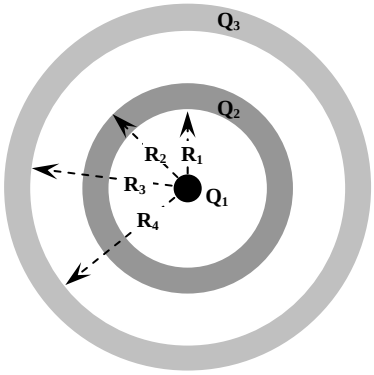
PHYS102 – Chapter 23 (Instructor: Dr. Al–Shukri)

Q1. Two charged concentric spherical shells and a point charge at the center are shown in the **Figure**. Assume $Q_1 = -4\ \mu C$, $Q_2 = 6\ \mu C$, $Q_3 = -2\ \mu C$, $R_1 = 10$ cm, $R_2 = 12$ cm, $R_3 = 20$ cm, and $R_4 = 22$ cm.



a) Find the charge distribution on the two shells.

$Q_{2in} = -Q_1 = 4\ \mu C$, $Q_{2out} = Q_2 - Q_{2in} = Q_2 + Q_1 = 6 - 4 = 2\ \mu C$
$Q_{3in} = -Q_{2out} = -2\ \mu C$, $Q_{3out} = Q_3 - Q_{3in} = -2 - (-2) = 0$.

b) Find the magnitude and direction of the electric field at the following positions from the center of the spheres: r = 5 cm, 11 cm, 15 cm, 21 cm, 25 cm.

$E(r=5\text{ cm}) = kq/r^2 = 9\times10^9(4\times10^{-6})/(0.05)^2 = 1.44\times10^7$ N/C (inward)
$E(r=11\text{ cm}) = kq/r^2 =$ zero (E =0 inside a conductor)
$E(r=15\text{ cm}) = kq/r^2 = 9\times10^9(2\times10^{-6})/(0.15)^2 = 8\times10^5$ N/C (outward)
$E(r=22\text{ cm}) = kq/r^2 =$ zero (E = 0 inside a conductor)
$E(r=25\text{ cm}) = kq/r^2 = 9\times10^9(\text{zero})/(0.25)^2 =$ zero

Q2. When a piece of paper is held with its face perpendicular to a uniform electric field the flux through it is 30 $N\cdot m^2/C$. When the paper is turned at certain angle with respect to the field the flux through it is 26 $N\cdot m^2/C$. What is the angle?

a. 30º b. 45º c. 75º d. 50º e. 15º

Q3. An infinitely long uniformly charged rod is coaxial with an infinitely long uniformly charged cylindrical shell of radius 5.0 cm. The linear density of the rod is $+15\times10^{-9}$ C/m and that of the cylindrical shell is -20×10^{-9} C/m. What is the magnitude of the electric field at a distance of 10 cm from the axis?

a. 900 N/C b. 2700 N/C c. 3600 N/C
d. 5400 N/C e. 4500 N/C

Q4. A particle, of mass 1.0 g and charge 1.0×10^{-6} C, is held stationary between two parallel non-conducting sheets that carry equal but opposite surface charge densities. What is the magnitude of the surface charge density?

a. 8.7×10^{-8} C/m^2 b. 1.7×10^{-7} C/m^2 c. 3.4×10^{-7} C/m^2
d. 4.4×10^{-8} C/m^2 e. 2.2×10^{-8} C/m^2

Q5. An insulating spherical shell of radius 15 cm has a total charge of 10 μC uniformly distributed on its surface. Calculate the electric field intensity at a distance of 14 cm from the center of the shell.

a. 0 b. 6.4×10^5 N/C c. 3.5×10^6 N/C
d. 4.6×10^5 N/C e. 4.0×10^6 N/C

Q6. Which of the following statements are INCORRECT?

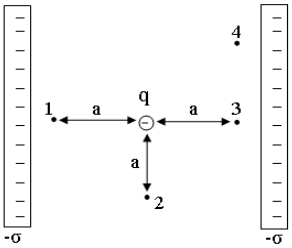
(1) The electric flux through a Gaussian surface depends on the shape of the surface.
(2) The electric flux through a closed surface depends on the net charge enclosed by the surface.
(3) The electric field inside a charged conductor in electrostatic equilibrium is zero.
(4) The electric potential inside a charged conductor in electrostatic equilibrium is zero.
(5) Electric field lines are always directed from negative charges to positive charges.

a. 1, 4 and 5 b. 1, 2 and 4 c. 2, 3, and 4
d. 3 and 4 e. 1 and 3

Q7. A conducting spherical shell, of inner radius a = 2.0 cm and outer radius b = 4.0 cm, is neutral. A small charge Q = 4.0 nC is located at the center of the shell. What is the magnitude of the electric field E at r = 1.0 cm and r = 3.0 cm from the center of the spherical shell, respectively?

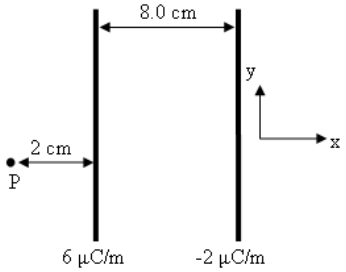
a. 36×10^4 N/C and zero b. Zero and zero
c. 16×10^4 N/C and zero d. Zero and 16×10^4 N/C
e. 36×10^6 N/C and 4×10^4 N/C

Q8. The **Figure** below shows two large, parallel, non-conducting sheets with identical negative uniform charge density of magnitude σ. A negative point charge q is placed between the two sheets. Rank the four numbered points according to the magnitude of the net electric field there, greatest first.



a. 1, 2, 3 tie, then 4
b. 1,2 tie, 3, 4 c. 1,2,3,4
d. 4,3,2,1 e. 3,1,2,4

Q9. The **Figure** shows short sections of two very long parallel wires carrying uniform linear charge densities +6.0 μC/m and –2.0 μC/m. Find the magnitude and direction of the net electric field at point P.



a. 5.0×10^6 (-i) N/C
b. 5.0×10^6 (i) N/C
c. 9.0×10^6 (-i) N/C
d. 9.0×10^6 (i) N/C
e. Zero

Q10. For the electric field: E = (10 i + 20y j) N/C, what is the electric flux through a 2.0 m^2 portion of the xy-plane?

a. Zero b. 40 Nm^2/C c. 20 Nm^2/C
d. 50 Nm^2/C e. 70 Nm^2/C

Q11. A solid non-conducting (insulating) sphere, of radius 4.0 m, has a uniform charge density. What is the ratio of the magnitude of the electric field at a distance 2.0 m from the center to the magnitude of the electric field at the surface of the sphere?

a. 0.5 b. 1.0 c. 2.0 d. 0.25 e. 3.0