Physics 4B
Fall 2022

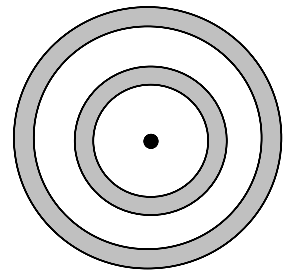
Name: ________________________________

Lab (circle one): 8:00 am 11:15 am 2:30 pm

Celebration #1: Chapters 21 – 25

Short Answer Questions (5 or 6 points each)

Question 1 (6 points)
A $+20\mu C$ point charge is surrounded by 2 conducting spherical shells as shown in the figure to the right. The inner shell has a charge of $+15\mu C$ and has an inner radius R_a and outer radius R_b. The outer shell has a charge of $-10\mu C$ and has an inner radius R_c and outer radius R_d



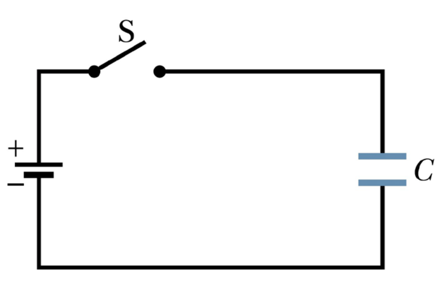
What is the charge on the **inner** surface of the **inner** shell (at radius R_a)?

What is the charge on the **outer** surface of the **inner** shell (at radius R_b)?

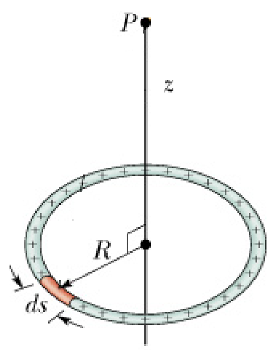
What is the charge on the **inner** surface of the **outer** shell (at radius R_c)?

What is the charge on the **outer** surface of the **outer** shell (at radius R_d)?

Question 2 (6 points)
The capacitor in the figure below has a capacitance of 25.0 μF and is initially uncharged. The battery provides a potential difference is 15.0 V. After the switch is closed, how many electrons will flow from the battery to the bottom plate of the capacitor?

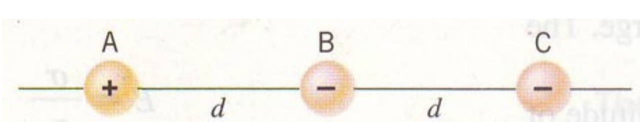


Question 3 (5 points)
The electric potential at point P, a distance z from central axis of a thin ring of radius R and linear charge density λ, can be written as $V = \lambda R / (2\varepsilon_0 \sqrt{z^2 + R^2})$. Show that both sides of this equation have the same units.



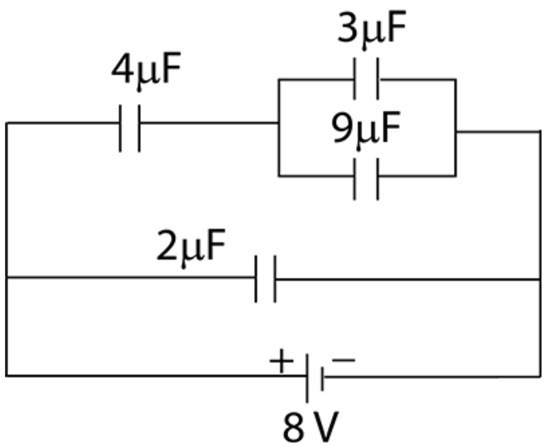
Question 4 (5 points)
You are given the potential function $V(x,y) = 6xy^3 + 3x^2y$, where V is in volts and x and y are in meters. Determine the magnitude of the electric field **E** at the point x = 1, y = 2.

Question 5 (6 points)
Three point charges have equal magnitudes. They are fixed in place on the same straight line, and are equally separated by a distance d. Consider the net electrostatic force acting on each charge. Calculate the ratio of the largest to the smallest net force.

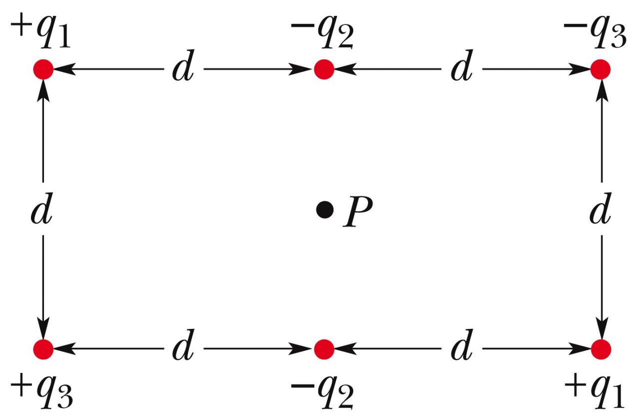


Problems (12 points each)

Problem 1
In the circuit shown below, what is the charge on and the potential difference across each capacitor?



Problem 2
In the figure below, point P is at the center of the rectangle, $q_1 = 4.00$ pC, $q_2 = 2.50$ pC, $q_3 = 5.00$ pC, and d = 3.50 cm. **(a)** What is the net electric potential at point P due to the six charged particles? **(b)** What is the magnitude and direction of the net electric field at point P due to the six charged particles?

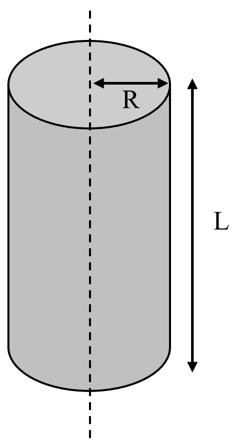


halliday_9e_fig_24_65

Problem 3

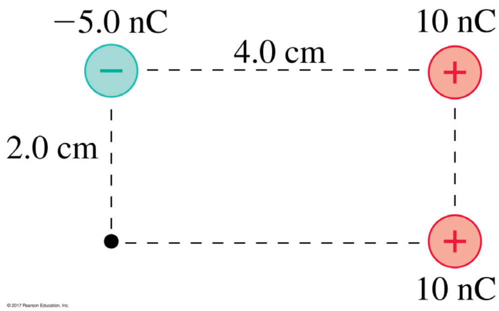
A long, solid *nonconducting* cylinder of length L and radius R has a nonuniform charge distribution of volume charge density $\rho = Ar/R$, where r is the radial distance from the cylindrical axis and A is a constant. Using Gauss' law, derive an expression for the electric field a radial distance r from the axis of the cylinder for points **(a)** inside the cylinder ($r < R$), and **(b)** outside the cylinder ($r > R$).

Hint: $q = \int \rho dV = \int \rho(2\pi rL)dr$



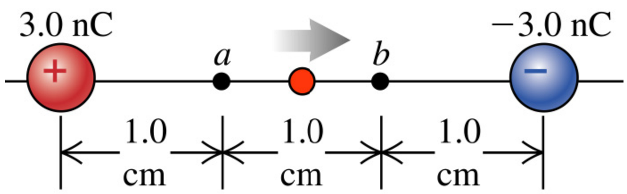
Problem 4

What is the magnitude and direction of the net electrostatic force on the -5.0 nC charge?



Problem 5

A dust particle with mass 5.0 μg and charge 2.0 nC starts from rest at point a and moves in a straight line to point b. What is its speed at point b?



Problem 6

Charge Q = 30.0 nC is uniformly distributed along a thin, flexible rod of length L = 15.0 cm. The rod is bent into a semicircle as shown in the figure below. What is the magnitude and direction of the electric field at the center of the semicircle?