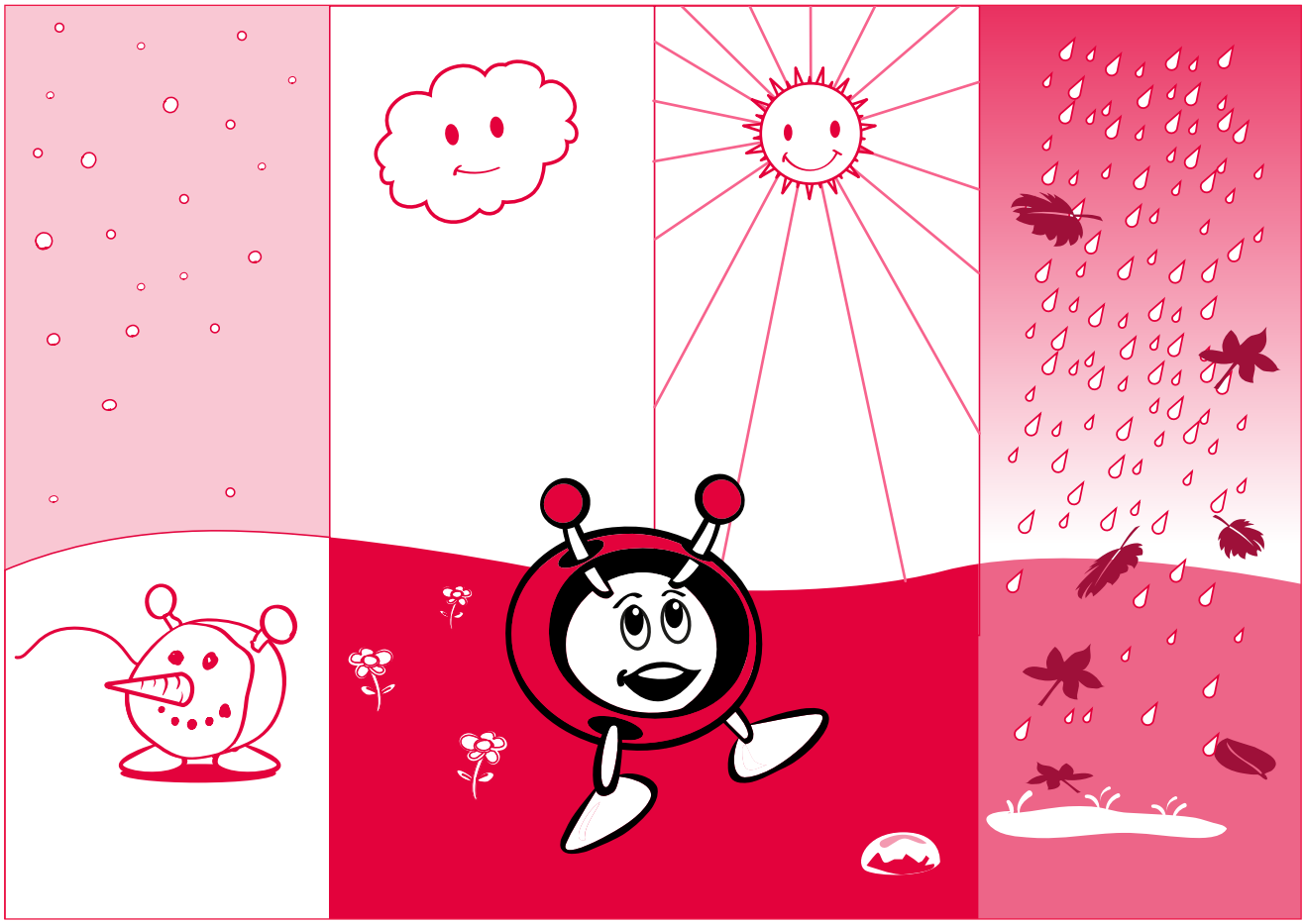
primary | PR45

teach with space

→ ONE YEAR ON EARTH

Understanding seasons



teacher guide & student worksheets

European Space Agency

teach with space – one year on earth | PR45
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→ ONE YEAR ON EARTH

Understanding seasons

Fast facts

Subject: Geography, Science

Age range: 8-12 years old

Complexity: easy to medium

Lesson time required: 90 minutes

Cost: medium (10-30 euros)

Location: indoors

Includes the use of: craft material, computer, internet

Keywords: Earth observation, Seasons, Climate, Vegetation, Geography, Science

Brief description

This resource is intended to foster and enhance pupils' knowledge of seasons, and focuses on the basic mechanism behind different seasons on Earth. The resource is divided into different parts, therefore enabling a gradual acquisition of the topic and content. The starting point is a general discussion about seasons by considering the changing colours on Earth over the course of a year. This is followed by a hands-on activity that aims to let pupils explore the influence of the Sun-Earth system on seasons.

Learning objectives

- Understand that some trees look different at different times of the year due to seasons.
- Understand that seasonal changes can also be seen from space.
- Explain the relationship between the Sun and the movement of the Earth, and its influence on daytime and night-time.
- Explain why there are seasons on Earth.
- Explain what influence the Sun has on the seasons.
- Analyse images and extract relevant information.
- Ability to work together and share conclusions.

→ Summary of activities

activity	title	description	outcome	requirements	time
1	Colours on Earth in the four seasons	Pupils assign the seasons, first to photographs of a tree and then to satellite images.	To become familiar with the four seasons and their influence on the appearance of some trees. In addition to finding out how the Earth changes colours (in the Northern Hemisphere).	None	30 minutes
2	Why does the Earth have seasons?	Hands-on activity to construct an experiment set-up to answer questions about the Earth-Sun relationship.	Understand the Sun's influence on the seasons.	None	60 minutes

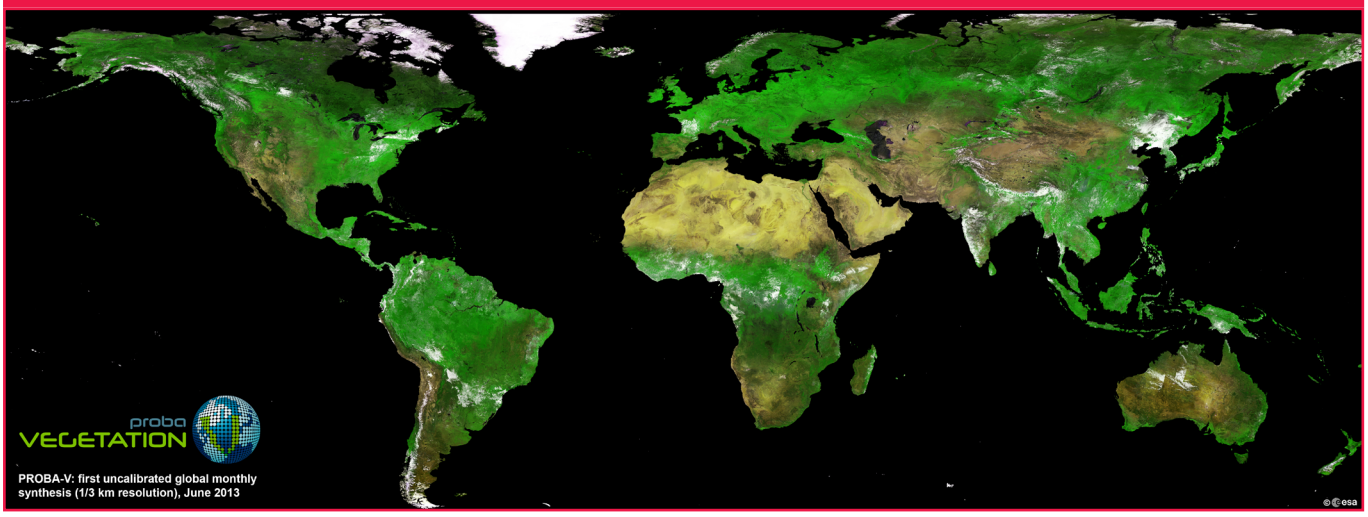
→ Introduction

The Earth takes 365 days, one year, to complete one orbit around the Sun. Over this period of time, changes are seen and felt, for example, days are shorter or longer, temperatures are higher or lower and colours in the nature around us change. These reoccurring cycles of weather conditions on Earth are called the seasons.

In plants, life cycle changes are often associated with seasonal patterns - such as the blossoming of leaves and flowers in spring and leaves falling in the autumn. The timing of seasonal life cycle events can be useful for understanding patterns of weather and climate.

Earth observation satellites can monitor seasonal changes on Earth from space. Satellites like the European Sentinel-3 carry instruments that can measure changing amounts of chlorophyll in plants, both in oceans and on land. They can also measure radiation emitted from the Earth's surface, revealing how the temperature of the land changes during the year. In addition, satellite data can be used to monitor the health of Earth's vegetation and to reveal how the colour of vegetation can change in a year! One ESA satellite specialised in observing vegetation is Proba-V, a minisatellite that is tracking global vegetation growth.

Figure 1



↑ Proba-V first global map.

→ Activity 1: Colours on Earth in the four seasons

In this activity, pupils will explore photos taken on Earth at different times of the year and then work with satellite images.

Equipment

- Student worksheet for each pupil

Exercise

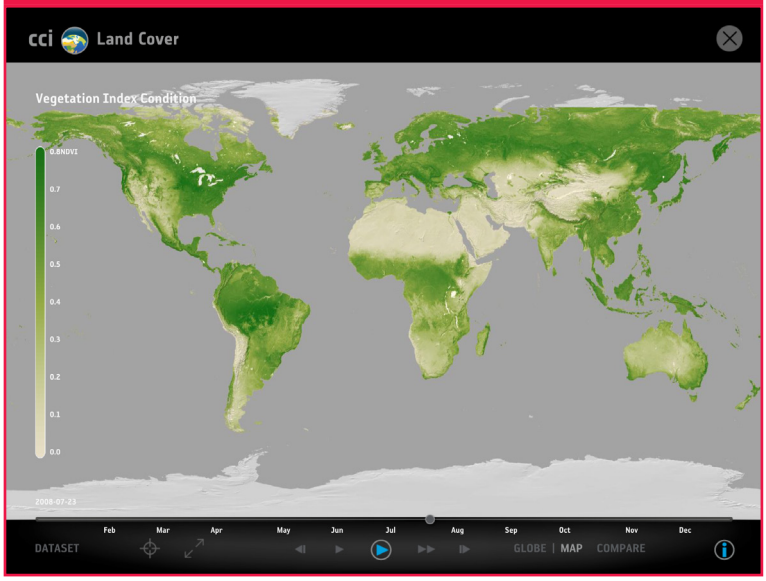
This activity can be done either as a classroom discussion or independently by the pupils using the worksheets. Teachers can choose to print the images of the tree and the satellite images (in Annex) and hand them out to the pupils. The satellite images were downloaded from the EO Browser, an online application where you can access ready-to-use images (see Links section).

1 - Ask pupils what the differences are between the images of the tree. Pupils can refer to the tree itself and the surroundings. The main focus will be on the colours of the image and if there are leaves on the tree. Discuss what time of the year each image was taken. The right order is 2-4-1-3. To connect to the pupils' daily lives, talk about what clothes they would wear if they stood next to this tree. If you can see a tree from your classroom, you could compare this tree to the four images and discuss which it looks most similar to.

2 - Pupils should look at the satellite images and discuss what time of the year they were taken. Relate the discussion to what they found out about the tree in part 1. The right order is 4-1-3-2. Conclude that the colours seen in the tree images can also be found in the satellite images and that it is also possible to observe seasonal changes from space.

Older students can also analyse satellite data showing vegetation index and observe how colours and plant health change globally at different times of the year. Scientists use this index to quantify the concentrations of green leaf vegetation around the globe. This is done by measuring the wavelengths and intensity of light reflected by the land surface back up into space. When looking at the vegetation and by analysing maps similar to the one in Figure 2 students can conclude that the seasons on the northern and southern hemisphere are opposite. Students can also conclude that close to the equator as well as the poles, there are areas with no or very little vegetation due to extreme climatic conditions.

Figure 2



↑ Vegetation index in summer (northern hemisphere) from the app "Climate from Space' (see Link section). White represents areas of no vegetation and dark green areas with a high density of vegetation.

3 – Based on their previous answers, pupils should be able to identify flowers blooming in spring or plants losing all their leaves in winter. Seasonal changes also include variations in day length or duration of sunlight as well as variations in weather conditions, such as, precipitation or temperature. As an introduction for the next activity teachers could ask pupils why do they think these changes take place.

→ Activity 2: Why does the Earth have seasons?

In this activity, pupils will investigate why the Earth has seasons. For that they will build an Earth-Sun model. They will learn that the Earth turns on its axis from West to East (anticlockwise); and discover that Earth is tilted on its axis and that this tilt is responsible for the seasons.

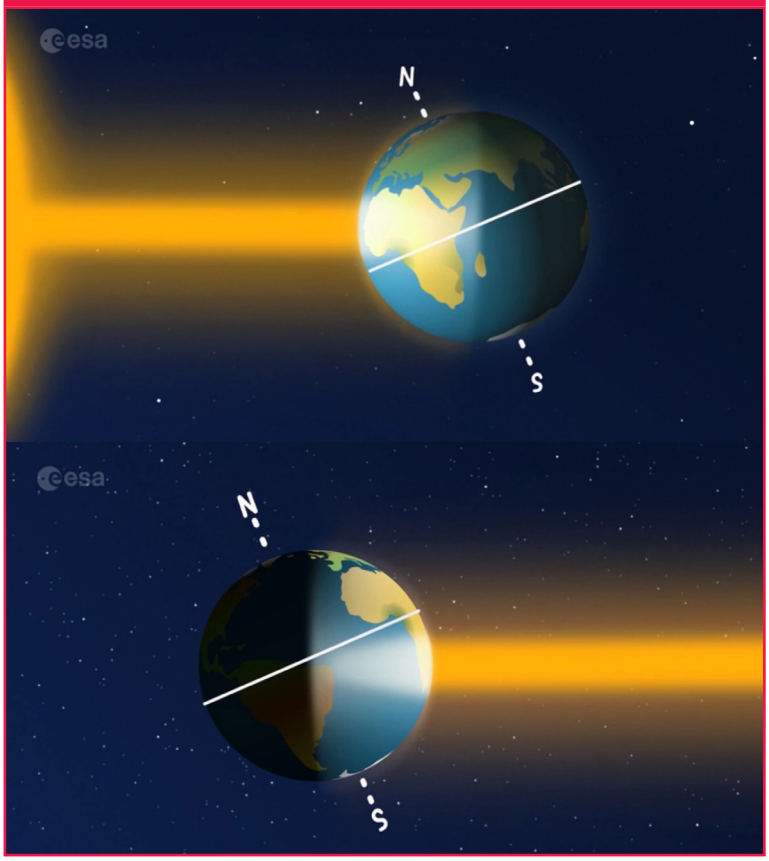
Background

The Earth orbits around the Sun once every year and spins on its axis of rotation once every day. This axis of rotation is tilted 23.5 degrees relative to the direction of Earth's orbit around the Sun. As Earth orbits the Sun, its tilted axis always points in the same direction. When the North Pole points towards the Sun, it is summer in the northern countries (northern hemisphere) (Figure 3 top) .

When the North Pole points away from the Sun, these countries have their winter (Figure 3 bottom). The seasons are the exact opposite to the south of the equator (southern hemisphere). The tilt of the Earth's axis is the main reason for the seasons.

During Summer, the Northern Hemisphere receives more directly sunlight than at any other time of year. The Sun appears higher above the horizon. This means that the sun's rays strike the ground more directly in Summer, warming it more efficiently.

Figure 3



↑ Schematic representation of Summer(top) and Winter (bottom) in the North Hemisphere. From Paxi animation on seasons (see Links section)

During Winter, the low angle of Sun means that incoming rays of solar radiation are more dispersed and spread over a larger area of ground, so the light received is more indirect and of lower intensity. Therefore, days will be colder.

Equipment

- Polystyrene sphere (approximately 10 cm diameter)
- Pen
- Small flag of your country
- 1 wooden skewer
- 2 sheets of A4 paper
- Sticky tape
- Drawing compass
- Torch
- Globe (optional)

Exercise

As an introduction teachers can ask the pupils what time they go to bed. Do they go to bed at the same time in the summer as in the winter? Do they find it harder to go to bed in the summer when it is still light outside? Conclude that during the summer the days are longer than during the winter.

Detailed instructions on how to run the exercise can be found in the student guide.

Part A – Build a Sun-Earth model

Pupils work in groups to complete part A on the worksheet . Give each group a polystyrene sphere, cocktail sticks and a pen. Explain that meridians are imaginary lines and that the equator is an imaginary horizontal line that runs the Earth midway between the North Pole and the South Pole. The Earth's axis is an imaginary line through the centre of the Earth from the North Pole to the South Pole. Use a globe to show this if you have one.

Part B - One year on Earth

Explain to pupils that the Earth completes a single orbit around the Sun in one year and a single rotation on its axis in 24 hours.

Make sure that the flag is facing the Sun; that the pupils do not change the tilt of their Earth's axis; and that they hold the torch at the same height as the equator.

Pupils should conclude that their country is not always in the same position in the lit area. In summer, European countries are closest to centre of the lit area and in winter, the country is furthest away.

Figure 4

↑ Experiment set-up for spring.

Part C - Long days, short days

This step adds the aspect of understanding day time and night time to the model. Make sure pupils turn the Earth anticlockwise when investigating the length of the days and that they do not change the tilt of their Earth's axis. Pupils should conclude that the season with the longest path is summer and the shortest occurs in winter.

Discussion

1. Pupils should use their conclusions from the previous sections to formulate their answer to this question. Due to the tilt of the Earth's axis, in summer the Sun appears to be higher in the sky (nearly directly above our heads or more overhead) so light and heat from the Sun reaches the Earth at a steeper angle in summer than it does in the winter. In winter the light and heat from the Sun is spread out over a larger area of the Earth's surface. Also, the days are shorter in winter, so the Sun cannot warm the Earth for as long as in summer.

2. After doing the experiment, pupils should deduce that when it is cold in their country in Europe, they have to travel to the Southern Hemisphere to find a warm beach for swimming.

→ Conclusion

Understanding why the Earth has seasons is one of the most difficult concepts for pupils to learn. Pupils should become aware that the tilt of Earth's axis affects the angle at which the Sun's rays strike Earth and this is what causes the seasons.

Teachers can summarise this activity by showing the Paxi video - Day, night, and the seasons (see Links section). In small groups, or as a class, pupils could then create their own short video (they could, for example, use the model they have built) to explain seasons and seasonal changes on Earth.

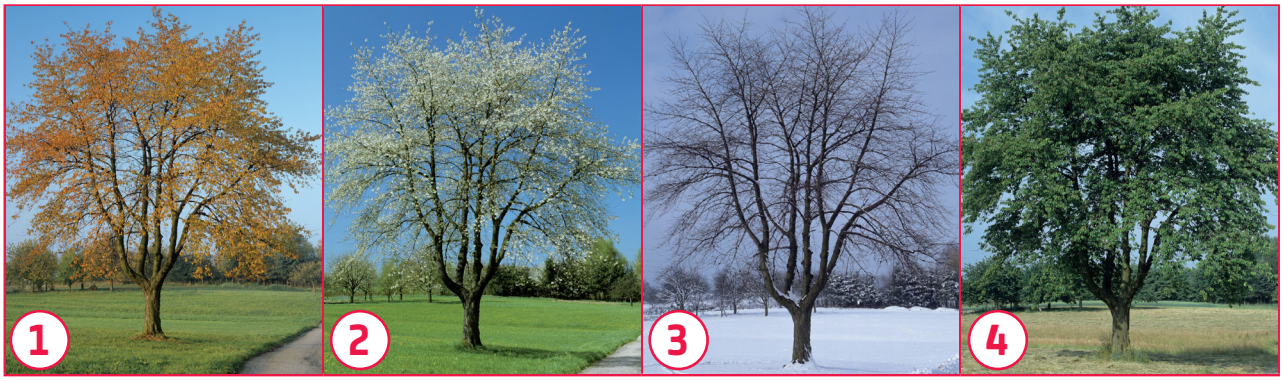
→ ONE YEAR ON EARTH

Understanding seasons

→ Activity 1: Colours on Earth in the four seasons

Exercise

1. Observe the pictures below that show one tree at different times of the year.



Assign the pictures to the different seasons of the year and explain your choice.

Spring Picture number: ___

Why ? _____

Summer Picture number: ___

Why ? _____

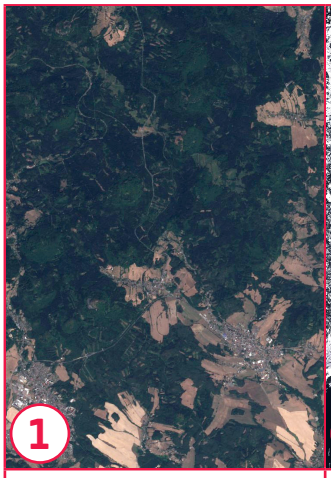
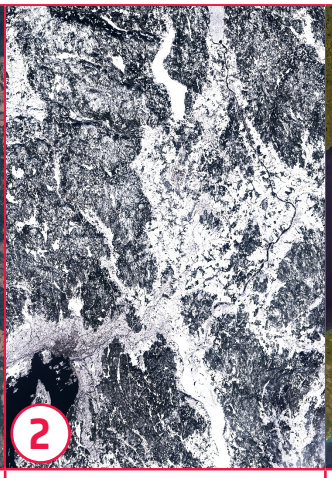
Autumn Picture number: ___

Why ? _____

Winter Picture number: ___

Why ? _____

2. You will now look from up high! The pictures below were taken by satellites orbiting the Earth and show different places on Earth at different times of the year.

			
Landscape in Czech Republic	Landscape in Norway	Forest in North America	Blooming of tulips in the Netherlands

Assign the pictures to the different seasons of the year and explain your choice.

Spring Picture number: ____

Why ? _____

Summer Picture number: ____

Why ? _____

Autumn Picture number: ____

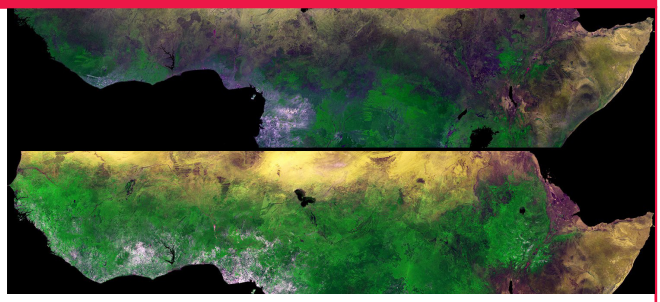
Why ? _____

Winter Picture number: ____

Why ? _____

3. Discuss with your classmates the natural events that happen at different times of the year that can help you identify seasons. Identify at least two events.

Did you know?



Plants respond to seasonal variations of temperature and precipitation driven by weather. Changes to the growing period of plants have a direct effect on food production and for this reason it is very important to monitor the health of vegetation and plants. Proba-V is a miniaturised ESA satellite that can map vegetation growth across the entire planet every two days. In dry environments, like some areas of Africa, it can be difficult to grow plants for food. In the satellite images you can see the Sahel in Central Africa before and during the rainy season. The rain made it possible for the plants to grow!

→ Activity 2: Why does the Earth have seasons?

Many areas on Earth appear in different colours over the four seasons. But why do we have the seasons? In this experiment, you will construct your own Earth-Sun model, which will help you to understand the reason why there are seasons on Earth, along with some of their characteristics.

Equipment

- Polystyrene sphere
- Pen
- Small flag of your country
- 1 wooden skewer
- 2 sheets of A4 paper
- Sticky tape
- Drawing compass
- Torch

Exercise

Part A - Build a Sun-Earth-Model

1. Draw a dot on the top and on the bottom of the polystyrene sphere (that represents Earth). Make sure the dots are on directly opposite sides of the globe. These are the North Pole (**N** on the top) and the South Pole (**S** on the bottom).

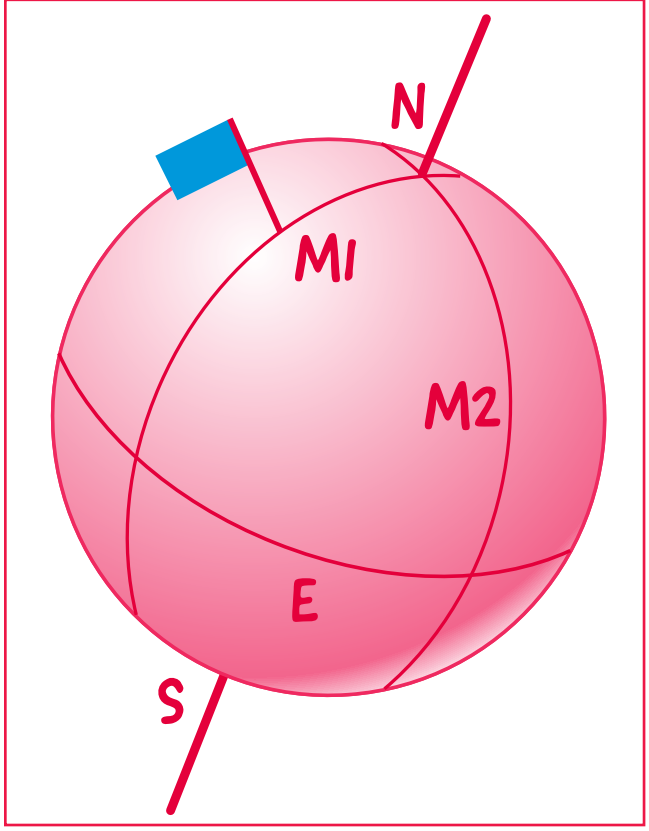
2. Divide your globe into four equal parts by drawing vertical lines (**M1**, **M2**) from the North Pole to the South Pole. These lines are called meridians.

3. Draw a horizontal line around the middle of the globe (**E**). This is the equator.

4. Stick the little flag into one of the meridians, halfway between the equator (E) and the North Pole (N). The flag represents your country on the globe in Europe.

5. Push one wooden skewer into the North Pole (N) that goes through the South Pole (S). This stick represents the Earth's axis.

Figure A1



↑ Set-up of the globe.

You have just build a model that represents Earth. You will now draw the path of the Earth's orbit around the Sun

6. Stick together two sheets of A4 paper along the longer side using sticky tape. Use the compass to draw a circle with diameter of 25cm. This circle represents the path of the Earth's orbit around the Sun.

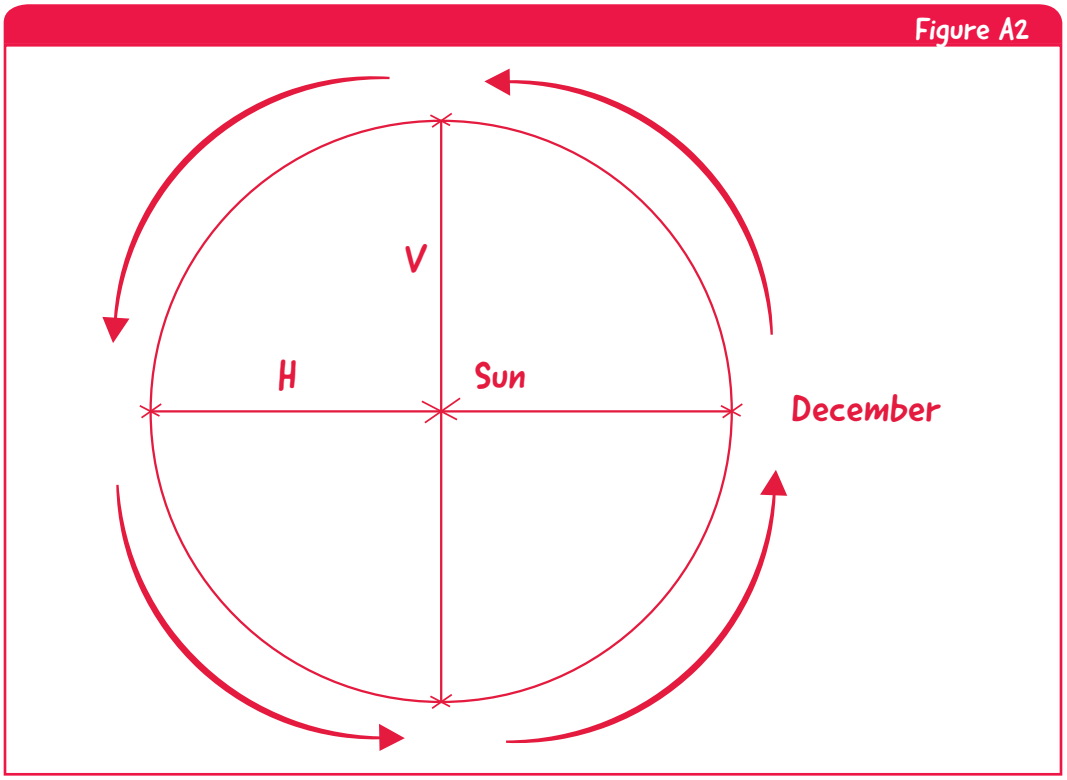
7. Mark the middle of the circle with a cross and write '**Sun**' next to it. Draw an arrow next to the circle in an anticlockwise direction as shown on Figure 2. The arrow shows in which direction Earth orbits around the Sun. It takes the Earth (about) one year to make one orbit around the Sun.

8. Draw a horizontal line (**H**) and a vertical line (**V**) through the centre of the circle and make sure they are perpendicular to each other. Draw a cross at the points where these lines cross the circle, as shown on Figure 2. Considering the time that Earth takes to finish one orbit around the Sun, the time difference between each cross is three months.

9. Write 'December' next to the right-hand cross and add the correct months next to the other three crosses.

You have just built a model to represent the movement of the Earth around the Sun!

Figure A2

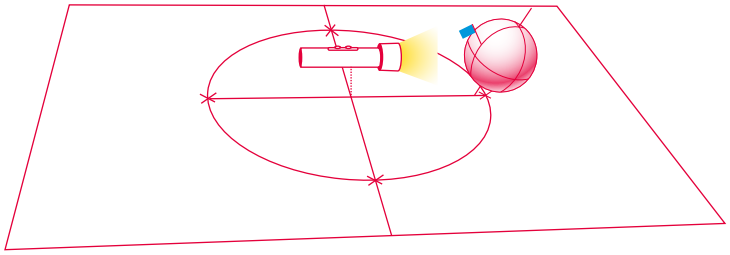


↑ Set-up of the paper

Part B - One year on Earth

1. Hold your globe above the cross where you wrote 'December'.

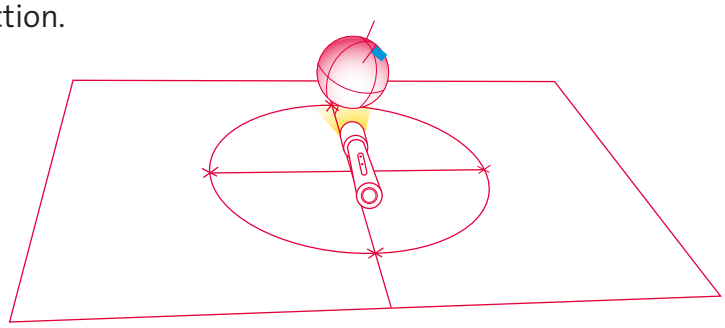
a. Make sure you tilt the Earth's axis as shown in the image.
b. Add sunlight to your model: hold the torch above the cross in the middle where you wrote 'Sun'. The Sun has to be at the same height as the equator.
c. Make sure it is day in your country where the flag is: move the flag so that it is facing the Sun and check again the tilt of the Earth's axis.
d. Observe the area on the globe that is illuminated by the Sun.



Which season is it in your country?

_____

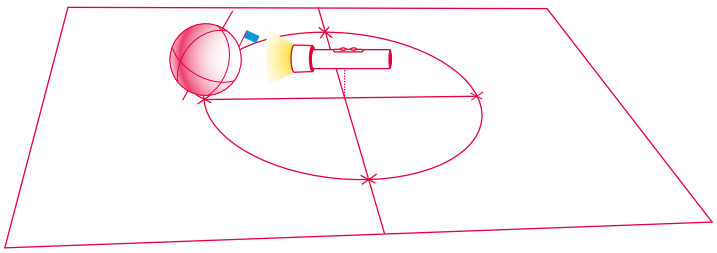
Move the globe to the next cross. Repeat steps 1a) to 1c). Don't forget that the Earth orbits around the Sun in an anticlockwise direction.



Which season is it in your country?

_____

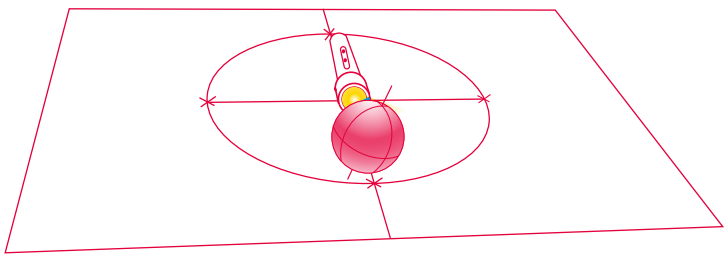
Move the globe to the next cross. Repeat steps 1.a. to 1.c.



Which season is it in your country?

_____

Move the globe to the last cross. Repeat steps 1.a. to 1.c.



Which season is it in your country?

_____

1. Circle the correct answers.

- Is your country always in the same position within the lit area? *yes / no*
- In the summer, your country is *nearest/furthest* away from the centre of the lit area.
- In the winter, your country is *nearest/furthest* away from the centre of the lit area.

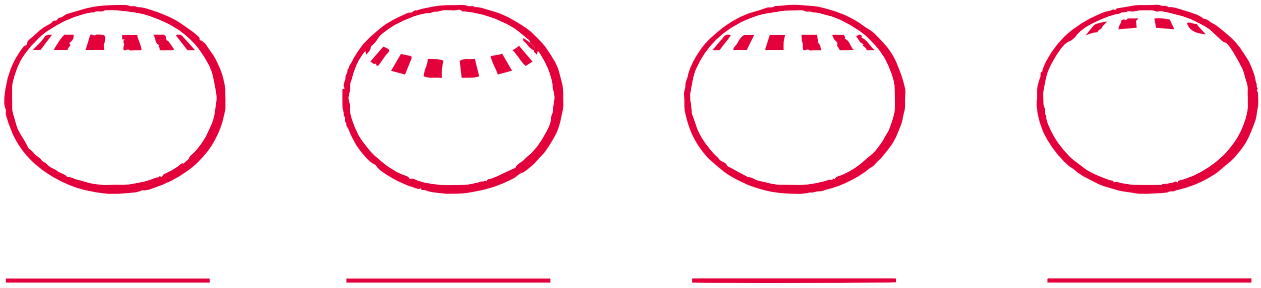
Part C – Long days, short days

1. Repeat the orbit of the Earth around the Sun with your model. This time, at each cross on the circle, turn your globe slowly to the left until the flag is again facing the Sun. You will observe day and night in your country.

2. Observe how the position of your country with respect to the Sun changes during the day.

3. The drawing below shows four frontal views of the Earth. Each drawing shows how the position of your country with respect to the Sun changes during the day.

   a. Under each drawing, write which season is shown.



   b. In which season does your country travel the longest path through the lit area? And in which season the shortest?

      The season with the longest path is: _____

      The season with the shortest path is: _____

Discussion

1. Why is it hotter in your country in the summer than in the winter? Give two reasons.

2. Imagine it is winter and you want to go to a beach where it is warm and you could go swimming. Where would you go? Explain your answer!

→ LINKS

ESA resources

ESA classroom resources
esa.int/Education/Classroom_resources

ESA Kids
esa.int/esaKIDSen

Paxi animation on seasons
esa.int/spaceinvideos/Videos/2017/01/Paxi_-_Day_night_and_the_seasons

ESA space projects

Sentinel-3 mission
http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinel-3

Proba-V mission
https://www.esa.int/Our_Activities/Observing_the_Earth/Proba-V

ESA's Climate Change Initiative
http://cci.esa.int/

Extra information

ESA app 'Climate from Space'
esa.int/Our_Activities/Observing_the_Earth/Space_for_our_climate/Climate_at_your_fingertips

EO Browser
https://www.sentinel-hub.com/apps/eo_browser

→ Annex 1

→ Annex II