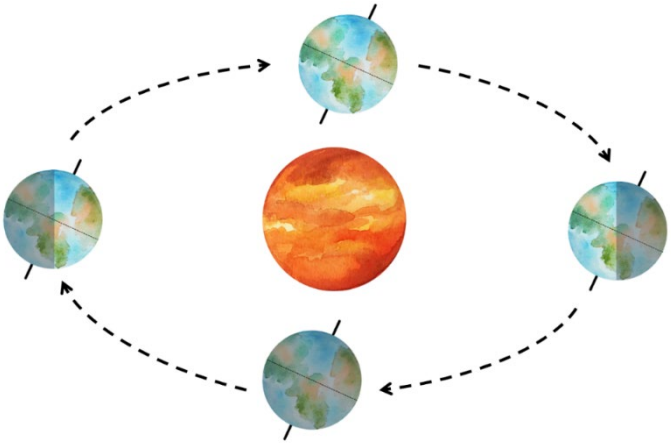
What Causes Seasons -Teacher Notes

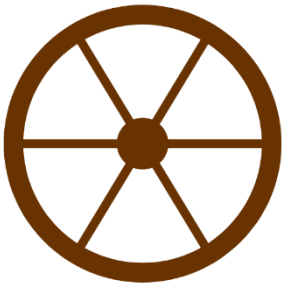
Earth's Orbit

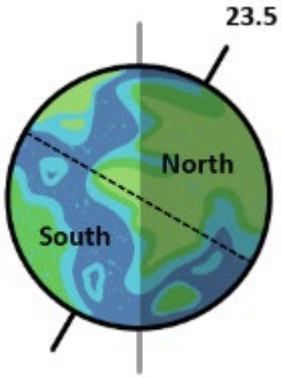
Many people think seasons are caused by Earth being closer to the Sun at that time of year. It is true that Earth has a slightly elliptical (oval shaped) orbit and that at some times of the year it is closer or further from the Sun. However, as it turns out, we are closest to the Sun when it is winter in the Northern Hemisphere and summer in the Southern Hemisphere. So, if it is summer and winter at the same time, there must be something else responsible for our seasons.



What is the Earth's axis?

Earth is a bit like a wheel which spins around in circles around a central axle. Here the "axle" is called Earth's axis and instead of spinning around a horizontal axle like wheels, Earth currently has a tilt of approximately 23.5 ° from vertical. The Earth makes one complete turn each day. As Earth orbits the Sun it spins on its axis, giving us day and night.





The Earth's tilt remains consistent throughout a year's journey around the Sun, pointing towards the same position in space. The North Pole consistently points towards the North Star (Polaris). Scientists believe that a large object called Theia collided with Earth not long after it formed which caused the Earth to tilt.

Seasons Explained

Earth's tilted axis causes the seasons. Throughout the year, different parts of Earth receive more sunlight than others and that sunlight is more concentrated. When one pole tilts towards the Sun, it receives more sunlight, which is also more concentrated, while the opposite pole tilts away from the Sun giving it less sunlight, which is also more dispersed.

So, when the North Pole tilts toward the Sun, it is summer in the Northern Hemisphere and winter in the Southern Hemisphere, and when the South Pole tilts toward the Sun, it is summer in the Southern Hemisphere and winter in the Northern Hemisphere.

It is summer in December in the Southern Hemisphere because more of the Sun's rays hit that part of Earth more directly than at any other time of the year. You should note at this time of year the Sun is more directly overhead at midday, days are longer and therefore there is a much greater heating effect on the Southern Hemisphere.

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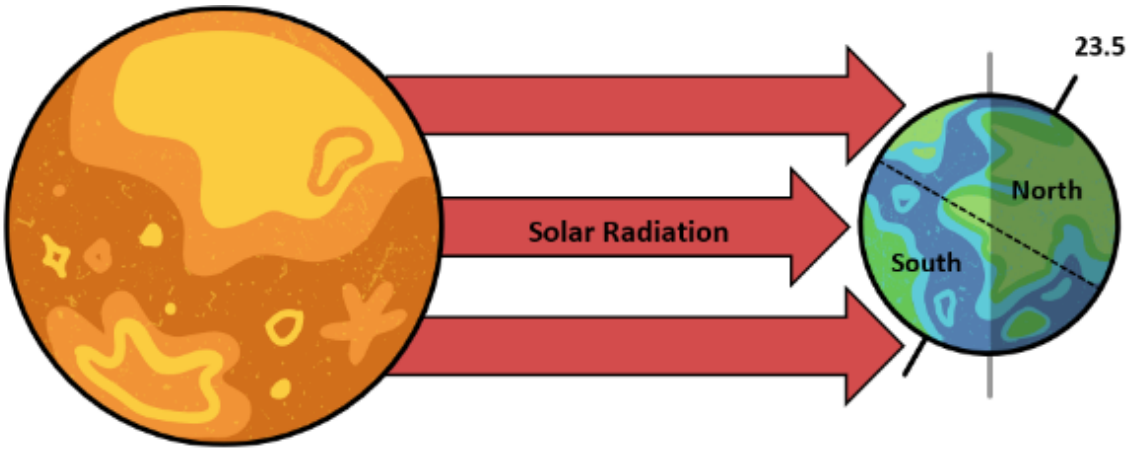

Aim

To understand the relationship between the angle of heating of a surface and surface temperature.
To measure the temperature of a surface under direct and indirect lighting.
Measuring angles accurately.

Materials

A lamp that has a high wattage incandescent globe or heat lamp e.g., 100W
Ruler
Piece of A4 graph paper
Protractor
Pencil
Clipboard folder
Timer
Digital thermometer

Method

1. Attach your graph paper to the clipboard and place it flat on the desk, with the lamp 2-5cm above it. Your lamp should be at 90 ° to your graph paper.
2. Place a thermometer directly under the lamp, in the centre of the illuminated area. Measure the temperature of the graph paper. Turn on the light for 2 minutes and record the temperature every 30 seconds in the table below.
3. Draw a shape on the graph paper the approximate size of the illuminated area. Estimate the area in cm^2 and record below.
4. Repeat the steps above changing the angle of the lamp to 70 °. Do not change anything else about the lamp besides the angle its light hits the paper. Place the thermometer in the middle of the illuminated area and repeat the process of recording the temperature of the paper. Mark the illuminated area with a different coloured pen this time.
5. Repeat again, increasing the angle to 50 ° then 30 °.

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Temperature of graph paper at different angles over time

		Temperature at 30 second intervals				
		Time (s)				
Angle of lamp (°)	Area of light cm^2	0	30	60	90	120
90						
70						
50						
30						

You will have varying results here but overall; they should show that a larger area is illuminated but it has less of a heating effect due to the heat being spread over the larger area.

Discussion

Cross out the incorrect words below and then answer the following questions.

- As the angle of the light changed from 90 ° to 30 °, the area of light increased.

- As the angle of the light changed from 90 ° to 30 °, the temperature of the paper went down every time. *Note: this may vary in reality.*

1. At which angle was the light most intense/ direct onto the paper? 90 °

2. At which angle was the light least intense/ direct onto the paper? 30 °

3. Describe the relationship between the intensity of the light and the temperature of the paper?
   This is a direct relationship, as the intensity of the light goes down, so does the temperature. However, there may not be a precise mathematical relationship.

4. Describe the relationship between the angle of the light and the temperature of the surface.
   This is also a direct relationship, as the angle decreases so does the temperature of the surface. However, there may not be a precise mathematical relationship.

5. Was this a fair test? Explain your answer and how you could improve the activity.
   No. When the light's angle was lowered parts of the lamp were closer to the paper and parts were further away making an accurate comparison difficult.
   Therefore, we should choose the middle of the lighted section from which to take the measurement.

Conclusion (cross out the incorrect response)

The more directly the Sun's energy hits the Earth the greater the heating effect.

Extension

Try the same activity with a solar panel and a voltmeter. Measure the voltage produced when the solar panel is at different angles to the light/Sun.

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