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NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Scholarship 2021
Earth and Space Science

RESOURCE BOOKLET

Refer to this booklet to answer the questions for Scholarship Earth and Space Science.

Check that this booklet has pages 2–7 in the correct order and that none of these pages is blank.

YOU MAY KEEP THIS BOOKLET AT THE END OF THE EXAMINATION.

Resource for

QUESTION ONE: EL NIÑO – SOUTHERN OSCILLATION (ENSO) AND NEW ZEALAND

New Zealand's prevailing westerly winds pick up moisture as they blow across the Tasman Sea. They rise over the Southern Alps that stretch the length of the South Island, Te Waipounamu, and rain on the western region of the South Island.

Figure 1a

Adapted from: https://en.wikipedia.org/wiki/South_Island#/media/File:Turbid_Waters_Surround_New_Zealand_-_crop.jpg

Figure 1b: Annual precipitation.

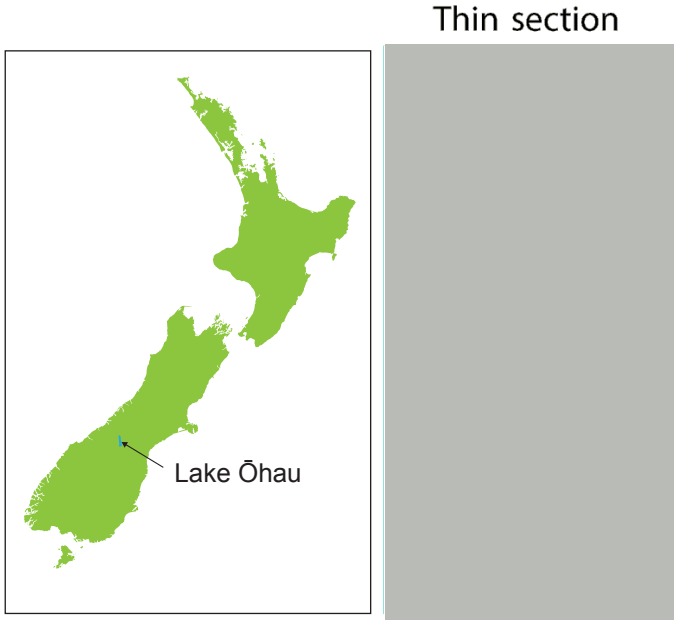

Figure 2: Sediment core taken from Lake Ōhau, highlighting sedimentary layers that include lighter (summer) and dark (winter) layers.

Adapted from: https://sd.copernicus.org/articles/24/41/2018/

El Niño – Southern Oscillation (ENSO) is an irregular periodic variation in winds and sea surface temperatures over the tropical Pacific Ocean, which affects New Zealand weather in a number of ways. It has two phases, El Niño and La Niña. El Niño tends to experience stronger or more frequent winds from the west in summer, which can encourage dryness in eastern areas and more rain in the west. In winter, the winds tend to blow more from the south, causing colder temperatures across the country.

Figure 3
Source: https://line.17qq.com/articles/chcqhssax.html

La Niña tends to experience greater north-easterly winds, bringing moist rainy conditions to north-eastern areas of the North island, and reduced rainfall to lower and western South Island. Warmer-than-average air and sea temperatures can happen during this time.

Figure 4
Source: https://www.interest.co.nz/rural-news/108216/we-look-we-have-la-ni%c3%b1a-weather-pattern-settling-and-not-all-bad-new-zealand

Resource for
QUESTION TWO: VOLCANISM ON THE MOON AND THE EARTH

The Moon formed at the same time as the Earth. Its gravity is one sixth of the Earth, and its surface shows no evidence of plate tectonics, unlike the Earth.

The diagram shows the interior of the moon as well as the crust, which is thinner on the near side, and thicker on the far side of the Moon.

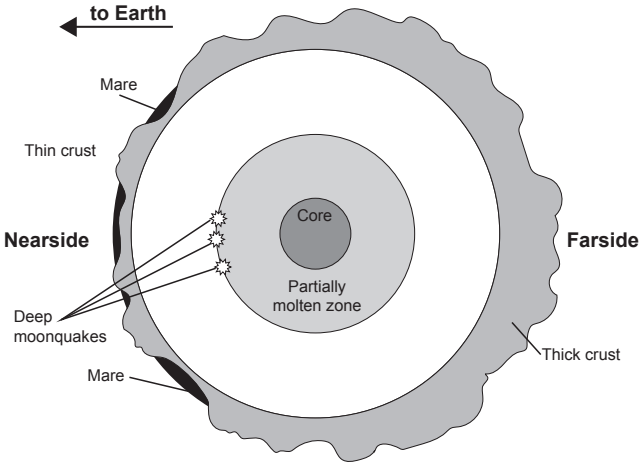

Figure 1
Adapted from: https://ase.tufts.edu/cosmos/view_picture.asp?id=1064

Early scientists thought the dark stretches of the Moon might be oceans so named them *maria*, which is Latin for "seas" (singular, *mare*). The maria are pools of hardened basaltic lava that range from 200 km to 1200 km in diameter. They have a large diameter due to the low viscous nature of the basaltic magma. Apollo astronauts brought back basaltic samples from the Moon and they were found to contain elements such as potassium, phosphorous, oxygen, and silicon. Also they found rare-earth elements and radioactive elements such as uranium and thorium. Radioactive elements contribute to at least 0.1% of the Moon's mass and generate heat.

Figure 2: Lunar nearside (facing the Earth) vs. farside (facing away from the Earth). Notice the stark absence of large mare areas on the farside. The only exception being Mare Moscoviense. White scar like patches are evidence of asteroid impacts.

Source: https://documen.site/download/file-5af71540e81c8_pdf

The lunar maria are primarily found on one side of the Moon. They cover nearly one-third of the lunar nearside, but less than 2% of the lunar farside. Most volcanism on the Moon appears to have occurred between 3 and 4 billion years ago, with no evidence of recent volcanism. Typical mare samples are ~3 500 000 000 years old. Even the youngest mare flows have estimated ages of nearly 1 billion years. These "young" rocks have not been sampled or directly dated. However, because they contain radioactive elements, they could be radiometrically dated. For comparison, the oldest dated rock on the Earth is ~3.9 billion years old.

Volcanism on the Earth is hot-spot or subduction based. Two examples are the Hawaiian volcanic chain and subduction under the North Island of New Zealand, causing the Taupō Volcanic Zone.

Figure 3
Source: https://upload.wikimedia.org/wikipedia/commons/f/f1/Hawaii_hotspot_cross-sectional_diagram.jpg

Figure 4
Source: https://teara.govt.nz/en/diagram/8693/subduction-under-the-north-island

Resource for
QUESTION THREE: GLOBAL SEA-LEVEL RISE

Figure 1 shows four major ice ages, on a cycle of roughly 100 000 years. The last ice age peak was just over 20 000 years ago. The sea level was almost 120 metres below the present, due to the huge quantity of water locked up in the ice sheets about 2 km deep over North America and Europe. The $T_{anomaly}$ refers to the difference in temperature from the average temperature over the last 10 000 years.

Source: https://www.haaretz.com/us-news/.premium-eight-ways-trump-has-led-the-fight-against-combating-global-warming-1.9282233

Figure 1

Earth's ice is melting as the climate warms, and globally, sea levels have risen 10 cm to 20 cm since the last century. They will continue to rise as the ice melts, which is putting coastal communities worldwide at risk. There are two major areas in the world where ice forms: on the sea (sea ice) and on land (land ice).

Roughly 15% of the world's oceans are covered by sea ice during a portion of the year. Sea ice is largely found in the Arctic Ocean and Figure 2 shows the ice extent in October 2020 and the pink lines show its former extent.

Source: https://nsidc.org/arcticseaicenews/2020/11/blue-waves-in-november-in-the-arctic/

Figure 2

Figure 3a Figure 3b

Adapted from: https://uncensored.co.nz/2019/09/15/did-earth-steal-martian-water/

Land ice differs from sea ice in the way that it is formed. Fresh water becomes less dense as it approaches freezing point.

Land ice is found in the form of ice sheets and glaciers that cover approximately 15 million km^2, roughly equivalent to 10% of the Earth's land surface area. If the Greenland Ice Sheet melted, global sea levels could rise about 6 metres and the Antarctic Ice Sheet could cause the global sea level to rise by about 60 metres.

Source: https://guardianlv.com/2013/10/channels-the-height-of-the-eiffel-tower-found-within-antarctic-ice/

Figure 4

Albedo is a measure of the reflectivity of a surface. The albedo effect when applied to the Earth is a measure of how much of the Sun's energy is reflected back into space. A perfectly reflective surface has an albedo of 1, while a completely dark object has an albedo of 0.

Source: www.exploratorium.edu/climate/ice

Figure 5

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