**Explaining summer**

Many countries are not close to the Equator.

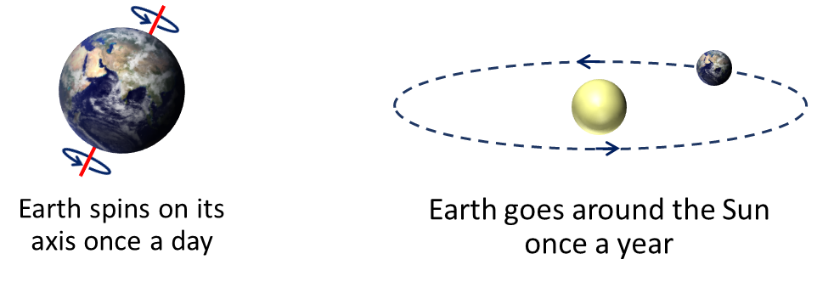
In summer it is warmer than usual in these countries.

In winter it is cooler.

The Earth spins on a tilted axis.

It spins round once each day.

It orbits the Sun once each year.



These statements are about the reasons for summer and winter.

Some are right and some are wrong.

Use *some* of the statements to explain why it is warmer in summer.

The Earth is closer to the Sun.

One half of the Earth is tilted towards the Sun.

The Sun is lower in the sky.

Heat radiation from the Sun is less spread out when it reaches the ground.

There is less heat radiation from the Sun.

As the Earth spins, this part of the Earth is in daylight for longer than darkness.

The Earth is further from the Sun.

One half of the Earth is tilted away from the Sun.

The Sun is higher in the sky.

Heat radiation from the Sun is more spread out when it reaches the ground.

There is more heat radiation from the Sun.

As the Earth spins, this part of the Earth is in darkness for longer than daylight.

It is warmer in summer because …

Explaining summer cards

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*Physics > Big idea PES: Earth in space > Topic PES2: Earth and Sun > Key concept PES2.1: Days and seasons*

|  |
| --- |
| **Response activity** |
| **Explaining summer** |

**Overview**

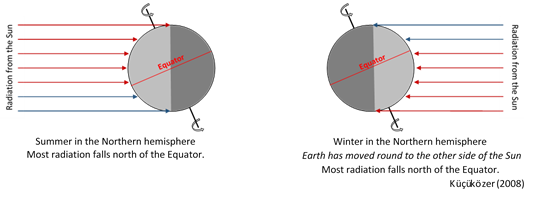
|  |  |
| --- | --- |
| Learning focus: | The temperature is higher in the summer because the tilt of the spinning Earth increases the length of a day and increases the heating effect of the Sun’s radiation. |
| Observable learning outcome: | Explain why average temperature is higher in summer and lower in winter. |
| Activity type: | Explanation story |
| Key words: | Radiation, heating, heat radiation, Equator |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Hot summer days

**What does the research say?**

In the summer one reason temperatures are higher is because the part of the Earth experiencing summer is tilted towards the Sun. This means the Sun is higher in the sky and the radiation from it is spread out over a smaller area of land giving a bigger heating effect. Ojala (1992) suggested representing the uneven distribution of the Sun’s radiation over the Earth’s surface with a diagram that shows how equal amounts of radiation spread. Küçüközer (2008) used a computer simulation to show what proportion of all radiation reaching the Earth fell above or below the equator during the summer and the winter.



In text book diagrams, rays representing radiation from the Sun reaching the poles appear significantly longer than those reaching the equator. Such diagrams can reinforce the misunderstanding that it is warmer in the summer because we are closer to the Sun. When students encounter these diagrams for the first time they often do not have an accurate understanding of scale and do not realise that the differences in distances here are too small to make a noticeable difference to temperature (Ojala, 1992; Ojala, 1997). Ojala also found that the common practice of showing all four seasons on one diagram caused confusion and suggested using a separate diagram for each season.



The most common reason students (wrongly) give for why it is warmer in the summer is the Earth being closer to the Sun at that time (Allen, 2014; Driver et al., 1994; Baxter, 1989). Bakas and Mikropoulos (2003) found that Greek students aged 11-13 (n=102) were more likely to explain that higher temperatures in summer are caused by the Sun being higher in the sky, or because the days are longer, but without explaining the cause of these phenomena.

Constructivist teaching strategies that challenge student misunderstandings were shown to significantly improve knowledge about the causes of seasons (Trumper, 2006) and elicit longer retention of the scientific concepts (Tsai and Chang, 2005).

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It is best done as a pencil and paper exercise.

Students should read the statements and follow the instructions on the worksheet. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

The task may be extended by asking students to use other cards from the pack to explain why it is cooler in the winter. Students could also be asked to explain what season they expect it to be in South America when it is summer in North America.

Both of these extensions are on the PowerPoint as extra slides.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as the scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

It is warmer in summer because …

One half of the Earth is tilted towards the Sun. As the Earth spins, this part of the Earth is in daylight for longer than darkness. (So days are longer and this part of the Earth is heated for longer each day.)

The Sun is higher in the sky. Heat radiation from the Sun is less spread out when it reaches the ground. (So it heats each part of the ground more strongly/quickly.)

*It is also true that when the Sun is higher in the sky the radiation passes more directly through the atmosphere. This means less radiation is scattered away from the surface of the Earth and more of the heat radiation reaches the ground. It may be helpful to use these ideas to extend understanding for some students.*

It is cooler in winter because …

One half of the Earth is tilted away from the Sun. As the Earth spins, this part of the Earth is in darkness for longer than daylight. (So days are shorter and this part of the Earth is heated for less time each day.)

The Sun is lower in the sky. Heat radiation from the Sun is more spread out when it reaches the ground. (So it heats each part of the ground less strongly/quickly.)

When it is summer in North America …

B … it is winter in South America.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG); Summer scene: <https://pixabay.com/vectors/landscape-twilight-light-night-1844229/>; winter scene: <https://pixabay.com/vectors/landscape-winter-ice-cold-xmas-2024099/>; globe 1: CC0 Public Domain; globe 2: <https://pixabay.com/vectors/globe-earth-continents-planet-296471/>.

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