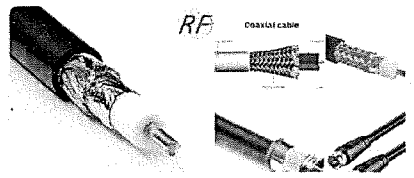
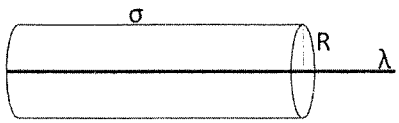
In-class problems, Mar 3, 2020

23.4 - 23.6 applying Gauss's law

1. Coaxial cables, used in many electrical systems, have a central conductor and an outer conducting shell.

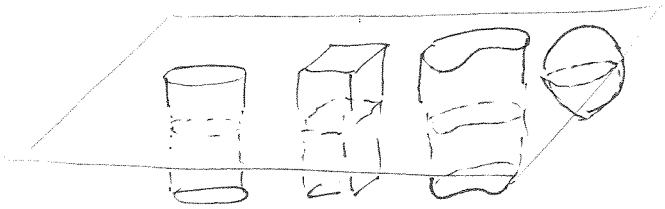


Model the coaxial cable as an infinite line of charge ($+\lambda$ along the x axis), surrounding by a thin cylindrical sheet of radius R with an opposite charge $\sigma = -\lambda/2\pi R$.

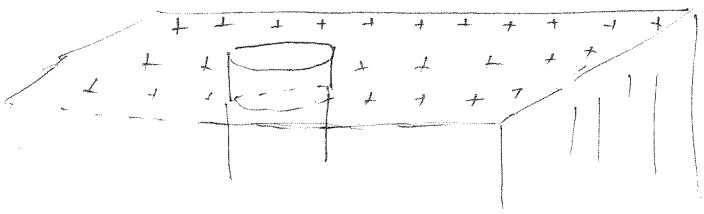


Use Gauss's law to determine an expression for the electric field E for
(a) $r < R$
(b) $r > R$

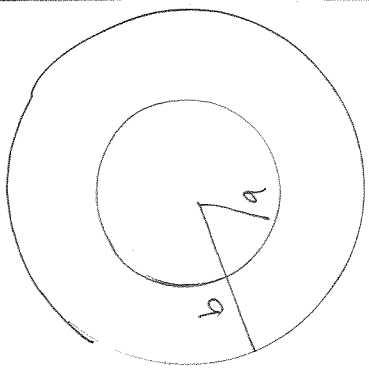
2. Consider an infinite sheet of charge. Which of the following surfaces would it be appropriate (easy!) to use in calculating $\oint \vec{E} \cdot d\vec{A}$



3. Consider a slab of conducting material. Inside a conductor, $E = 0$, and the excess charge is on the surface. Determine an expression for the electric field just above the surface of a conductor. Use the Gaussian surface shown on the figure.



4. Consider a thick spherical shell. A positive net charge is uniformly distributed throughout the solid part of the shell, with charge density ρ (units of C/m^3).



(a) Is this sphere a conductor or an insulator? How can you tell?

Use Gauss's law to determine an expression for the electric field for

(b) $r < a$
(c) $a < r < b$
(d) $b < r$

Wed 4

Due Tue Mar 3, 2020, beginning of class

24.1 Electric potential and electric potential energy

1. Electric potential energy is denoted by U_{E}. Electric potential is given by V_{E}.
   (a) What are the SI units for U?
   (b) What are the SI units for V?
   (c) Write an equation that related V and U.

2. (Review) A pine cone falls, from rest, from a height of 10m above the ground. It passes by a squirrel sitting on a branch, 7m above the ground. Calculate the

   (a) potential energy difference, $\Delta U = U_{\mathrm{final}} - U_{\mathrm{initial}}$ this motion corresponds to (initial fall to passing by the squirrel). Is this a positive or negative difference?

   (b) corresponding change in kinetic energy, $\Delta K = K_{\mathrm{final}} - K_{\mathrm{initial}}$. Is this a positive or negative difference?

   (c) speed of the pine cone as it passes the squirrel.

   Assume that the effects of air resistance (drag) are neglible.

3. (Review) A bowling ball rolls towards a spring with an initial speed of 15 m/s. The spring slows the ball down and stops it, at a maximum compression of 20cm. Calculate the

   (a) change in kinetic energy of the system. Is this a positive or negative difference?

   (b) change in potential energy of the system. Is this a positive or negative difference?

   (c) spring constant of the spring.

   Assume no drag or frictional effects.