Ages: 12 to 14 years old

SCIENCE CASE:

Why is there winter and summer?[1]

Members of the team

Writer: _____

Equipment management: _____

Reader: _____

Spokeperson: _____

Context

January is cold and July is hot. Why do you think is that?

Write your hypothesis here

[1] *Educational material manufacturated by "Asociación Planeta Ciencias" under the initiative and coordination of the European Space Agency inside the CESAR program framework.*

January is cold and July is hot… as long as you live in Europe. But someone from Australia would experience the opposite!: “January is hot and July is cold”.

Do you have a second hypothesis to explain this? (You can also draw it, if you wish)

Reasoning

Tycho Brahe carefully observed the paths of the planets at the end of the XVI century. After his death, in 1601, Johannes Kepler used those data to develop a set of laws that rule the way the planets orbit round the Sun. We already know that the Earth rotates and it translates around the Sun but, thanks to Tycho Brahe and Johannes Kepler, we also know that **the Earth is inclined 23º,** approximately. Which is to say, the *axis of the Earth* is not perpendicular to the plane of the solar system, but it has an inclination over it, as can be seen in Figure 1:

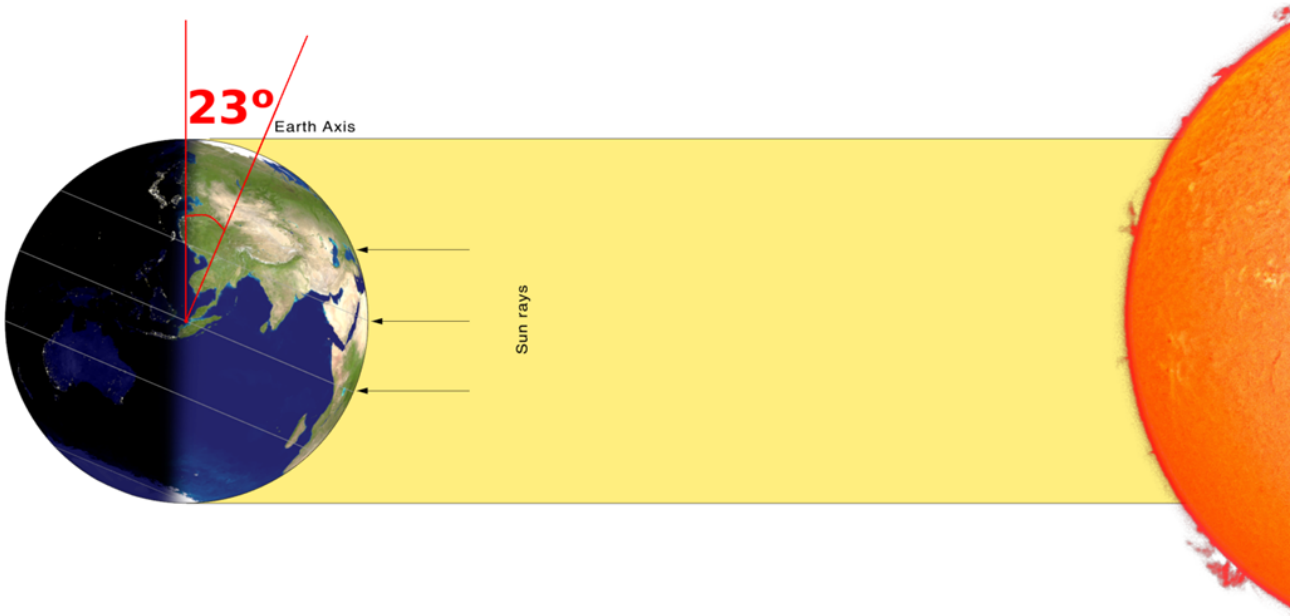

Figure 1: inclination of Earth. Credit: Planeta Ciencias (modified from wikimedia.org)

Look Figure 1 closely. Which hemisphere is the hottest? Why? *Take into account that during summer the Sun can be seen high over our heads, whereas in winter it cannot be seen so high.*

According to Figure 1, in what month would we be? Why?

Now look Figure 2:

Figure 2: Earth's inclination during winter and summer.
Credit: Planeta Ciencias (modified from wikimedia.org)

According to Figure 2, in what month would be in the Earth on the right? *Beware: the picture is not at scale, the Sun is further away from the Earth than what is shown here.*

In conclusion, why is there winter and summer?

Any remaining doubts? Go watch the following video:
http://www.esa.int/spaceinvideos/Videos/2017/01/Paxi_-_Day_night_and_the_seasons

Demonstration

One way to prove our reasoning is to perform a simulation of the system Earth-Sun at a smaller scaler.

Material for research

You can use the following:

- Sun model: Lamp with filament bulb.
- Planet Earth model, with 23º inclination.
- Digital infrared thermometer[2].
- Computer.
- Pencil, ruler, eraser, sharpener and worksheets.

Procedure

1. We can visualize the Earth in a circular motion around the Sun (even though the orbit is an ellipse). Once you have stablished the Sun-Earth system, you can picture where the Earth will be in different moments of the year: December, March, June and September.

2. Put the Earth 50 cm away from the light bulb in each season of the year, and fill the following table:

	TEMPERATURES			
	December	March	June	September
Nothern hemisphere				
Southern hemisphere				
Equator				

Conclusions

[2] *In case this piece of the equipment is not available, it can be substituted by other types of thermometers, or ounces of chocolate, which will melt sooner or later, depending on the inclination respect to the lamp.*

What did you observe? Why does the inclination of the Earth affect the temperature?

Observe the Sun-Earth model closely. There are four very special days during the year: between the 20th and 21st of March (equinox of spring), between the 20th and 21st of June (solstice of summer), between the 22nd and the 23rd of September (equinox de full) and between the 20th and 21st of December (solstice of winter)[3].

[3]These dates vary slightly each year.

What does it happen each of these days?

More educational resources:

CESAR: http://cesar.esa.int
ESA education: http://sci.esa.int/education/
Paxi - Day, night, and the seasons: http://www.esa.int/spaceinvideos/Videos/2017/01/Paxi_-_Day_night_and_the_seasons
ESA Kids: http://www.esa.int/kids/en/home
CESAR booklets: http://cesar.esa.int/index.php?Section=Booklets&ChangeLang=en