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|  | Australian Curriculum Year 7 Science sample assessment ׀ Sample response  Why do the seasons change? |

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### Observations:

* Climate is the typical weather of an area and there seems to be distinct climate zones over the Earth.
* I love the tropical climate of Far North Queensland.

#### Scientific explanation

Distinct **climate** zones can be observed on the Earth. Climate of an area is determined by its altitude, temperature, winds, water availability and its latitude on the Earth. Using latitude to name zones:

* tropical climate around the equator is the hottest
* subtropical between the Tropics of Cancer and Capricorn
* temperate climate is cooler
* polar climate around the Arctic and Antarctic circles, the coldest.

The climate zones are so different because the earth is a sphere causing some areas to receive more **solar energy** than others.

Solar energy reaching the earth near the equator is spread over a small area giving much light and heat. However; at the poles the same amount of energy is spread over a larger area causing there to be less light and heat.

Another way to look at this is that around the equator, between 23° north and 23° south latitudes the sun hits the earth directly, close to 90°. Everywhere else the sun’s energy hits the earth at an angle. At the poles, the angle is the smallest so the least amount of energy reaches there, causing them to be very cold.

#### Representation

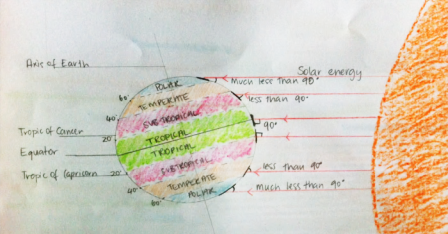


Diagram 1: The tilt of the Earth’s axis causes different climate zones.

#### Features of the Model

Feature 2 shows that the earth is a sphere. If lines were drawn from the sun to the earth to represent solar energy hitting the earth the different angles could be seen.

Feature 5 shows that the earth is always at the same distance from the sun and the height of its orbit doesn’t change. If it did, this would mean the climate zones on earth would also change.

#### Patterns and timeframe

The earth is a sphere so the angle of the sun’s energy hitting the earth follows a pattern from the equator out to the poles. Therefore the climate zones follow the same pattern from the equator to each pole.

Since the shape of the earth is not likely to change, this pattern of climate zones will also stay the same for millions of years. However, scientists studying Paleoclimatology, use sediments, ice cores, tree rings and coral to predict ancient climates. This shows that the climate of a particular area may have changed over time.

# **Observations:**

* Locations around the equator have nearly even day and night times, but near the poles locations show a bigger difference in daylight hours over a year.
* In Antarctica there are usually two weeks in midwinter, around June 21, when the sun does not rise, and a couple of weeks in summer, around Christmas, where there is 24 hours of sunlight.

#### Scientific explanation

Diagram 2 shows that closer to the equator, such as Thursday Island, places don’t have much change in their day length over a year. However, places closer to the poles, such as Hobart, show bigger changes in day length over a year. This is because the axis of the earth is tilted and stays in the same position as it rotates around the sun.

If the Earth was not tilted there would be no change in daylight hours over a year, the sun would rise and set at the same times every day.

Equinox is when the day length and night length are equal. It happens twice each year when the sun is directly over the equator at midday (Diagram 3). The solstice is the opposite. That is, when the day length is either the shortest (in winter) or the longest (in summer). Diagram 3 shows the position of the sun on these days. This occurs because the sun appears to be at its lowest or highest points in the sky at midday.

During the summer solstice the arctic has nearly three months of sunlight because it is always facing the sun in this position. The opposite is true during winter when the Arctic faces away from the sun for about three months.

#### Representations



Diagram 2: Daylight hours for Thursday Island and Hobart



Diagram 3: The position of the earth at the equinox and solstice

#### Features of the model

Feature 3 shows that the earth’s axis is tilted and stays in the same position in space even when the earth revolves and rotates around the sun, shown by Feature 6.

#### Patterns and timeframe

The pattern is roughly equal day and night hours near the equator but bigger changes occur near the poles where there are more daylight hours in summer and less in winter. Patterns in day length occur yearly because they are caused by the earth’s changing position in its rotation around the sun. Because the earth’s orbit does not change the pattern of day length stays the same from year to year. Therefore the day length for any location can be accurately predicted many years ahead. Ancient cultures even celebrated the solstices thousands of years ago.

### ***Observation***:

* A total solar eclipse occurred in 2012 but it only lasted a few minutes and the next one seen in Australia will be in 2028.

#### Representation

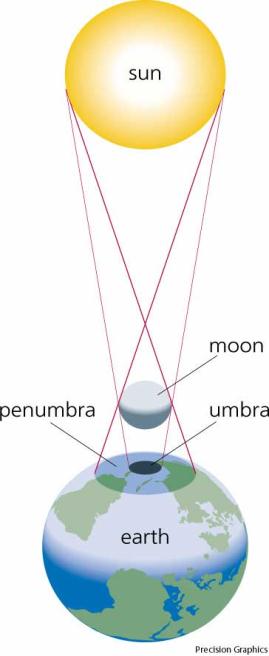


Diagram 4: The moon can cause a solar eclipse

#### Scientific explanation

An eclipse occurs when one object passes in front of another so that it can’t be seen. There are two types of eclipses: lunar and solar. The moon can appear to cover the sun even though it is many times smaller. This is because the moon is just far enough away to appear to be the same size as the sun which is much further away. Diagram 4 shows how a view of the sun can be eclipsed by the moon. This only appears to happen for part of the earth at once. In November, 2012 some of Australia could see (with safety glasses) the moon move in front of the sun. It started at 6:55am, reached its zenith (highest point) at 8:07am and ended at 9:33am. The total darkness only lasted a few minutes because the moon continued to orbit the earth on its daily rotation. The moon takes 27 days to orbit the earth and has an elliptical path like the earth. Sometimes the earth will pass between the sun and the moon.

#### Patterns and timeframe

The orbit of the moon takes 27 days and causes the different phases seen over a month. However, it is very rare that the earth, moon and sun are all in line to cause a solar eclipse. This happens every 18 years because of the elliptical orbits of the earth and moon and the different planes they are on. It is predictable because the orbits do not change over time. However, the moon is slowly getting further away from the earth and so in 600 million years there will be no more solar eclipses for the earth to see.

#### Features of the model

The model shows that the moon is much smaller than the earth in Feature 5 and that the sun is a long distance from both the earth and the moon. It also shows that the moon can rotate around the earth.

### ***Observations***:

* Traditional ecological knowledge shows that plants and animals have grown and moved in predictable ways for thousands of years, following seasonal patterns.
* When its winter in the southern hemisphere, its summer in the northern hemisphere.

#### Scientific explanation

Many people think that hot seasons are where the earth is closer to the sun and cold seasons where the earth is further away from the sun. This cannot be true because summer and winter occur at the same time in different parts of the planet.

Seasonal patterns are caused by both the earth’s tilt and its orbit around the sun. The axis of the earth is not vertical but is tilted at an angle of 23.4°possibly due to a large impact when the earth was forming. It takes 365 days for the earth to orbit or rotate around the sun and the axis always points in the same direction. This means that during a year as the earth orbits the sun the southern hemisphere is pointed towards the sun then is pointed away from the sun (Diagram 5.) This causes changes in seasons in the same way as day length.

Places near the equator are less affected by the tilt so those areas don’t have as much change in temperature from season to season. However, closer to the poles there is a greater effect of the tilt and the different seasons are more noticeable.

#### Representation



Diagram 5: Seasons change as the earth orbits the sun

#### Features of the model

Feature 3 shows the tilt of the earth’s axis and that it is fixed in position. It is difficult to tell whether this model will show that when the arm makes the earth orbit the sun, the axis stays pointing in the same direction.

However in Feature 6, the arm in the model would make a circular path around the sun, even though in real life the path is an ellipse.

#### Patterns and timeframe

The rotation of the earth around the sun takes one year therefore the seasonal patterns occur from year to year.

The pattern of seasons within a year depends on the location. In the tropics the seasons are often described as wet and dry, or hot, wet and cold and can be between one and six months long. Indigenous weather knowledge or Traditional ecological knowledge shows that these same patterns have been followed for thousands of years. Other cultures, in temperate on sub-polar regions, describe seasonal patterns as summer, autumn, winter and spring, each three months long and show distinct changes in temperature.

### Conclusion

#### Why are observations of the earth predictable?

Observations of the earth such as climate, seasons, day length and eclipses are predictable because they form patterns that do not change over time. The movement of the earth and moon are constant and the distance between the sun, earth, and moon do not change. Therefore the patterns that result from these features also do not change over time (the small changes in positions happen over hundreds of millions of years). The patterns can be used to predict events in the future. It is not only scientists that know and can use the patterns. Many ancient cultures have observed these patterns also for thousands of years and have used them to survive and celebrate their connection with the earth.

### Bibliography

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| --- | --- |
| TEDed, *Reasons for the seasons* | <http://ed.ted.com/lessons/reasons-for-the-seasons-rebecca-kaplan> |
| Climate charts.com, *Australia,* | [www.climate-charts.com/Countries/Australia.html](http://www.climate-charts.com/Countries/Australia.html) |
| University of Nebraska-Lincoln, *Daylight hours explorer* | <http://astro.unl.edu/classaction/animations/coordsmotion/daylighthoursexplorer.html> |
| Australia Geographic, *Australian solar eclipse: Friday 10 May 2013* | [www.australiangeographic.com.au/journal/australias-solar-eclipse-friday-morning.htm](http://www.australiangeographic.com.au/journal/australias-solar-eclipse-friday-morning.htm) |
| The Free Dictionary, Eclipse | [www.thefreedictionary.com/eclipse](http://www.thefreedictionary.com/eclipse) |
| ABC Science, *Your guide to the 2013 Ring of fire eclipse* | [www.abc.net.au/science/articles/2013/05/08/3750833.htm#.Uc2lh1p-\_IU](http://www.abc.net.au/science/articles/2013/05/08/3750833.htm#.Uc2lh1p-_IU) |
| NASA, *Solar eclipses of 2012* | <http://eclipse.gsfc.nasa.gov/solar.html> |
| Bureau of Meterology, *Indigenous Seasonal descriptions* | [www.bom.gov.au/iwk/climate\_culture/Indig\_seasons.shtml](http://www.bom.gov.au/iwk/climate_culture/Indig_seasons.shtml) |
| Bureau of Meterology, *Indigenous weather knowledge* | [www.bom.gov.au/iwk](http://www.bom.gov.au/iwk/) |
| Mirima Council, *Miriwoong Seasonal Calendar* | [www.mirima.org.au/calendar](http://www.mirima.org.au/calendar/) |