University of KHEMIS MILIANA
Faculty of Science and Technology
Department of Science of Matter - L1 ST-SM-ENG
Exercise Series of GW of Physics 2, 2023-2024
Exercise Series Number 2. Conductors in Electrostatic Equilibrium

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*Exercise 1:

Consider two conducting spheres of radii R_1 and R_2 ($R_1 > R_2$) and charge densities σ_1 and σ_2, connected by a long thin conducting wire as shown in **Fig.** 1.

1. Show that:
$$\frac{\sigma_1}{R_2} = \frac{\sigma_2}{R_1} \tag{1}$$
2. Provide a brief explanation of the derived expression.

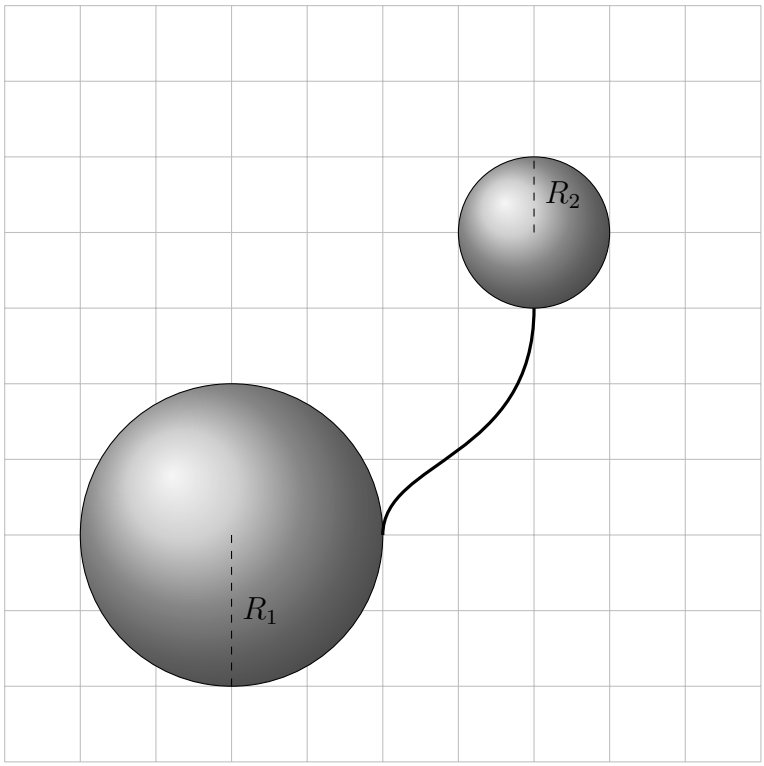

Figure 1: Two metallic spheres connected by a long conducting wire

Exercise 2:

A hollow conducting sphere of radius R is divided into two unequal parts by a horizontal plane: the result is two spherical caps with a common base of a circle of radius $r = R\sin\alpha$. The isolated sphere is held at potential $V > 0$.

1. Determine the force exerted by the lower cap, assumed to be fixed, on the upper cap as a function of V and α.
2. From this, find the value of this force in the case of two hemispheres raised to a potential of $V = 30kV$.

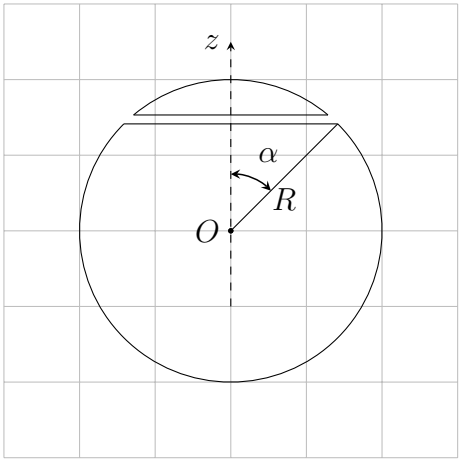

Figure 2: spherical caps

Exercise 3:

Determine the electric potentials of two concentric metallic spheres carrying charges Q_1 and Q_2 and radii R_1 and R_2, respectively, where $R_1 > R_2$.

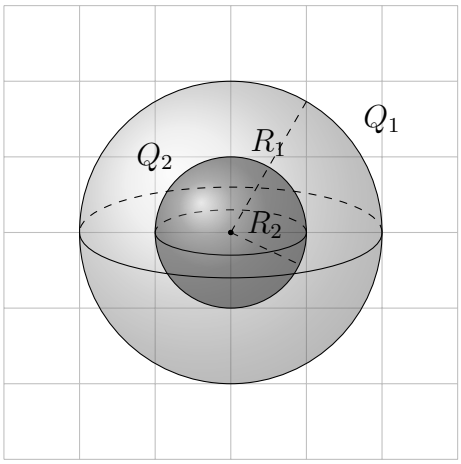

Figure 3: Concentric metallic Spheres

*Exercise 4:

Calculate the capacitances of the following conductors with different geometric shapes:

1. Conductor formed by two conducting plates of width ℓ, length L, and separated by a distance d.
2. Conductor formed by two coaxial conducting cylinders of length ℓ and radii R_1 and R_2 ($R_2 > R_1$). Consider the case where ($R_2 \approx R_1$).
3. Conductor formed by two concentric conducting spheres of radii R_1 and R_2 ($R_2 > R_1$). Consider the case where ($R_2 \gg R_1$) and ($R_2 \approx R_1$).

Exercice 5:

Consider a conductor A completely enclosing a conductor B of charge Q_B.

1. Calculate the internal charge of conductor A.
2. Calculate the external charge Q_A^{ext} in the following two charges:

(a) Conductor A is isolated and initially neutral.

(b) Conductor A carries an initial charge q.

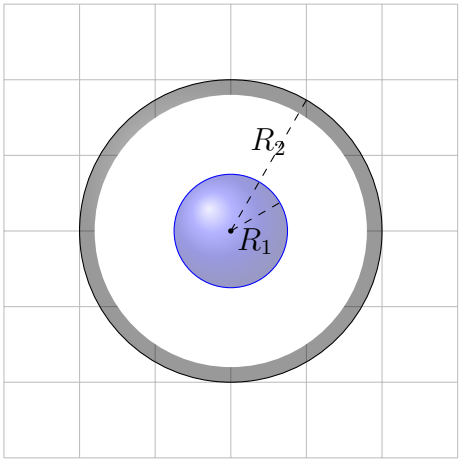

Figure 4: Two conductors in complete influence