This assessment is based on a now-expired version of the achievement standard and may not accurately reflect the content and practice of external assessments developed for 2026 onwards.

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Draw a cross through the box (☒) if you have NOT written in this booklet

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Earth and Space Science 2024

91413 Demonstrate understanding of processes in the ocean system

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of processes in the ocean system.	Demonstrate in-depth understanding of processes in the ocean system.	Demonstrate comprehensive understanding of processes in the ocean system.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

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QUESTION ONE: LAYERS OF THE OCEAN

The ocean is divided into layers: the mixed surface layer, the transition layer, and the deep ocean layer. The properties of the ocean changes with depth, causing these layers to form.

Figure 1: Ocean layers at varying latitudes

Source: http://geophile.net/Lessons/seawater/seawater_05.html

Explain the properties of each layer, and what causes the depth of the different layers of the ocean to change with latitude.

In your answer, you should:

- describe the properties of each of the layers, including density, temperature, and salinity
- explain the processes that cause each of the layers to form
- explain why the depth of the layers vary at low, mid, and high latitudes.

An annotated diagram may assist your answer.

There is more space for your answer to this question on the following pages.

QUESTION TWO: ENSO EFFECTS ON NEW ZEALAND

In June 2023, meteorologists measured a change in surface ocean temperatures in the Pacific that indicated the La Niña phase of the previous three years had transitioned into the El Niño phase of the El Niño Southern Oscillation (ENSO).

Figure 2: Central Pacific Ocean Surface Temperatures

https://www.linkedin.com/pulse/understanding-climate-phenomena-el-ni%C3%B1o-la-ni%C3%B1a-enso-maya

Compare the conditions in the **western equatorial** Pacific Ocean during El Niño and La Niña.

In your answer, you should:

- explain the formation of El Niño and La Niña, including winds and surface currents
- consider the conditions present in both El Niño and La Niña events, including surface ocean temperature, thermocline, and sea level
- explain the relationship between winds, ocean surface temperature, and sea level as La Niña transitions to El Niño
- explain how this transition from La Niña to El Niño is likely to affect New Zealand.

An annotated diagram may assist your answer.

There is more space for your answer to this question on the following pages.

QUESTION THREE: TIDAL FLOODING IN THE MARSHALL ISLANDS

The Marshall Islands are a group of small islands in the western Pacific Ocean that have an average height of two metres above sea level. In December 2021, they experienced three days of extreme flooding. This was due to a combination of sea-level rise, extreme spring tides, and an intense wind produced by nearby storms.

Figure 3: The Marsall Islands

Adapted from: https://ontheworldmap.com/marshall-islands/marshall-islands-location-on-the-pacific-ocean-map.html

Figure 4: Global mean sea level change since 1870

Source: https://www.icsm.gov.au/sites/default/files/2017-05/PCG-SSSC_2013_Canberra.pdf

Discuss the flooding risk factors to the Marshall Islands.

In your answer, you should:

- explain the effects of climate change on sea levels
- explain the causes and effects of spring tides, and other more extreme high tides
- discuss how the combination of climate change, tropical storms, and spring tides increases the risk of flooding.

An annotated diagram may assist your answer.

There is more space for your answer to this question on the following pages.

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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