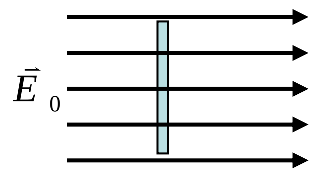
Discussion Question 3A
P212, Week 3
Electric Flux

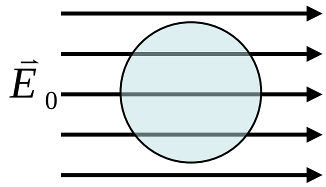
Electric Flux refers to the net amount of electric field flowing through a surface. A way to write this is: flux, $\Phi \equiv \int \vec{E} \cdot d\vec{A}$. Why do we care about flux? Because Gauss' law states that flux = $\int \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0}$, which gives us an easy way to calculate electric fields for charge distributions. So, as first step, let's see how to find $\int \vec{E} \cdot d\vec{A}$, or the net flux, through some surfaces … [Remember that you care about <u>net</u> flow through a surface, which is the difference between flow in and flow out]

(a) An infinitely thin imaginary plane (a "Gaussian surface") is placed in a uniform electric field as shown. Is there a net flux through the plane?



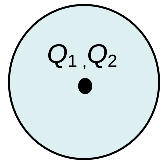
Would there be a net flux if the plane were rotated 90º?

(b) An imaginary sphere is now placed in the uniform field. Is there a net <u>flux</u> through the sphere? Is there a net <u>field</u> in the sphere?



Is Gauss' Law relevant for finding the field in this case? Why?

(c) A Gaussian sphere encloses charges Q_1 and Q_2 at its center, where $Q_1 + Q_2 < 0$. Draw the electric field lines due to these charges.

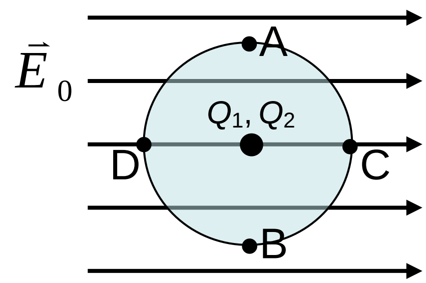


Now use arrows to show the direction of $d\vec{A}$.

Is the net flux through the sphere positive, negative, or zero?

(d) What is the surface area, $\int dA$, of the sphere in part (c) if it has a radius R?
Is Gauss' Law relevant here?
Find $\vec{E}$ at the surface of the sphere.

Discussion Question 3A
P212, Week 3
Electric Flux



(e) The sphere is now placed in a uniform electric field, $\vec{E}_0$. Draw an arrow showing the direction of the net field at point A.

How does the magnitude of the field at point A compare to the field at point B?

How does the magnitude of the field at point C compare to the field at point D?

Write an expression for $\vec{E}$ at point C.