)