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Bringing Nobel Prize Physics in the Classroom

"From the electroscope to cosmic rays"

Astroparticle Group C

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Background information for teachers

- Knowledge of the atom's structure (atoms consist of a nucleus containing protons and neutrons, surrounded by electrons). Protons are positively charged and electrons negatively charged particles.
- Knowledge of static electricity (attraction and repulsion of opposite and like charges respectively).
- Construction, use and utility of the electroscope.
- What is electroscope discharge time?
- What cosmic rays are and how we detect cosmic rays using an electroscope.

Overview of this lesson pack:

Name of the activity	Construction, use and utility of the electroscope
Topics introduced	Static electricity, Electroscope, Electroscope Discharge time, Detection of Cosmic Rays
Curriculum Connection	GREECE: Science, 5th grade Chapters: ”Static electricity”, “The electroscope” (p. 94-100 of workbook), Arts (cross-curricular approach).
Reference Demonstrator	https://www.youtube.com/watch?v=4aQOe98MC4s https://www.youtube.com/watch?v=91801Y1IsCg
Age of students	11 years old
Duration	2 hours (90 min.)

Overview of this lesson pack:

Type of activity	Experiment in the classroom designed according to the inquiry-based form of learning.
Description of activity	**Teacher activities**: a)Demonstration and implementation of the electroscope's experiment, b) Give the students the stimulus to think about cosmic rays interaction through historical facts and data. **Student activities**: a) Construction of an electroscope with simple materials (connection with "Playing with Protons"), b) use of newly acquired knowledge to discuss about cosmic rays and particles' interaction with earth's atmosphere.
Equipment requirements	Materials for the electroscope's construction (glass jar, aluminium foil leaves, scissors, copper wire, cardboard, tape, tissue, plastic straw), PC with internet connection, projector.
Prior knowledge for students	Atom's structure. Opposite charges attract each other and like charges repel each other. When we rub a plastic straw on a tissue, the straw is negatively charged. When we rub a tissue on a plastic straw, the tissue is positively charged.

Background and overview of the, electroscope discharge time and cosmic rays demonstrators:

The electroscope discharge time demonstrator includes the concept of the different ways in which we can discharge a charged electroscope. Before the demonstration students will try to do the same by touching the wire of their electroscope with their hand. Then, they will see all other ways (radiation and X-rays) through the video. The analysis of how different factors affect electroscope discharge time will allow students to make a connection between the electroscope and the detection of cosmic rays and discuss their ideas in the classroom.

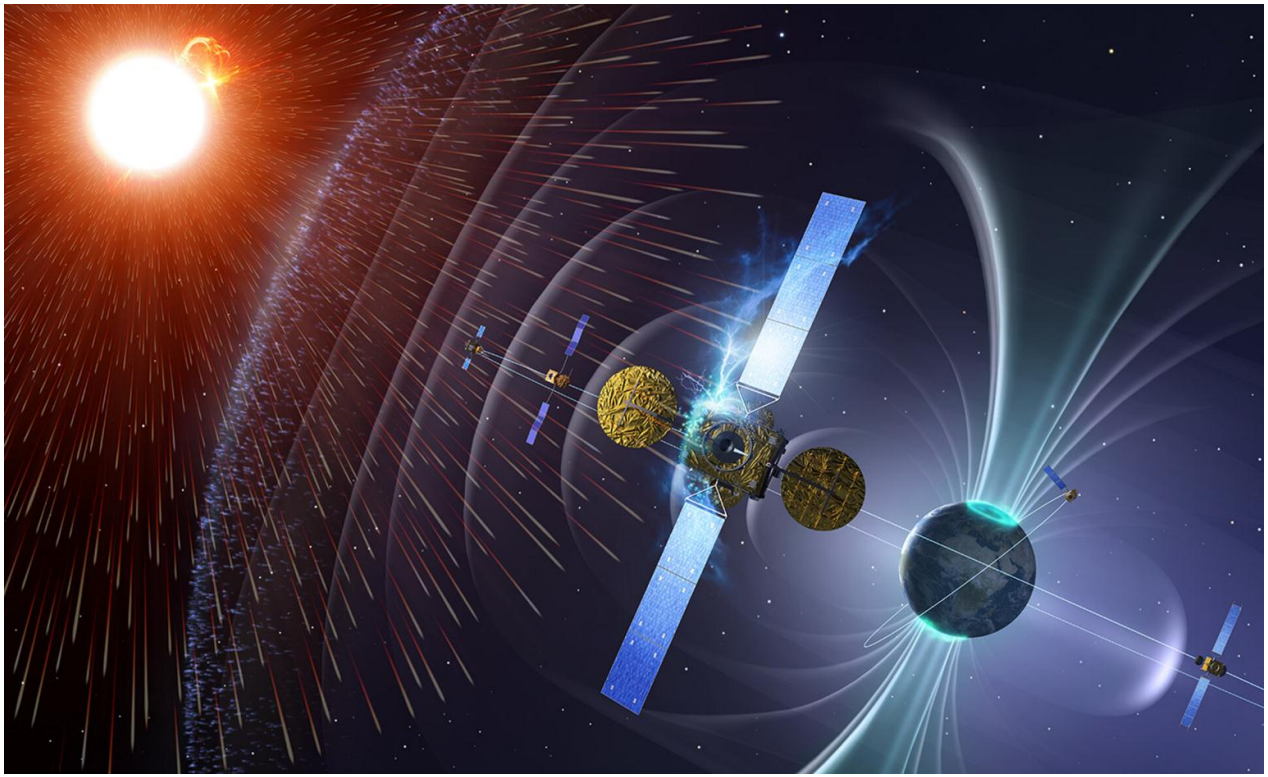
Video: https://www.youtube.com/watch?v=4aQOe98MC4s

The cosmic rays demonstrator includes the concept of the cosmic rays, presenting historical facts about their detection, in 1912 from Victor Hess using the electroscope, and the scientific facts the scientific community has so far. Students will have the chance to discuss this specific topic and reflect on how cosmic rays affect our everyday life.

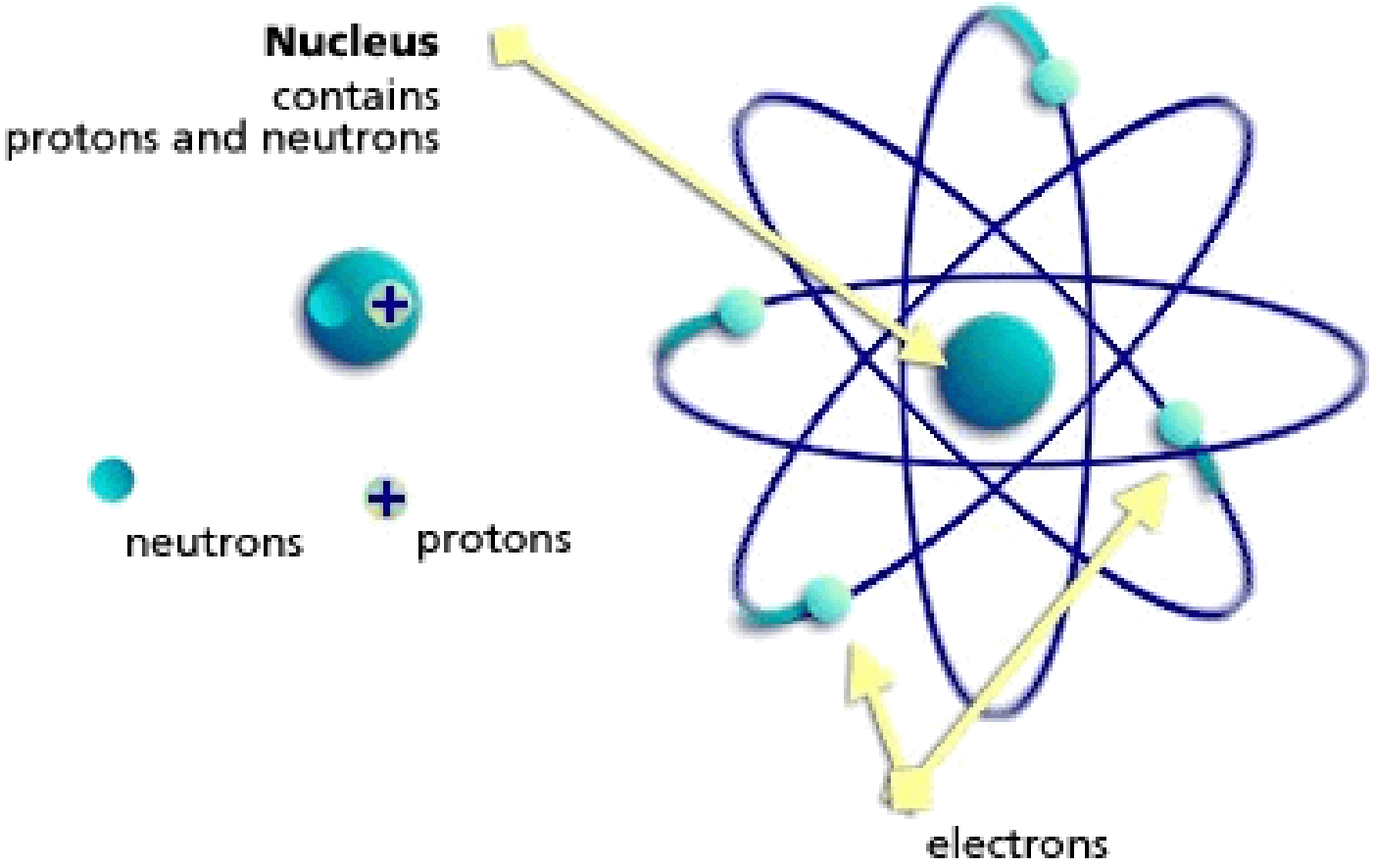
Video: https://www.youtube.com/watch?v=91801Y1lsCg

From the electroscope to cosmic rays

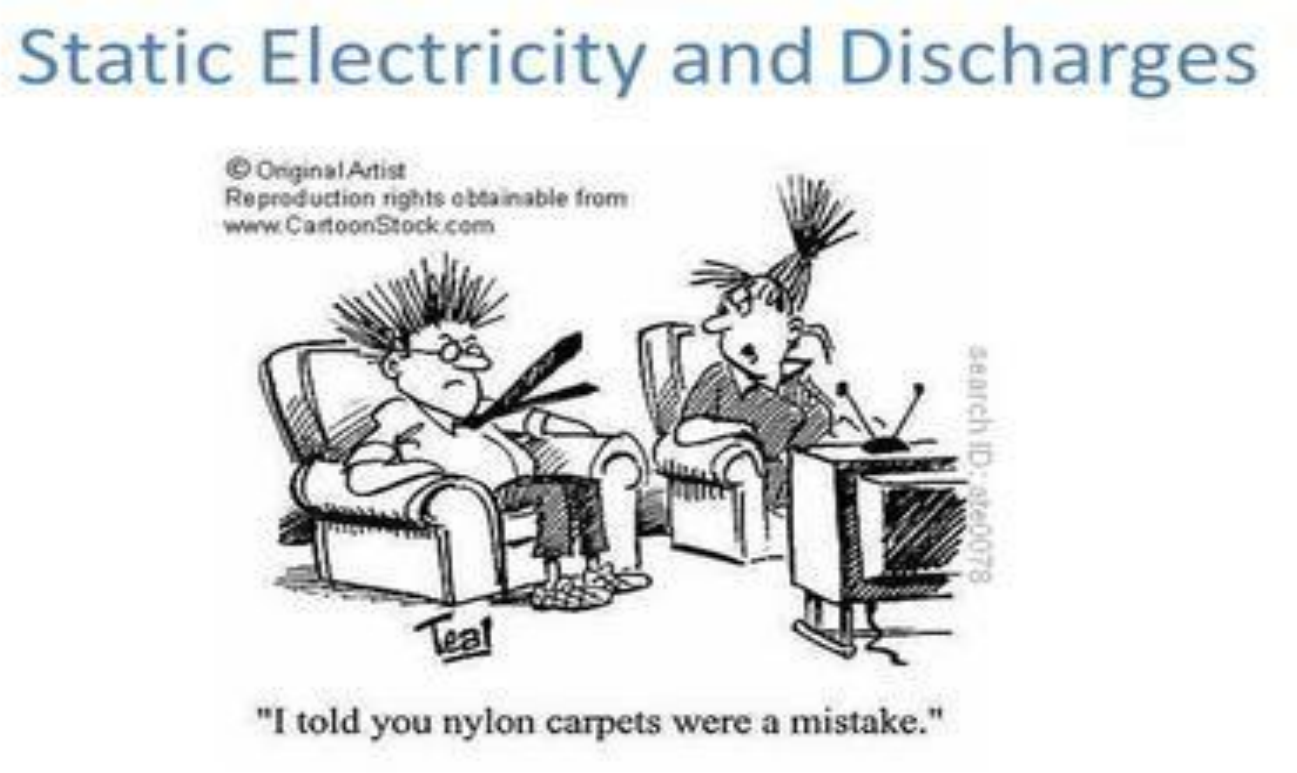
Students' Presentation



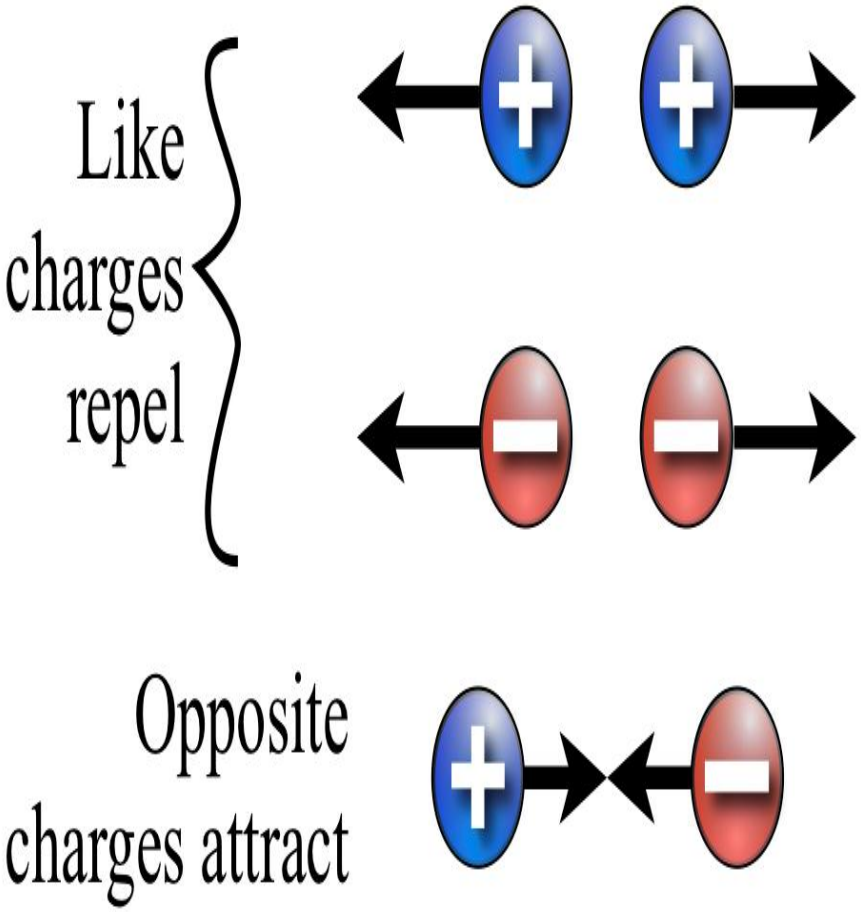
A few thing to remember...



What about these guys?



- Two objects with static charges can attract or repel each other.
- If the charges are the same (both positive or negative they will repel).
- If the charges are different, they attract.



Let’s figure some more things out!

Materials

- glass jar
- 2 aluminium foil leaves
- scissors
- copper wire
- cardboard
- tape
- tissue
- straw

Step 1: Bend the copper wire at one edge and attach the two aluminium foil leaves.

Step 2: Cover the glass jar with cardboard, stabilise it with tape and make a small hole to insert the copper wire with the aluminium foil leaves.

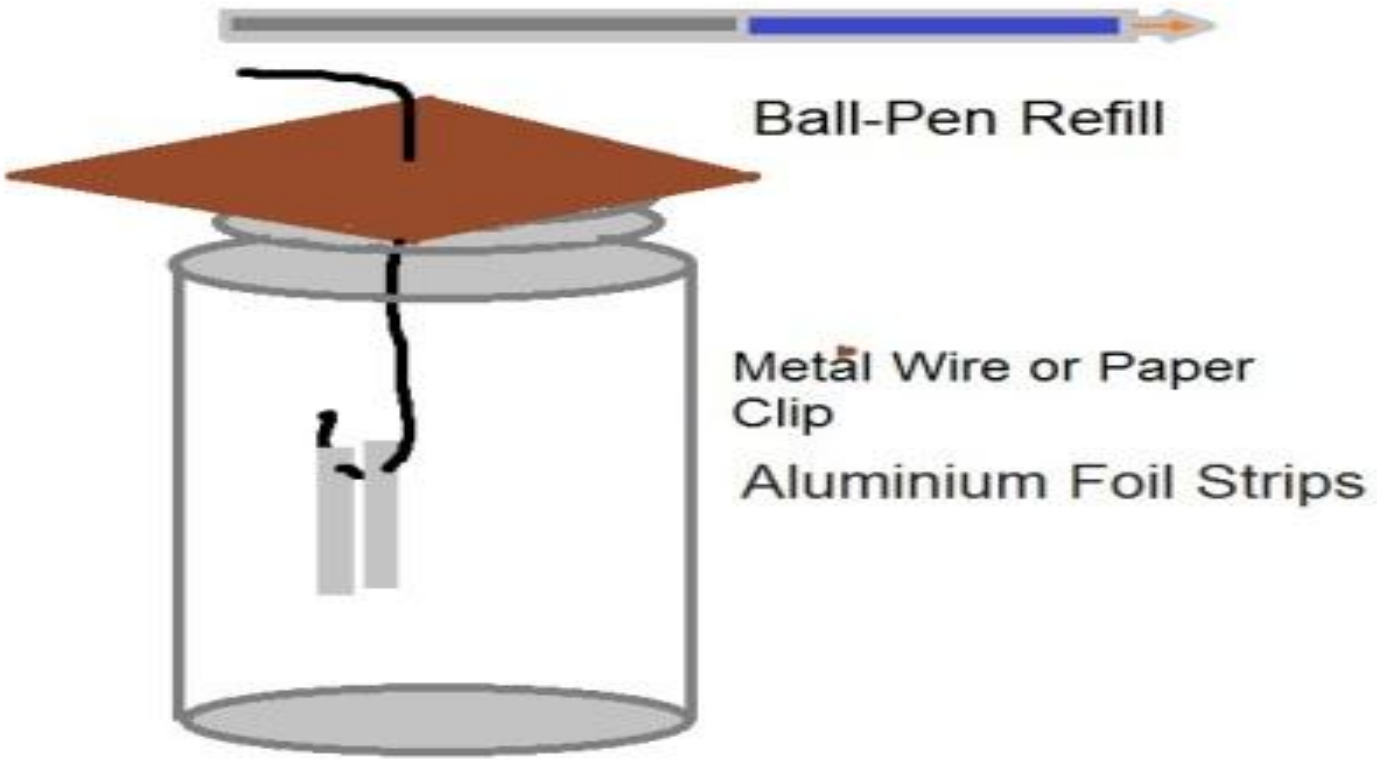
Step 3: Rub the straw on the tissue and then get the straw close to the edge of the copper wire which is outside the glass jar.

- What do you observe?
- Why you think is that happening?

(Brainstorming)

Write your conclusion.

Your electroscope should be something like this...



A simple electroscope to detect a charged body

Charging electroscope: done!

- What about discharging it?

- How can we do that and how much time will it take?

(Brainstorming)

Write your conclusion.

Let’s have a look!

https://www.youtube.com/watch?v=4aQOe98MC4s

Now, a little bit of history!

In 1912 Victor Hess set out to explore variations in the atmosphere's level of radiation, on board a flying balloon during an eclipse, which had been thought to emanate from the Earth's crust.

What did his measurements showed?

Radiation actually increased at greater altitudes and the Sun could not be its source.

So, where did this radiation come from??

Cross-curricular approach with Arts

Music: How do cosmic rays sound like?? (Activity using a musical instrument or sonification software).

Art: How do you imagine cosmic rays? Paint it!

Resources

Chaniotakis, M. (2020). Ionizing radiation and the electroscope (Lesson plan).

Nantsou, T. (2017). *Cosmology with simple materials.* Playing with Protons, Greece. Retrieved from: https://indico.cern.ch/event/618792/contributions/2695835/attachments/1521400/2378549/FINAL_2017_Playing_with_Protons_.pdf

Images

Image 1: https://images.app.goo.gl/Q9bDeC1WiQLr3B5s9

Image 2:
https://images.app.goo.gl/1PCWE3rHTyKbCjZk9

Image 3:

https://images.app.goo.gl/1W67oCEKj9Vw5fs3A

Image 4:

https://images.app.goo.gl/DqDWiZkso2xdCx66A

Image 5:
https://images.app.goo.gl/2GE7HtXQ3JC717AM6

Image 6:
https://images.app.goo.gl/3uWBkzxbm8oRKCGs7

Image 7:
https://images.app.goo.gl/HGydzVD4HzxeKwQc7

"Thank you so much for your time and attention!"