

Physics 02: Electricity and magnetism

University Year 2023-2024

Series N° 01: ELECTROSTATICS

Part 1: Electrostatic charges and fields

EXERCISE 01

1- How many electrons would have to be removed from a penny to leave it with a charge of $1 \times 10^{-7} \text{ C}$?

2- To what fraction of the electrons in the penny does this correspond?

Assume that penny is made entirely of copper, mass (penny) = 3.11 g, $M(\text{Cu}) = 63.54 \text{ g/mol}$, $Z=29$.

EXERCISE 02

You comb your hair on a dry day. The comb gained 2.3×10^4 electrons.

1. Does your hair or plastic comb have a greater affinity for electrons? Why?

2. Assume your hair and comb were all neutral before combing. What is the charge of the comb afterwards?

3. What is the charge of your hair afterwards?

EXERCISE 03

Consider a hydrogen atom in which the proton ($m_{e^+} = 1.67 \times 10^{-27} \text{ Kg}$) and the electron ($m_{e^-} = 9.1 \times 10^{-31} \text{ Kg}$) are separated by a distance $r = 5.3 \times 10^{-11} \text{ m}$.

1- Calculate the electrostatic force between the two particles 'electron and proton'.

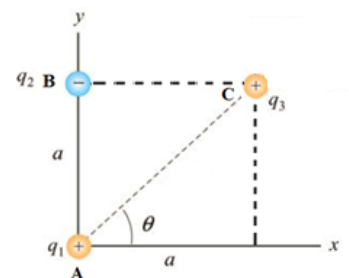
2- Calculate the gravitational force between the two particles 'electron and proton'.

3- What is the ratio of the electric force to the gravitational force?

4- Describe some of the similarities and differences between the electrical force and the gravitational force.

EXERCISE 04

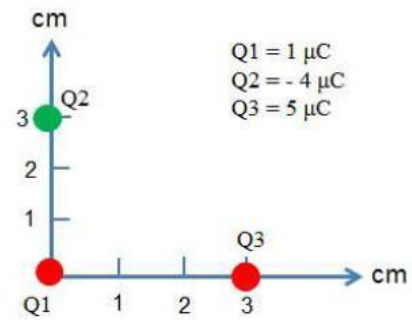
Three charges are arranged as presented in figure. Find the force on the charge q_3 . Assuming that $q_1 = 6 \times 10^{-6} \text{ C}$, $q_2 = -q_1 = -6 \times 10^{-6} \text{ C}$, and $q_3 = 3 \times 10^{-6} \text{ C}$, $a = 2 \times 10^{-2} \text{ m}$.



EXERCISE 05 (home work)

Three point charges are fixed in place in a right triangle.

- 1- What is the electric force on the $5.0 \mu\text{C}$ charge due to the other two charges?
- 2- Find the force on $1 \mu\text{C}$ charge?
- 3- Find the force on $-4 \mu\text{C}$ charge?



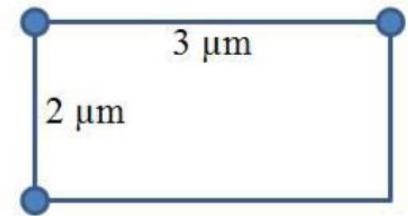
EXERCISE 06

Two small positively charged spheres have a combined charge of $5.0 \times 10^{-5} \text{ C}$. If each sphere is repelled from the other by an electrostatic force of 1.0N when the spheres are 2.0 m apart, what is the charge on each sphere?

EXERCISE 07

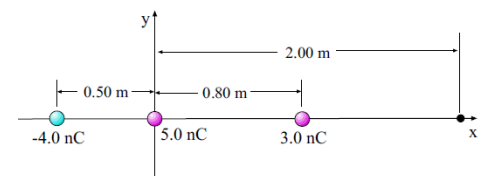
Positive point charges, $1 \mu\text{C}$ each, are placed at three corners of a rectangle, as shown in the figure.

- 1- What is the electric field at the fourth corner?
- 2- A small object with a charge of $+2.0 \mu\text{C}$ is placed at the fourth corner. What force acts on the object?



EXERCISE 08 (home work)

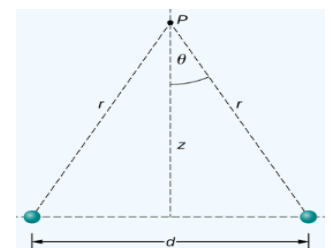
Three point charges are aligned along the x-axis as shown in figure. Find the electric field at the position $x = +2.0 \text{ m}$, $y = 0$.



EXERCISE 09

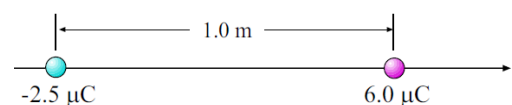
Find the electric field (magnitude and direction) a distance z above the midpoint between two equal positive charges that are a distance d apart.

Check that your result is consistent with what you'd expect when $z \gg d$.



EXERCISE 010

Two unlike charges are aligned along the x-axis as shown in figure. Determine the point (other than infinity) at which the total electric field is zero.



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