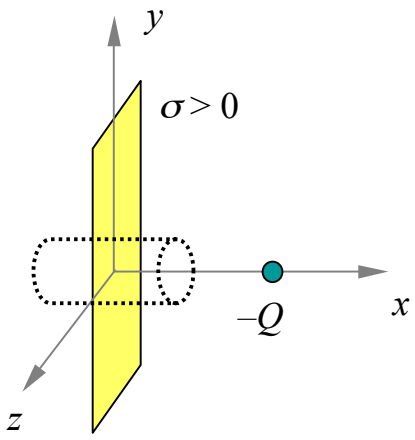
Name: _____ Sec. _____ **P212: Quiz 2C Week 3**

1) An infinite sheet with positive charge density $\sigma > 0$ is aligned with the y-z plane. A negative charge $-Q$ is located on the x-axis at $x = +a$. Define a Gaussian surface to be a cylinder intersecting the infinite plane, as shown by the dashed lines in the figure. Define Φ_b to be the flux through the barrel (*i.e.* the curved side only) of the cylinder. Which of the following relations is true? (Remember the sign convention: flux through closed surfaces, or portions thereof, is positive when it points *outwards*.) **[4]**

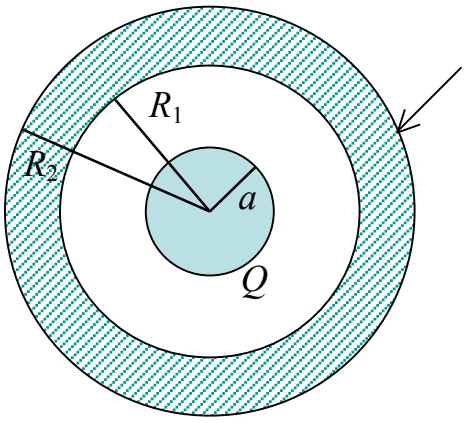
(a) $\Phi_b < 00$
(b) $\Phi_b = 00$
(c) $\Phi_b > 00$
(d) the sign of Φ_b is impossible to determine given this information



The flux is negative. The plane contributes no flux to the barrel portion because the E-field is parallel to the surface. The point charge contributes negative flux.

Award 4 points for correct answer
Award 2 points for correct set-up and logic

Consider a non-conducting sphere of radius a, which carries a total charge Q distributed *uniformly* throughout the volume. This sphere is surrounded by a conducting spherical shell of inner radius R_1 and outer radius R_2. The conducting shell is uncharged.

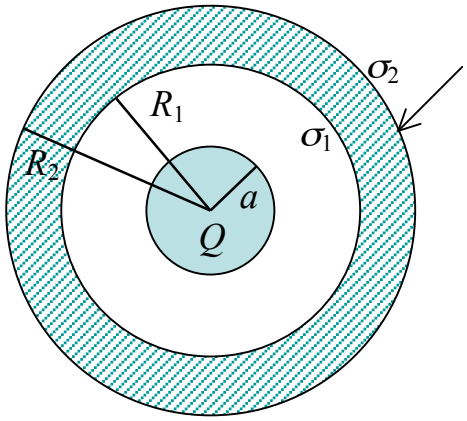


$a = 1.5$ mm
$R_1 = 4.5$ mm
$R_2 = 6.0$ mm
$Q = -8$ μC

2) What is the electric field at a radius of 5.0 mm from the center of the system? **[4]**

E = 0 because this is inside a conductor

Award 4 points for correct answer
Award 2 points for correct set-up and logic



uncharged metal shell

a = 1.5 mm
R_1 = 4.5 mm
R_2 = 6.0 mm
Q = –8 μC

3) What is the surface charge density σ_1 on the inner surface of the spherical shell? **[8]**

Set up Gaussian surface with radius r satisfying R1 < r < R2 (2 points)

Flux through this surface is 0 because E=0 inside the conductor (2 points)

Set up Gaus's law: $\Phi = 0 = Q + \text{area} \times \sigma_1 = Q + 4\pi R_1^2 \sigma_1$
➔ $\sigma_1 = -Q/(4\pi R_1^2)$ (3 points)

Plug in numbers to get σ_1 = 0.031 μC / mm^2 (1 point)

4) What is the volume charge density ρ of the non-conducting sphere? (Please leave your answer in symbolic form, no numbers required.) **[4]**

ρ = Q / volume = Q / (4/3 π a³)

Award 2 points for ρ = Q / volume
Award 2 points for correct solution