

Radiation in Space

Field: Physics

Age group: High school

Class: All

Length: Two hours (can be split into two lessons)

Study space: Classroom + lab

Description:

This activity will introduce us to the different types of radiation that exist. We will experience radiation by constructing a cloud chamber and then demonstrate how radiation can create a short circuit and damage electronic components. We will learn about radiation's potential danger and how to protect ourselves from it.

Rationale:

Radiation is a topic that frightens most people. But not everyone knows that “radiation” is a generic name for various physical phenomena, some of which are dangerous and some not at all. On his trip to space, Eytan Stibbe will be exposed to two types of radiation: cosmic and solar. On the spaceship Eytan will travel with, both the passengers and the electronic devices will be relatively well-protected from the dangers of cosmic radiation, but less so from solar radiation. Eytan will wear the AstroRad vest to demonstrate how astronauts can protect themselves from radiation without wearing cumbersome suits. We will learn more about this protective vest in the lesson. Eytan will also demonstrate the protective case for electronic components developed by the COTS program (which coordinates commercial deliveries to the International Space Station). We'll learn about this case in the lesson too.

Activity objectives:

1. To understand what solar and cosmic radiation are and know the difference between them.
2. To experience the radiation that reaches Earth and experiment with ways to protect ourselves from it.
3. To understand the potential danger of solar radiation and learn how we can protect ourselves from it.
4. To understand how the AstroRad vest works to protect its wearer from radiation.
5. To understand how the COTS-Capsule protects electronics from cosmic rays.

Type of learning:

In-person instruction, research (experiments), group work (Kahoot quiz)

Equipment:

- Materials for the “short circuit” experiment: 9V battery, steel wool, glass or ceramic plate
- Computer and projector
- Links:

Kahoot quiz: <https://play.kahoot.it/v2/?quizId=61b5bd11-c024-427f-8237-f15e0b4b7fbb>

Instructions for the “short circuit” experiment: <https://davidson.weizmann.ac.il/online/scienceathome/physics/>

Preparation:

Prepare the slideshow, experiment supplies, and links in advance. Additionally, make sure all the students have cell phones so they can participate in the Kahoot quiz.

Lesson:

(Note: scientific explanations can be found in the body of each slide and in the accompanying notes)

- Introduction: arousing students’ curiosity, getting them motivated, and connecting the topic to their previous knowledge (slides 1-4)
 - o What does the concept of radiation mean to you? Mentimeter word cloud (slides 2-3)
 - o Have the students take the Kahoot quiz to see what they already know about radiation (slide 4)
 - o Add to their knowledge as needed so all students have a basic background in the topic
- Explanation + experiment: electromagnetic radiation (slides 5-8)
 - o What is radiation? (slide 5)
 - o What is the electromagnetic spectrum? (slides 6-7)
 - o Experiment: protecting cell phones with aluminum foil. The experiment demonstrates that it is impossible to locate or call the protected phone (slide 8)
- Explanation + video: learning about solar and cosmic radiation (slides 9-20)
 - o Electromagnetic and nuclear radiation (slide 9)
 - o What is solar radiation? (slides 10-11)
 - o What is cosmic radiation? (slide 12)
 - o Story of the discovery of cosmic radiation (slides 13-19)
 - o Watch the video about the discovery of cosmic radiation (slide 17) (you can also switch the order and begin with the video)
 - o What is cosmic radiation made of? (slide 18)
 - o Explain the phenomenon of the northern and southern lights. You can incorporate pictures from the links below (slides 19-20)
- Explanation + video: protection from radiation (slides 21-29)
 - o Protection from radiation on Earth (slides 21-22)
 - o Protection from radiation in space (slides 23-24)
 - o Dangerous radiation – which radiation do we need to be careful with? How dangerous is it? (slides 25-27)
 - o Cloud chamber experiment (or watching the video of the experiment) (slides 28-29)
- Explanation: radiation damage in electronics (slides 30-35)
 - o Radiation can cause damage to electronic equipment. We have already seen this occur – radiation once even changed the results of an election (slides 30-32)
 - o Watch the video: how radiation changed the results of an election in Belgium (slide 33)

applies to additional electronic components, make sure to stress that this experiment is an “allegory” – since we cannot create a short circuit with radiation in the classroom, we create it using “iron particles” that are meant to simulate the charged particles (slides 34-35)

- Class discussion, explanation, and experiment: protecting electronics from radiation damage (slides 36-38)
 - o Class discussion – how do you think it is possible to protect electronics from radiation?
 - o Slideshow – possible protection solutions (slide 36)
 - o Introducing COTS’ protective capsule and describing the experiment Eytan will conduct in space (slides 37-38)
- Explanation: radiation damage in humans and the AstroRad vest (slides 39-48)
 - o Why do we need a new spacesuit? (slide 39)
 - o Watch the video about the AstroRad vest (slide 40)
 - o How does the vest’s structure both protect against radiation and offer improved ergonomics? (slide 41-42)
 - o The vest was tested first with simulations and then with Helga and Zohar – robotic dummies sent to space (slides 43-45)
 - o Eytan’s experiment in space will test out the ergonomics of the AstroRad vest and the feasibility of 3D printing it at the International Space Station. Hold a class discussion about 3D printing and recycling in space (slides 46-48)
- Kahoot quiz: what we’ve learned and summary (slides 49-50)

Reference Material

- “Short circuit” experiment:
<https://davidson.weizmann.ac.il/online/scienceathome/physics/אש-באמצעות-סוללה-קצר-והתחשמלות/>
- Protecting phones from radiation experiment:
<https://davidson.weizmann.ac.il/online/scienceathome/physics/איך-לחסום-קרינת-סלולר-ורדיו-—-כלוב-פאראדיי/>
- Remote radiation experiment:
<https://davidson.weizmann.ac.il/online/scienceathome/physics/איך-לחסום-קרינת-סלולר-ורדיו-—-כלוב-פאראדיי/>
- Cloud chamber:
<https://davidson.weizmann.ac.il/online/scienceathome/physics/איך-לחסום-קרינת-סלולר-ורדיו-—-כלוב-פאראדיי/>
- Article about cosmic radiation:
<https://davidson.weizmann.ac.il/online/askexpert/קרינה-בשחקים/>

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- Series of articles about the electromagnetic spectrum:

<https://davidson.weizmann.ac.il/online/maagarmada/astrophysics/מבוא-האלקטרומגנטי>

- Pictures of the northern lights from Earth:

<https://web.archive.org/web/20100902122923/http://www.twanight.org/newTWAN/gallery.asp?Gallery=Aurora&page=1>

- Pictures and videos of the northern lights photographed by NASA from the International Space Station

https://www.nasa.gov/mission_pages/sunearth/aurora-videos/index.html

- What is light? Crash Course Physics:

https://www.youtube.com/watch?v=7kb1VT0J3DE&ab_channel=CrashCourse

- Non-ionizing radiation – Davidson Institute website:

<https://davidson.weizmann.ac.il/tags/%D7%A7%D7%A8%D7%99%D7%A0%D7%94-%D7%91%D7%9C%D7%A%D7%99-%D7%9E%D7%99%D7%99%D7%A0%D7%A0%D7%AA>

- Is radiation dangerous? Ted Ed:

<https://ed.ted.com/lessons/is-radiation-dangerous-matt-anticole#review>

- What are cosmic rays? Davidson Institute website:

<https://davidson.weizmann.ac.il/online/askexpert/astrophysics/%D7%9E%D7%94%D7%9F-%D7%A7%D7%A8%D7%A0%D7%99%D7%99%D7%9D-%D7%A7%D7%95%D7%A1%D7%9F%D7%99%D7%95%D7%AA>

- How do cosmic rays help us understand our universe?

<https://blog.ed.ted.com/2014/10/14/3-brand-new-ted-ed-lessons-written-by-cern-scientists/>

- What is Aurora? Ted Ed:

<https://ed.ted.com/lessons/how-epic-solar-winds-make-brilliant-polar-lights-michael-molina>

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