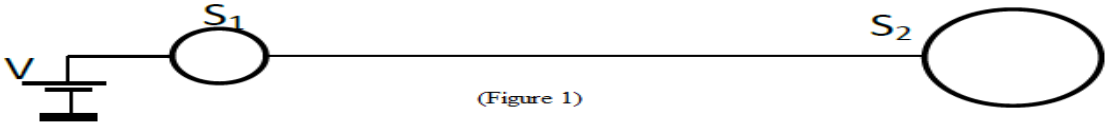
Chapter 2 Conductors in Electrostatic Equilibrium TD N°2

Physical constants : $e = -1.602\ 10^{-19}C$; $\varepsilon_0 = 8{,}854\ 10^{-12}F/m$; $\frac{1}{4\pi\varepsilon_0} = 8{,}987\ 10^{9}Nm^2C^{-2}$

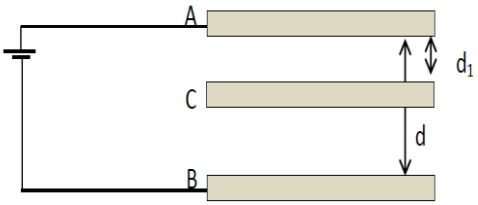
Exercise 01: Two conducting spheres S_1 of radius R_1 = 1 cm and S_2 of radius R_2 = 100 cm are connected by a thin and very long conducting wire so that mutual influence is neglected by the wire. As shown in the figure 1. Are connected in conductor S_1 to a direct voltage generator V = 900V. Calculate the charges carried by the two spheres at equilibrium. Compare their charge densities σ_1 and σ_2. Conclude.



(Figure 1)

Exercise 02: A parallel plate capacitor has square plates of side 5 cm and separated by a distance of 1 mm. (a) Calculate the capacitance of this capacitor. (b) If a 10 V battery is connected to the capacitor, what is the charge stored in any one of the plates.

Exercise 03: Three metallic plates A, B and C, neutral and identical surfaces = 0,1m^2, of thickness e= 4mm, are arranged in parallel with the others. The distance between the internal faces of A and B is equal to d= 50cm.The distance between the internal faces of A and C is noted in $d_1$figure below.1) Calculate the capacitance C_0 and the charge Q of this capacitor are connected to a potential difference of V_A-V_B = 300V.2) What is the electrostatic force that is acting on plate C. 3) The charged system is isolated, remove the initially neutral plate C, Calculate the new capacitance C formed by A and B. 4) Deduce the new potential difference between A and B.

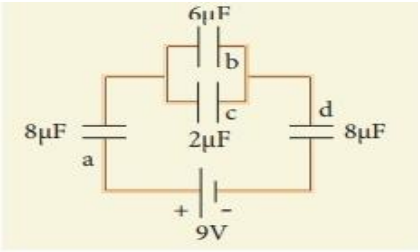


Exercise 04: For the given capacitor configuration

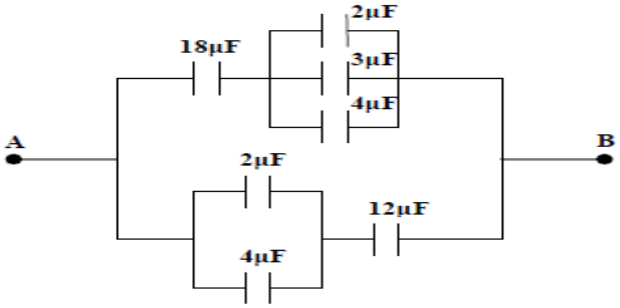
(a) Find the charges on each capacitor

(b) Potential difference across them

(c) Energy stored in each capacitor



Exercise 05: In the circuit below, If $V_A - V_B$ = 100 volts of potential difference is applied between A and B .We ask you to: 1 - Find the charge and the potential difference across each capacitor. 2 - Find the energy stored in the circuit.



Homework

Exercise 01:A Consider a non-conducting rod of length l having a uniform charge density λ. Find the electric potential P at, a perpendicular distance Y above the midpoint of the rod (Figure 1).

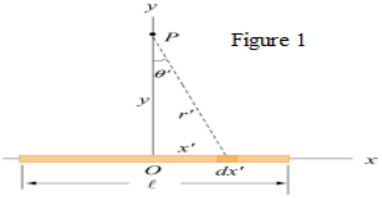


Figure 1

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Exercise 01: B Consider a uniformly charged ring of radius *R* and charge density λ (Figure 2). What is the electric potential at a distance *z* from the central axis?

Exercise 01: C Consider a uniformly charged disk of radius *R* and charge density σ lying in the *xy*-plane. What is the electric potential at a distance from the central axis? (Figure 3).

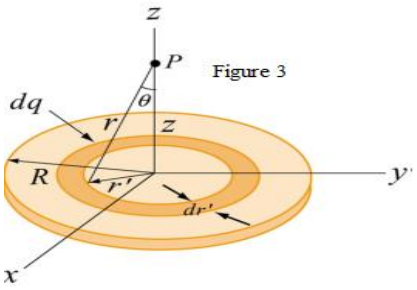


Figure 3

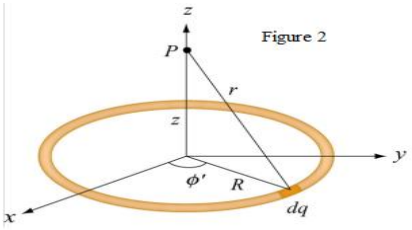


Figure 2

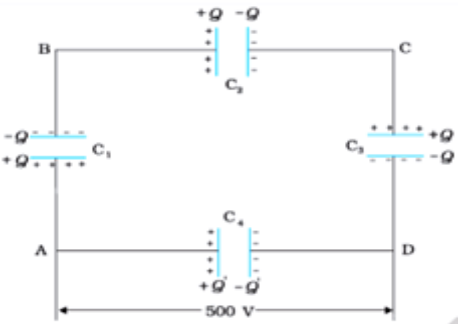
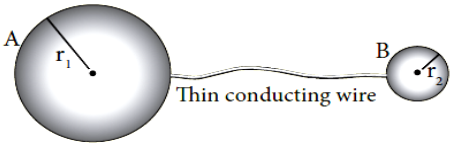


Fig 4

Exercise 02: A network of four 10 mF capacitors is connected to a 500 V supply, as shown in Fig 4. Determine (a) the equivalent capacitance of the network and (b) the charge on each capacitor. (Note, the charge on a capacitor is the charge on the plate with higher potential, equal and opposite to the charge on the plate with lower potential.)

Exercise 03: Two conducting spheres of radius r_1 = 8 cm and r_2 = 2 cm are separated by a distance much larger than 8 cm and are connected by a thin conducting wire as shown in the figure. A total charge of Q = +100 nC is placed on one of the spheres. After a fraction of a second, the charge Q is redistributed and both the spheres attain electrostatic equilibrium. A) Calculate the charge and surface charge density on each sphere. (b) Calculate the potential at the surface of each sphere.



Exercise 04: Three capacitors of capacitances 2 pF, 3 pF and 4 pF are connected in parallel.
(1) What is the total capacitance of the combination?
(2) Determine the charge on each capacitor if the combination is connected to a 100 V supply.

Exercise 05: A spherical capacitor has an inner sphere of radius 12 cm and an outer sphere of radius 13 cm. The outer sphere is earthed, and the inner sphere is given a charge of 2.5 μC. The space between the concentric spheres is filled with a liquid of dielectric constant 32.
(a) Determine the capacitance of the capacitor.
(b) What is the potential of the inner sphere?
(c) Compare the capacitance of this capacitor with that of an isolated sphere of radius 12 cm. Explain why the latter is much smaller.

Exercise 06: Four point charges, q_1,q_2,q_3,q_4, of charges Q, -2Q, 2Q, and Q, respectively, are placed in locations (a,0), (0,b), (0,-b) and (0,0) as shown.
a) What is the electric force on q4?.
b) Now q4 is moved from (0,0) to (-2a,0), how much is the work done by the electric forces due to other three (fixed) charges during the process?