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92046

NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Physics, Earth and Space Science 2024

92046 Demonstrate understanding of the effect on the Earth of interactions between the Sun and the Earth-Moon system

Credits: Five

ASSESSMENT TASK

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the effect on the Earth of interactions between the Sun and the Earth-Moon system.	Explain the effect on the Earth of interactions between the Sun and the Earth-Moon system.	Analyse the effect on the Earth of interactions between the Sun and the Earth-Moon system.

Refer to this document to respond to the task for Physics, Earth and Space Science 2024 92046.

Make sure that you have Resource Booklet 92046R.

Check that this document has page 2 and that the page is not blank.

Do not use chatbots, generative AI, or other tools that can automatically generate content.

DO NOT TAKE THESE ASSESSMENT MATERIALS OUT OF THE ASSESSMENT ROOM.

Merit

TOTAL 15

This report is about how interactions between the Sun and the Earth-Moon system affects Earth. There are three parts that cover three different effects. Use specific evidence from Resource Booklet 92046R and your own knowledge to respond to all parts of the report.

PART ONE: CHANGES IN SHADOW LENGTH IN A DAY

The length and direction of shadows change throughout the day.

Explain why the length and direction of shadows change.

Your explanation should include:

- How the Sun's height changes throughout a day.
- Why the shadows at 9 a.m., midday, 3 p.m., and 6 p.m. have different lengths.
- Why the shadows at 9 a.m., midday, and 3 p.m. have different directions.
- Why Auckland and Invercargill have different shadow lengths during the same day.

PART TWO: SEASONAL CHANGES BETWEEN CHRISTCHURCH AND SCOTT BASE

Many research scientists fly out from Christchurch Airport to research stations such as Scott Base in Antarctica. These two places experience different day lengths in different seasons.

Explain why there are seasonal changes between Christchurch and Scott Base.

Your explanation should include:

- How the tilt of the Earth creates differences in day length between the seasons.
- The differences between equinoxes and solstices.
- How the Sun's path appears to change throughout the year.
- Why daylengths are different between Christchurch and Scott Base throughout the year.

PART THREE: ECLIPSES

Explain the conditions necessary to observe **solar** and **lunar eclipses** using the figures provided in the resource booklet as needed.

Your explanation should include:

- The relative positions of the Sun, Moon, and Earth during solar and lunar eclipses.
- The relevant phases of the Moon for solar and lunar eclipses.
- Why solar and lunar eclipses do not occur every month.
- Why a lunar eclipse lasts longer than a solar eclipse.

Level 1 Physics, Earth and Space Science 2024 **Credits: Five**

92046 Demonstrate understanding of the effect on the Earth of interactions between the Sun and the Earth-Moon system

This report is about how interactions between the Sun and the Earth-Moon system affects Earth. There are three parts that cover three different effects. Use specific evidence from Resource Booklet 92046R and your own knowledge to respond to all parts of the report.

Question 1:

As the Earth rotates, the sun has apparent movement in the sky; rising in the East and setting in the West. As a result, the sun's height will change as the day progresses. In the early morning, the sun will be low in the sky as the rotation of the Earth has only just brought the sun over the horizon. Closer to noon, the sun will reach its highest point in the sky as the Earth faces it more directly. In the later afternoon, the sun will once again be lower and closer to the horizon. However, in the evening the sun is in the West, as opposed to in the morning it will be in the East.

The angle in which the sun's light hits the Earth at a specific time directly influences the length of the shadows created. At 9 a.m, the sun will still be relatively low in the sky, as the Earth's rotation has yet to bring it higher. This means that the angle in which light reaches us is shallow, and therefore creates much longer shadows. In comparison to this, shadows at 3 p.m would be much shorter. This is because the sun will be at a higher point in its trajectory across the sky, and the light rays will be hitting at a steeper angle. This causes shorter shadows than the shadows at 9.am. Even later in the day at 6 p.m, shadows will be longer. As the sun begins to set over the horizon, the angle of sunlight has changed once again to that of a much shallower degree. This causes longer shadows. The length of shadows is directly proportional to the angle in which the sunlight is reaching the Earth; the shallower the angle the longer the shadow, and the steeper the shorter the shadow. Due to this, objects will create different length shadows throughout the day.

The Earth's rotation causes apparent movement of the sun in the sky. This movement sees the sun rise in the East and set in the West. At midday, the sun will be most directly overhead, and on either side of noon the sun will either be further to the East in the morning, and the West in the evening. Because of this, shadow length changes throughout the day. The direction that light is hitting the Earth changes as the day progresses, and the shadow direction also changes with a direct correlation to the positon of the sun. For example, when the sun is in the East, it will be casting shadows to the West. Same applies for when the sun is in the West in the evening; it will be casting shadows to the East. This means that the shadows at 9a.m, 3 p.m, and 6 p.m will have different directions.

Shadow length and direction are affected by the position of the sun. In the mornings, the sun is low in the sky in the East, casting long shadows to the West. At noon, the sun is more directly overhead, casting shorter shadows more directly down. In the evening, the sun is in the West and lower in the sky, causing shades to point to the East and to be longer.

The position of the sun is all relative to position on Earth, as it is the rotation of our planet that causes the apparent movement of the sun across our sky. This means that the angle and direction of the sun's rays will be different in different areas on Aotearoa. For example, the shadows in Auckland will be shorter than the shadows in Invercargill. This is due to Invercargill's latitude being lower than Aucklands, however all of New Zealand falls in the

same time zone. This means that at 3 p.m in Aotearoa, Auckland's sees the sun more directly overhead than Invercragill will, therefore having different shadow lengths.

Question 2:

The Earth orbits the sun on an axis tilted 23.5 degrees. This axis points in the same direction throughout the orbit, and is the reason we experience seasons. At different points in the orbit, the Southern hemisphere is either tilted towards the sun or away. When we are tilted towards we experience summer, with longer sun light hours, and when we are tilted away we experience winter, with shorter hours of daylight. This is because the tilt of the axis means the hemisphere experiencing summer is facing the sun more directly In between these we experience transitional seasons of Spring and Autumn. As the Earth rotates, this will cause the apparent movement of the sun across the sky to reach higher. In summer, the sun's trajectory across the sky takes longer, as the sun reaches higher. This means that from the Earth's rotation bringing the sun from horizon to horizon takes longer, as more rotation is necessary due to the more direct angle of the hemisphere to the sun. The opposite is true for winter, as the hemisphere experiencing that season will be tilted away from the sun. This means that the time it takes for Earth's rotation to bring sun from horizon to horizon is less, as the sun does not reach as high in the sky.

An equinox occurs when the sun is almost directly overhead the equator. As the equator is the mid way point from each pole, this causes day and night to be an equal 12 hours almost every where on earth. This occurs twice a year, the Vernal equinox on September 23rd, and the Autumnal equinox on March 21st. The sun's positioning during this time means that the tilt of the Earth's axis is at a minimum in relation to the sun.

A solstice occurs when the tilt creates either a maximum angle towards the sun. This means that the difference in day and night lengths is also at a maximum, due to the angle. The tilt of the axis points the same direction the full orbit of the sun, meaning that at two points in its orbit it will have a maximum tilt either towards or away from the sun. This means that the respective hemispheres will have their longest hours of daylight whilst in summer. For the southern hemisphere this is in December, and the northern hemisphere experiences their longest day in June. This is flipped for the shortest day.

An equinox is when the hours of day and night are equal, and a solstice is when the difference between the two lengths is at a maximum.

The sun's path through the sky will appear to change throughout the year. In summer it will appear to reach higher than in winter. In winter it will stay lower over the horizon, and move from East to West much quicker than in Summer. The sun still moves from East to West in Summer, yet it's trajectory will reach higher over the horizon.

The tilt of the earth is what's responsible for the different day lengths for Scott Base and Christchurch. Scott Base is located on Antarctica, also known as the South Pole. This means it has a much lower latitude than Christchurch. Because of this, the tilt of the earth's axis will affect Scott Base much more as it is further away from the equator. This means that the angle in which Scott Base sees the sun is different to that of Christchurch. Since this is what affects day light hours, the day lengths in Scott base will be different to that in Christchurch. For example at the Summer solstice, Christchurch will experience 12 hours 25 minutes of day, and Scott Base will have 8 hours 56 minutes of day.

Question 3:

A solar eclipse occurs when the moon passes between the Sun and Earth and aligns in such a way that the sun is blocked from the Earth. The moon passes in between the sun and

earth, blocking sunlight from reaching Earth.The relative position of the three planetary bodies during a solar eclipse means that certain locations on Earth will fall into the Umbra created by the moon. The umbra is the shadow that the moon casts on Earth during a solar eclipse, and the penumbra is a larger but lighter shadow that also occurs due to the moon passing between the Sun and the Earth Because of this, only parts on Earth will experience a total solar eclipse. For this to happen, you must be within the umbra part of the shadow casted on Earth, the small yet very dark part of the shadow. If this occurs, the Sun and environment will go dark. A larger area will fall into the penumbral part of the shadow, and experience a partial solar eclipse. This might look as though there is a piece missing from the sun in the sky.

For a lunar eclipse to happen, the Earth must block the Sun from the Moon by passing in between. During a lunar eclipse, the Earth blocks the sun's light from the moon. As the moon only reflects the light emitted by the Sun, this causes a change in the moon's appearance. During a total lunar eclipse, the moon is in the Earth's umbra and appears to have a red glow. This is sometimes referred to as a 'blood moon.' This is because whilst the light is blocked by the Earth, the larger red wave lengths are scattered and refracted through the Earth's atmosphere and still reach the moon. A lunar eclipse can also occur when the moon is partially in the umbra and partially in the penumbra. Some eclipses also occur when the moon is fully in the penumbra, which would just appear to darken the appearance slightly.

As the moon orbits Earth, we experience different phases depending on the amount of light hitting the moon in its current positon. For a solar eclipse to occur, the moon must be in it's New Moon phase, where the sun lit side is facing away from Earth. A lunar eclipse can only happen during the full moon phase.

Whilst the moon cycles through these phases every month, eclipses do not occur every time. This is because the moon's orbit is tilted 5 degrees, and for an eclipse to occur the three orbital planes of the planetary bodies must align in a specific way. This alignment does not occur every month due to the tilted orbit. This means that the Earth does not block the Moon from the sun every full moon, and the moon does not always block the Sun from Earth every New moon.

A total solar eclipse might last up to four minutes, whereas a total lunar eclipse can last up to three hours. This extreme difference is due to the different speed of orbit of the two planetary bodies. The moon moves around the Earth much quicker than the Earth is orbiting the Sun. Because of this, the amount of time that the moon is in the correct positon to block the Sun is much shorter, as it's relative position to Earth changes a lot quicker. This leads to short solar eclipses. In comparison, the Earth's movement is slower. This means that the amount of time that the Earth stays in a position that allows a lunar eclipse to occur is longer relative to a solar eclipse. The shadow created by Earth is also larger than that created by the moon. This also affects the time that the two kinds of eclipses will last, as the area that a solar eclipse can occur within is much smaller than a lunar eclipse. Combined with the difference in rates of movement, this is why lunar eclipses will last longer than solar.

Merit

Subject: Physics, Earth and Space Science

Standard: 92046

Total score: 15

Q	Grade score	Marker commentary
One	5	Candidate has explained why the length and direction of a shadow changes throughout a day. However, they have not explained how differences in latitude causes a change in length of shadow.
Two	5	Candidate has explained how the Sun's path changes between seasons as well as the difference between equinox and solstice. However, they did not discuss how the differences in latitude between the two locations causes a change in day length.
Three	5	Candidate has explained how the tilt of the Moon's orbit affects the frequency of solar and lunar eclipses. Also, they have linked the phase of the moon and location of Sun, Moon and Earth for a solar eclipse. However, they did not discuss the differences in the length of time for a solar and lunar eclipse.