Mon Feb 6, 2017

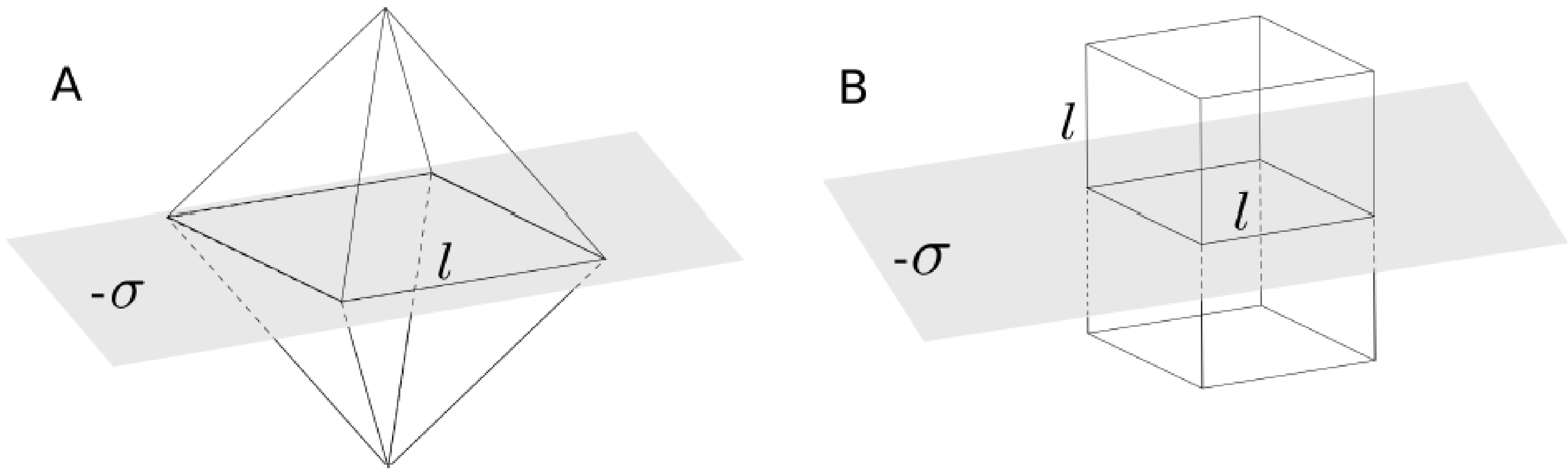
Last time

- Van de Graaff generator: demonstration
- Calculating electric field flux: Group Activity

This time

- Group Activity – review
- Properties of conductors
- Infinite charged plane: non-conducting vs. conducting
- Gauss' Law applied to conductors

(10 marks) The figure below shows an octahedral Gaussian surface made up of equilateral triangles with a square base of length l and a pill-box with a square base of length l. The horizontal plane represents a large thin sheet with uniform surface charge density $-\sigma$. Find the electric flux through the octahedral Gaussian surface.



1. **(1 mark)** In one sentence, state the meaning of Gauss' relation $\oiint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$.

2. **(3 marks)** Find the total electric flux through the Gaussian surface in figure B and draw the surface area vectors for each face.

3. **(2 marks)** For the pill-box in figure B, using Gauss's relation; $\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$, find an expression for the electric field in terms of the charge density σ.

4. **(1 mark)** What is the difference between the electric field flux through the pill-box and the octahedron? Explain.

5. **(2 marks)** Find the total electric flux through the octahedral Gaussian surface?

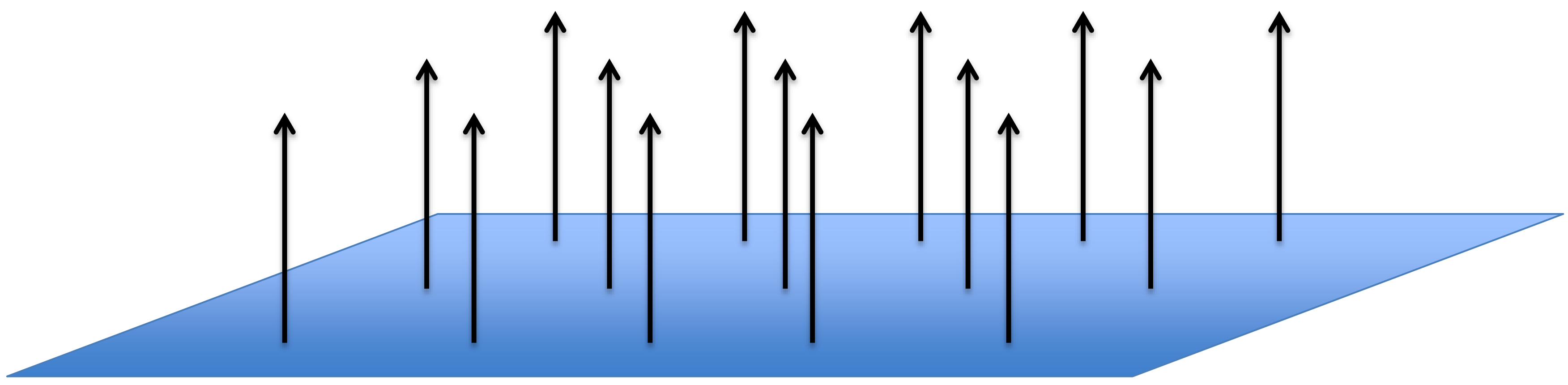
(1 mark for the correct answer) What is the electric flux through the octahedron? Express your answer in terms of σ using the relation $E = \sigma/2\epsilon_0$.

A. $-\frac{\sigma}{2\epsilon_0}l^2$ B. $-\frac{\sigma}{\epsilon_0}l^2$ C. $\frac{\sigma}{2\epsilon_0}l^2$ D. $\frac{\sigma}{\epsilon_0}l^2$

Planar Symmetry

An infinite plane is perfectly symmetric under side to side translations, and rotations in the x,y plane. Consequences:

1) E-field must point in same direction everywhere (translations)
2) E-field must point perpendicular to the surface (rotations)

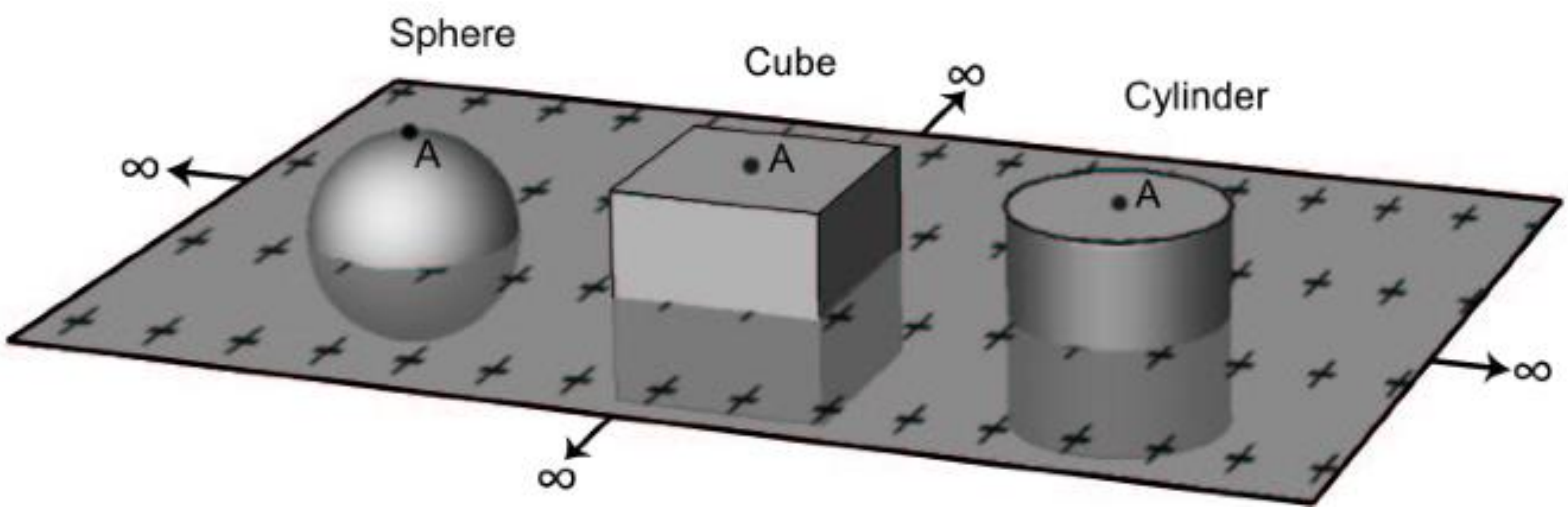


This alone is enough to predict E-field is uniform for infinite plane

Using the right symmetry

For which of these Gaussian surfaces will Gauss' law help us to calculate E at point A due to the plane of charge? *Point A is at the top center of each surface.*

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$$



TopHat questions

Conductors

A conductor is a material in which the charges are free to move.

This means that two things are true:

1. There is zero net charge inside a conductor. ($Q_{net} = 0$)

2. There is zero electric field inside a conductor. ($E_{in} = 0$)

Conductors -- Explanations

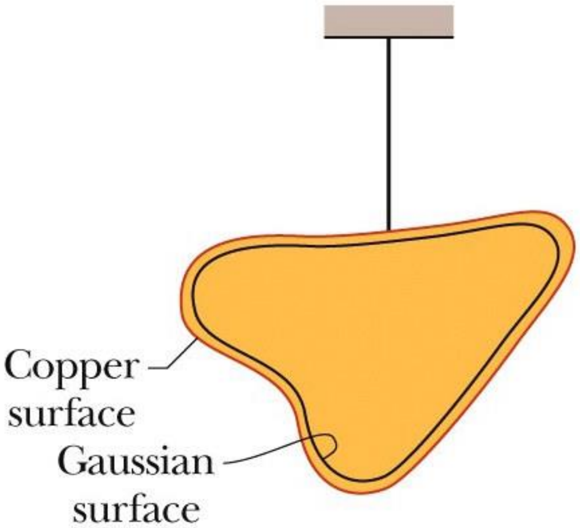
1. There is zero net charge inside a conductor. ($Q_{net} = 0$)

If there are 2 (or more) like charges inside a conductor then they will repel each other and push each other far away. (ie --to the surface)

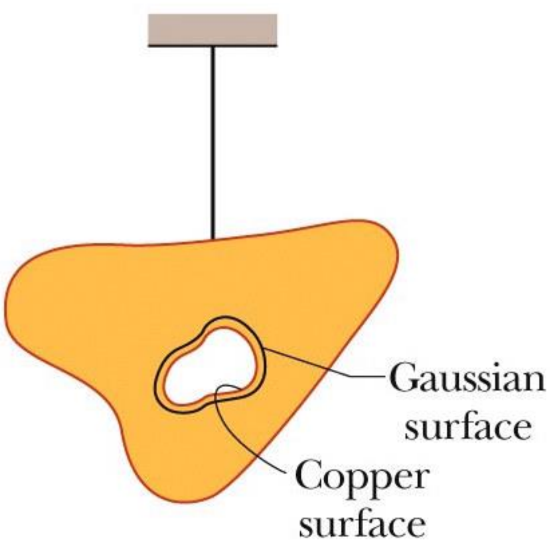
2. There is zero electric field inside a conductor. ($E_{in} = 0$)

If there is a non-zero E field then $F = qE$ implies there is a net force which means charges would move until the force on them is zero – we have a STATIC situation. (Equilibrium)

Hollow Conductors



(a)



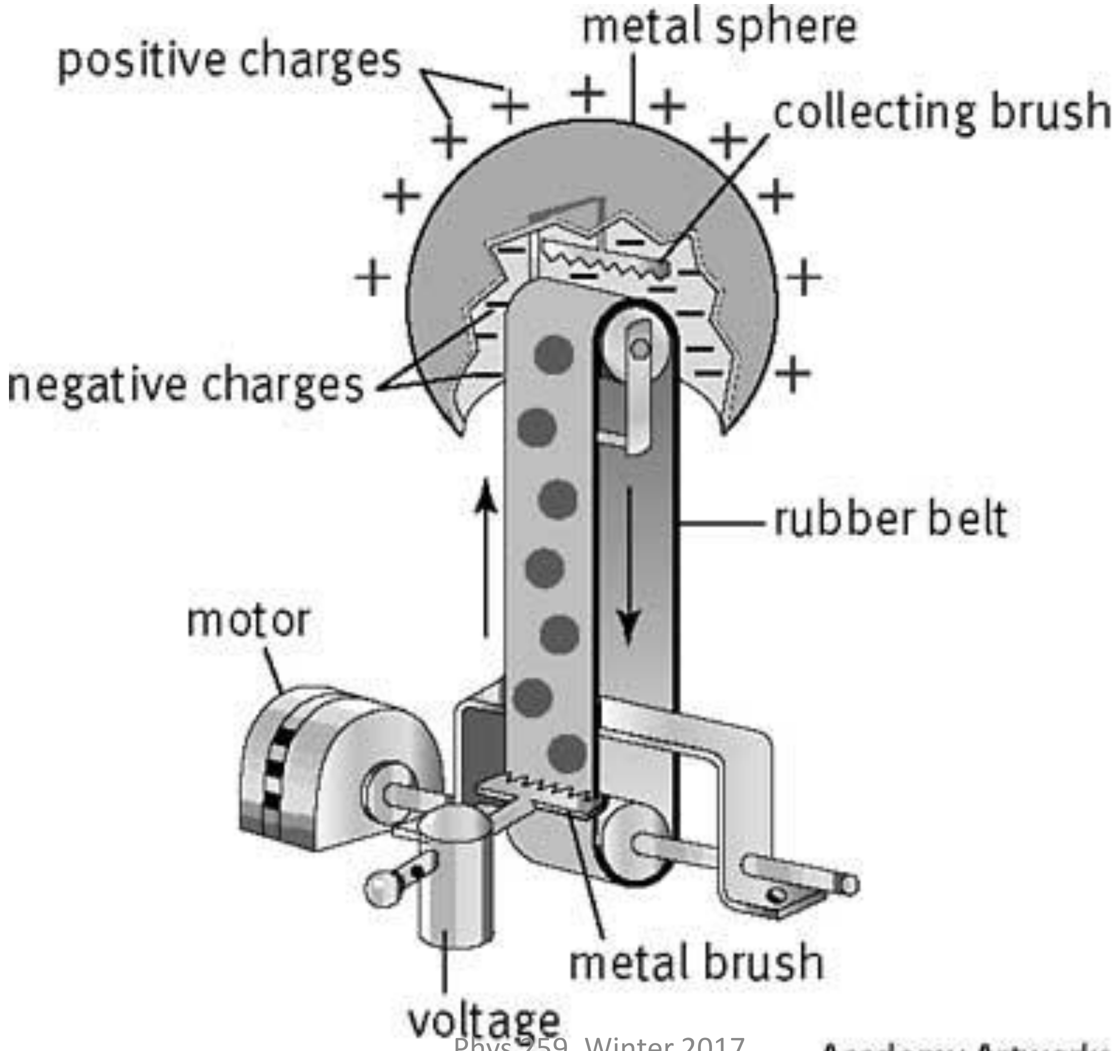
(b)

The electric field inside a conductor is zero. This immediately implies that conductors are electrically neutral in their interiors.

$$\oint \cancel{\vec{E}} \cdot d\vec{A} = 0 = \frac{q_{enc}}{\varepsilon_0}$$

This also means that the surface of a hollow cavity inside a conductor cannot carry any excess charge. All excess charge must reside on the outside surface only.

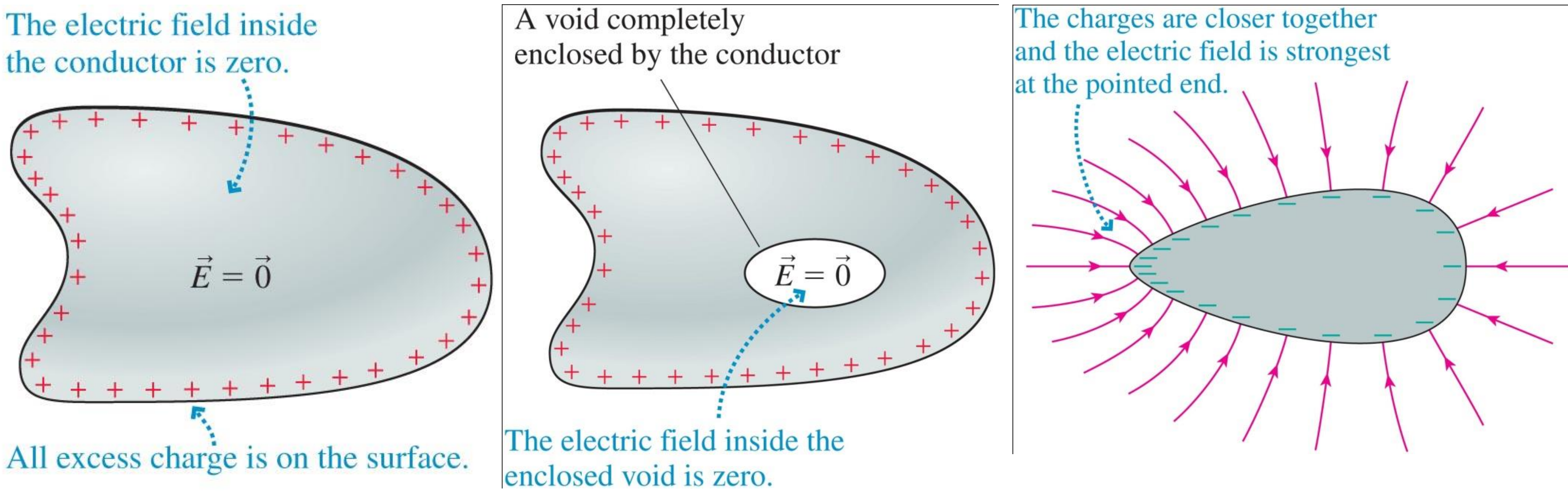
Van de Graaff generator



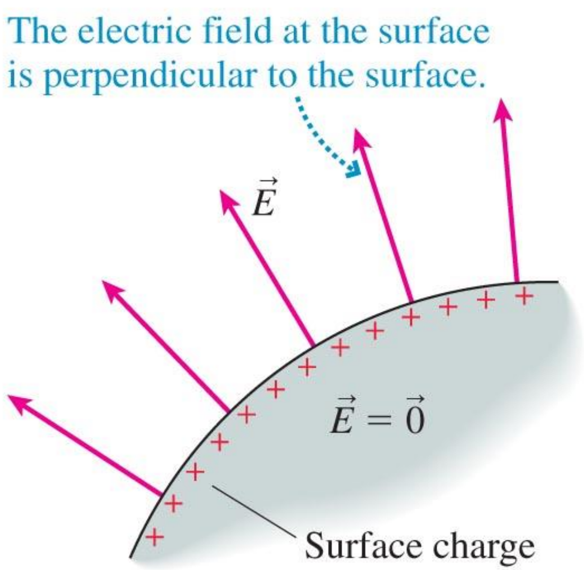
http://www.dictionary.com/browse/van-de-graaff-generator

Summary of Conductors and Electric Fields

(a)



(b)



Electric field due to conducting plate