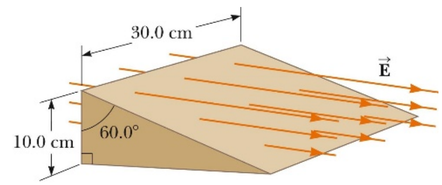
University Physics II

Homework Set 3

1. An upward, vertical electric field of magnitude $2.00 \ x \ 10^4$ N/C exists above the Earth's surface on a day when a thunderstorm is brewing. A car with a rectangular size of 6.00 *m* by 3.00 *m* is traveling along a dry gravel road sloping downward at 10.0º. Determine the electric flux through the bottom of the car.

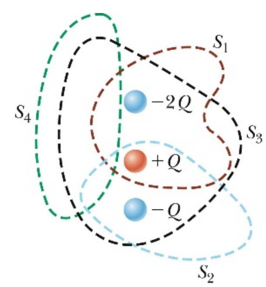
2. Consider a closed rectangular box resting within a horizontal electric field of magnitude $E = 7.80 \ x \ 10^4$ N/C as shown in the figure at right. Calculate the electric flux:
   a. Through the vertical rectangular surface
   b. Through the slanted surface
   c. Through the entire surface of the box



3. Human nerve cells have a net negative charge and the material in the interior of the cell is a good conductor. If a cell has a net charge of – 8.65 pC, what is the magnitude and direction (*inward or outward*) of the net flux through the cell boundary?

4. The following charges are located inside a submarine: 5.00 μC, – 9.00 μC, 27.0 μC and – 84.0 μC.
   a. Calculate the net electric flux through the hull of the submarine
   b. Is the number of electric field lines leaving the submarine *greater than*, *less than* or *equal to* the number entering it?

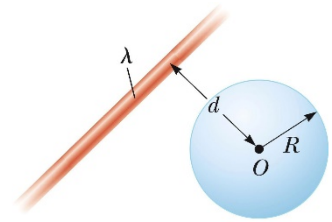
5. Four enclosed surfaces, S_1 to S_4, surround some or all of the charges shown in the figure at right. Find the electric flux through each surface in terms of Q/ε_o.



6. The six faces of a cubical box each measure 20.0 *cm* by 20.0 *cm*, and the faces are numbered such that the faces 1 and 6 are opposite each other, as are faces 2 and 5, and faces 3 and 4. The flux through each face is given in the table below. Find the net charge inside the cube.

Face	**Flux** ($N \ m^2 / C$)
1	– 70.0
2	– 300.0
3	– 300.0
4	+300.0
5	– 400.0
6	– 500.0

7. **An infinitely long line charge having a uniform density λ lies a distance *d* from point *O* as shown in the figure at right. Determine the total electric flux through the surface of the sphere of radius *R* centered at *O* if:

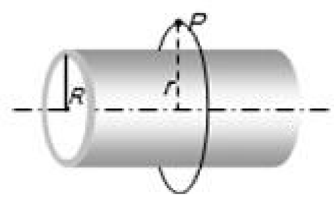


   a. $R < d$
   b. $R > d$

8. The linear charge density on a very long, straight filament is – 90.0 μC/*m*. Find the electric field using Gauss's Law for perpendicular distances above the filament at:
   a. 10.0 *cm*
   b. 20.0 *cm*
   c. 100 *cm*

9. A thin, spherical shell of radius 14.0 *cm* has a total charge 32.0 μC distributed uniformly on its surface. Find the magnitude of the electric field from the center of the sphere at distances of:
   a. 10.0 *cm*
   b. 20.0 *cm*

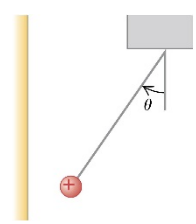
10. A cylindrical shell of radius R = 7.00 *cm* and length L = 2.40 *m* carries a uniform surface charge density (σ) on its curved face. The magnitude of the electric field at a point 19.0 *cm* radially outward from its central axis is 36.0 *k*N/C. Find:



   a. The surface charge density (σ)
   b. The net total charge (Q) on the shell
   c. The electric field at a point 4.00 *cm* radially outward from the central axis.

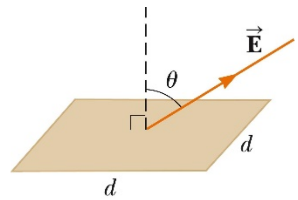
11. A non-conducting solid sphere of radius 40.0 *cm* has a total positive charge of 26.0 μC uniformly distributed throughout its volume. Calculate the magnitude of the electric field from the center of the sphere at:
   a. 0 *cm*
   b. 10.0 *cm*
   c. 40.0 *cm*
   d. 60.0 *cm*

12. A small sphere of mass 4.00×10^{-6} *kg* and charge 5.00×10^{-8} C hangs from a thread near a very large, uniformly charged insulating sheet as shown in the figure at right. The surface charge density (σ) of the sheet is equal to -2.50×10^{-9} C/m^2. Find the angle of the thread.

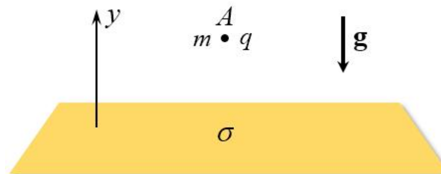


13. Two identical conducting spheres, each having a radius of 0.500 *cm*, are connected by a light, but very strong 2.00 *m* long conducting wire. A charge of 60.0 μC is placed on one of the conductors. Assume the surface distribution of charge on each sphere is uniform. Determine the tension in the wire.

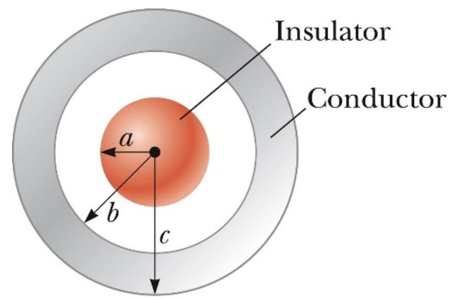
14. Consider a plane surface in a uniform electric field shown in the figure at right, where d = 15.0 *cm* and θ = 70.0°. If the net flux through the surface is 6.00 N m^2/C, find the magnitude of the electric field.



15. An object with mass m = 1.00 *g* and charge q is placed at point *A*, which is 0.0500 *m* above an infinitely large, uniformly charged, non-conducting sheet with $\sigma = -3.50 \times 10^{-5}$ C/m^2 as shown in the figure at right. Gravity is acting downward. Determine the number, *N*, of electrons that must be added to the object in order for it to remain suspended motionless above the charged plane.



16. For the configuration shown at right, suppose a = 5.00 *cm*, b = 20.0 *cm*, and c = 25.0 *cm*. Furthermore, suppose the electric field at a point 10.0 *cm* from the center is measured to be 3.60×10^3 N/C radially inward and the electric field at a point 50.0 *cm* from the center has a magnitude of 200 N/C radially outward. From this information, find:
    a. The net charge on the insulating sphere
    b. The net charge on the hollow conducting sphere
    c. The charge on the inner surface of the hollow conducting sphere
    d. The charge on the outer surface of the hollow conducting sphere



17. ** In one experiment, the electric field is measured for points at distances r from a line of charge that carries a uniform linear charge density λ and length l, where $l >> r$. In a second experiment, the electric field is measured for points at distances r from the center of a uniformly charged, insulating (non-conducting) sphere that has a volume charge density ρ and radius R = 8.00 *mm*, where $r > R$. The results of the two experiments are listed below in a table, but the experimenter, being distracted by people constantly contacting him on his phone, didn't label the data sets before leaving for the day.

r (*cm*)	1.00	1.50	2.00	2.50	3.00	3.50	4.00
Measurement A E (10^5 N/C)	2.72	1.79	1.34	1.07	0.902	0.770	0.677
Measurement B E (10^5 N/C)	5.45	2.42	1.34	0.861	0.605	0.443	0.335

For each data set, create <u>two</u> properly labeled graphs: Er^2 *vs* r and Er *vs* r

Hint: When creating your graphs, make sure everything is in the proper units

a. Use these graphs to determine which data set is for the uniform line of charge and which is for the uniformly charged sphere. Explain your reasoning.

b. Use the graphs in part (*a*) to calculate λ for the uniform line charge and ρ for the uniformly charged sphere.