Course and Section_____ Names _____

Date_____ _____

GAUSS LAW SIMULATION

Introduction

In class you learned the Gauss' Law: how the electric flux through a closed surface is related to the charge enclosed by that surface

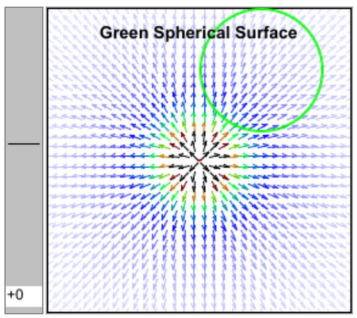
$$\Phi = \int \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\epsilon_0},$$

In this simulation you will explore some proprieties of Gauss' Law.

Submit your answers using Blackboard.

1 – Gaussian Surfaces

To calculate the flux we work with Gaussian surfaces. Open the simulation (https://physlets.org/pp/electromagnetism/gauss_law/illustration24_1.html)



green surface | red surface | orange surface | blue surface

The simulation displays a region with non-zero electric field. There are four buttons to select different Gaussian surfaces, in this case they are appear one dimensional. You can click on the surface and move it around. The bar on the left will display the value of the flux through the surface.

Using only the green, red and orange surfaces

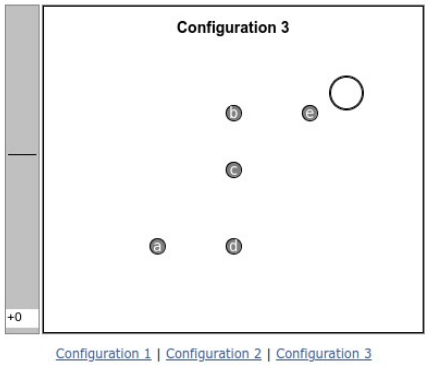
1. For which surface the flux is zero at any location?
2. Which surfaces are you unable to find a non-zero flux?
3. Which surface of red, green, and orange, has a different value of the flux, when you place the surface around the charge?

Select the green surface
4. How many fundamental charges make up the value of the enclosed charge? (answer in billions i.e. divide by 10^9).

Select the blue surface.
5. Is it no possible to find a location where the electric flux is non-zero.
6. If you can find a location how many can you find?
7. What is the name of the object making this electric field configuration?

2 – Rank the Charge

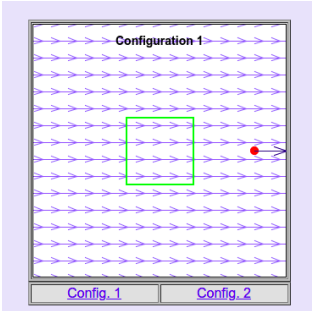
The flux is directly proportional to the enclosed electric charge.
Open the web page (https://physlets.org/pp/electromagnetism/gauss_law/default.html) and click on Problem P.24.1 the left panel.



This simulation displays a collection of charges with alphabetic labels and a Gaussian surface you can move. The bar on the left will display the flux through the Gaussian surface.
Select configuration 3
8. Rank the charges from most negative to most positive.
9. Consider a surface which encloses the charges a,b,d and e. What is the flux though the surface? (Nm^2/C)

3 – Find the Flux

In this simulation you'll try to find the electric flux through a cube.
Open the web page (https://physlets.org/pp/electromagnetism/gauss_law/default.html) and click on Problem P.24.6 the left panel.

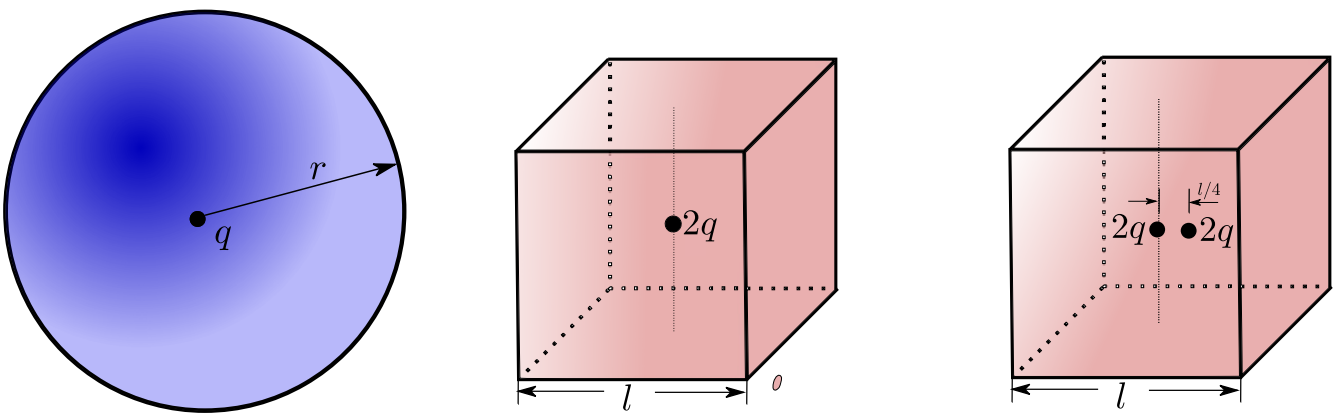


The simulation displays a region with non-zero electric field. The green square is a cross section of a cube. If you click on the red dot it will display the magnitude (N/C) and direction of the electric field at that location. In addition when clicking an holding, a yellow box appears at the bottom side of the screen which displays the coordinates (in meters) of the red dot. You can use the values of the coordinates to find the area of the side of the cube.
Select configuration 1
10. What is the flux through the cube? (Nm^2/C)
11. What is the charge enclosed in the cube? (nC) n = nano = 10^{-9}

Select configuration 2
12. What is the flux through the cube? (Nm^2/C)
13. What is the charge enclosed in the cube? (pC)

4 – How does Flux Scale?

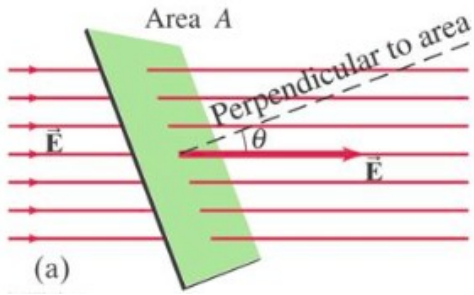
Consider an electric flux produced by a point charge q through a sphere of radius r, the flux is given as Φ_0. How does the flux change in the following cases:



14. The charge is quadrupled.
15. The volume of the sphere is tripled.
16. The surface is changed to a cube with a side length l with twice the charge placed in the center.
17. Relative to question 16 a second charge (also of 2q) is added and is displaced from the center of the cube by $l/4$ in the x-direction.
18. All of the charges are removed from the cube.

5 – Find the area *A*

A surface *A* is place in a uniform electric field *E*. The angle is $\theta = 25°$



Suppose that we have a device to generate the electric field and that we can set different values of its magnitude. We also measure the electric flux. Conducting these measurements we find

E (N/C)	1	1.5	2	2.5	3	3.5	4	4.5	5
Φ (Nm^2/C)	0.823	1.265	1.374	2.066	2.521	2.414	3.234	3.414	3.566

Make a plot of *Φ* vs *E*. Set zero intercept at the origin.

19. What is the value of the slope? (m^2)
20. What is the value of the area *A*? (m^2)