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Faculty of sciences
Field : Sciences of matter (SM)
1st year LMD   Semester 02.

جامعـة محمد بوضياف -المسيلـة
كليـة العلـوم
ميدان : علوم المادة
السنة الأولى ل م د - السداسي 02

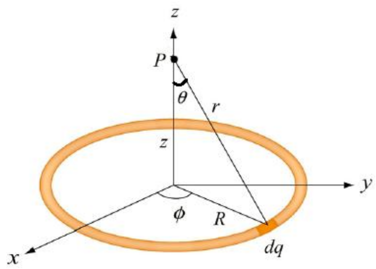
Physics 02: Electricity and magnetism

University Year 2023-2024

Series N° 02: ELECTROSTATICS

Part 2: Continuous distribution and theorem of Gauss

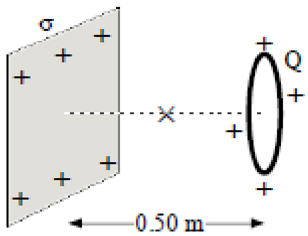
EXERCISE 01



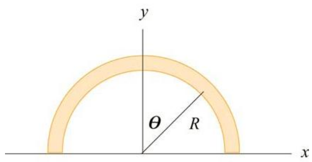
1- A ring of radius R with a uniform charge density λ and a total charge Q is lying in the xy - plane, as shown in the opposite figure. Compute the electric field at a point P, located at a distance z from the center of the ring along its axis of symmetry.

2- A charge Q is uniformily distributed on the surface of a disk of radius R. What is the electric field at point M on the z-axis a distance z from the center of the disk? Deduce the electric field in the case of infinite plane.

3- A uniformly charged ring, with a charge of 2 .50 μC and radius 0.20 m, and a very large, uniformly charged sheet, with charge density 1 μC/m^2, are placed 0.50 m apart such that the axis of the ring is perpendicular to the sheet, as shown above. What is the electric field at the point · midway between the ring and the sheet?



EXERCISE 02



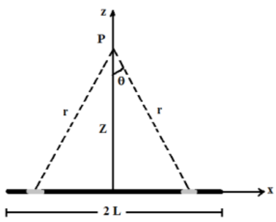
A semicircle of radius R is positively charged, as shown in the figure.

The total charge on the semicircle is Q. However, the charge per unit length along the semicircle is non-uniform and given by $\lambda = \lambda_0 cos\theta$.

1- What is the relationship between λ_0, R and Q?

2- If a particle with a charge q is placed at the origin, what is the total force on the particle?

EXERCISE 03 (home work)

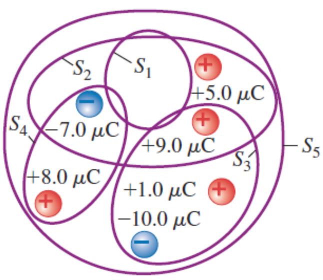


Find the electric field a distance above the midpoint of a straight line segment of length 2 L that carries a uniform line charge density λ.

EXERCISE 04

Five Gaussian surfaces S_1 , S_2 , S_3 , S_4 , and S_5 each enclose part of this plane.

Compute the electric flux through them.

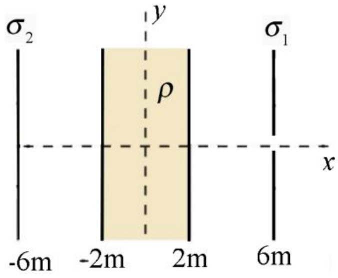


EXERCISE 05

An infinite slab of charge carrying a uniform volume charge density ρ has its boundaries located at x = -2 meters and x = +2 meters. It is infinite in the y direction and in the z direction. Two similarly infinite charge sheets (zero thickness) are located at x = -6 m and x = +6 m, with uniform surface charge densities σ_1 and σ_2 respectively.

In the accessible regions you've measured the electric field to be:

$$\vec{E}\,(x) = \begin{cases} \vec{0}\,, & x < -6\ m \\ \left(10\frac{N}{C}\right)\vec{\imath}, & -6\,m < x < -2\,m \\ \left(-10\frac{N}{C}\right)\vec{\imath}, & 2\,m < x < 6\,m \\ \vec{0}, & x > 6\,m \end{cases}$$



1- What is the charge density ρ of the slab?
2- Find the two surface charge densities σ_1 and σ_2 of the left and right charged sheets.

EXERCISE 06

A sphere of radius **R** has a uniform volume charge density. Find the electric field and electrical potential at a point outside the sphere and at a point inside the sphere. The electrical potential is **zero** at “infinity”. Plot both the electric field and electrical potential.

EXERCISE 07

A dielectric rod of radius a and length L has a total charge Q and uniform volume charge density ρ. The rod is surrounded by a thin conducting cylinder of radius b and length L. This outer cylinder which is grounder carries a charge of (- Q).
Use Gauss's Law to determine the electric field in the all regions. Deduce the electric potential. Plot both the electric field and electrical potential.

EXERCISE 08

A solid nonconducting sphere of radius R has a nonuniform charge distribution of volume charge density $\rho = \rho_0 \frac{r}{R}$, where ρ_0 is a constant and r is the distance from the center of the sphere.
1- Show that the total charge and the field **inside** the sphere are:

$$Q = \pi \rho_0 R^3$$

$$E = k\frac{Q}{R^4}\,r^2$$

2- Gives the magnitude of the electric field **outside** the sphere.

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