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

91414 Demonstrate understanding of processes in the atmosphere system

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of processes in the atmosphere system.	Demonstrate in-depth understanding of processes in the atmosphere system.	Demonstrate comprehensive understanding of processes in the atmosphere 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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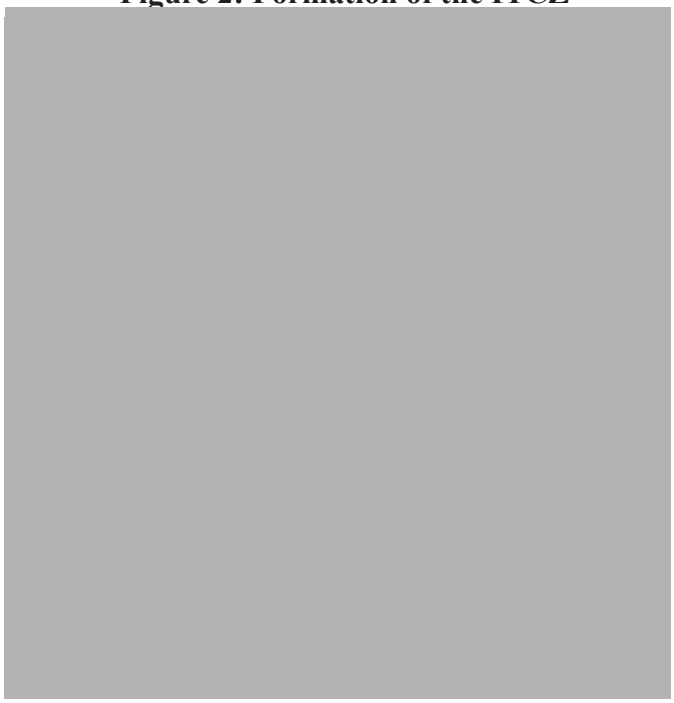
QUESTION ONE: INTER TROPICAL CONVERGENCE ZONE

The image from NASA's weather satellites (below left) clearly shows a band of clouds associated with the Intertropical Convergence Zone (ITCZ) over the Pacific Ocean. The ITCZ is found at or near the Equator and forms due to atmospheric circulation in the troposphere.

Figure 1: The band of cloud is due to the ITCZ

https://eos.org/research-spotlights/tropical-rainfall-intensifies-while-the-doldrums-narrow

Figure 2: Formation of the ITCZ



https://en.wikipedia.org/wiki/Hadley_cell#/media/File:NOAA_Hadley_cell_cross_section.jpg

Discuss the factors that lead to formation of the ITCZ.

In your answer explain:

- how temperature and pressure differences form Hadley circulation cells
- conditions at the ITCZ such as solar energy, atmospheric pressure and wind strength
- processes that lead to formation of constant clouds at the ITCZ
- why the position of the ITCZ changes during different seasons.

An annotated diagram may assist your answer.

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

QUESTION TWO: CARBON CYCLE AND THE GREENHOUSE EFFECT

Carbon dioxide and methane are the main greenhouse gases that New Zealand releases into the atmosphere. Greenhouse gases contribute to the greenhouse effect, which impacts atmospheric temperature. In 2016 New Zealand emitted a total of 78.8 million tons greenhouse gases.

Figure 4: 2016 New Zealand greenhouse gas emissions in CO_2 equivalent

https://environment.govt.nz/assets/Publications/Files/FINAL-Zero-Carbon-Bill-Discussion-Document.pdf

Table 1: Lifetime and heating effect of greenhouse gases

Greenhouse gas	Lifetime in atmosphere	Relative heating effect
Carbon dioxide (CO_2)	300 – 1000 years	1
Methane (CH_4)	12 years	28

Discuss the impact of carbon dioxide and methane emissions on climate.

As part of your answer:

- explain the greenhouse effect
- explain how energy use and agriculture increase greenhouse gas concentrations in the atmosphere
- explain how increasing carbon dioxide and methane affects atmospheric temperature
- compare the impact of carbon dioxide and agricultural methane on atmospheric temperature.

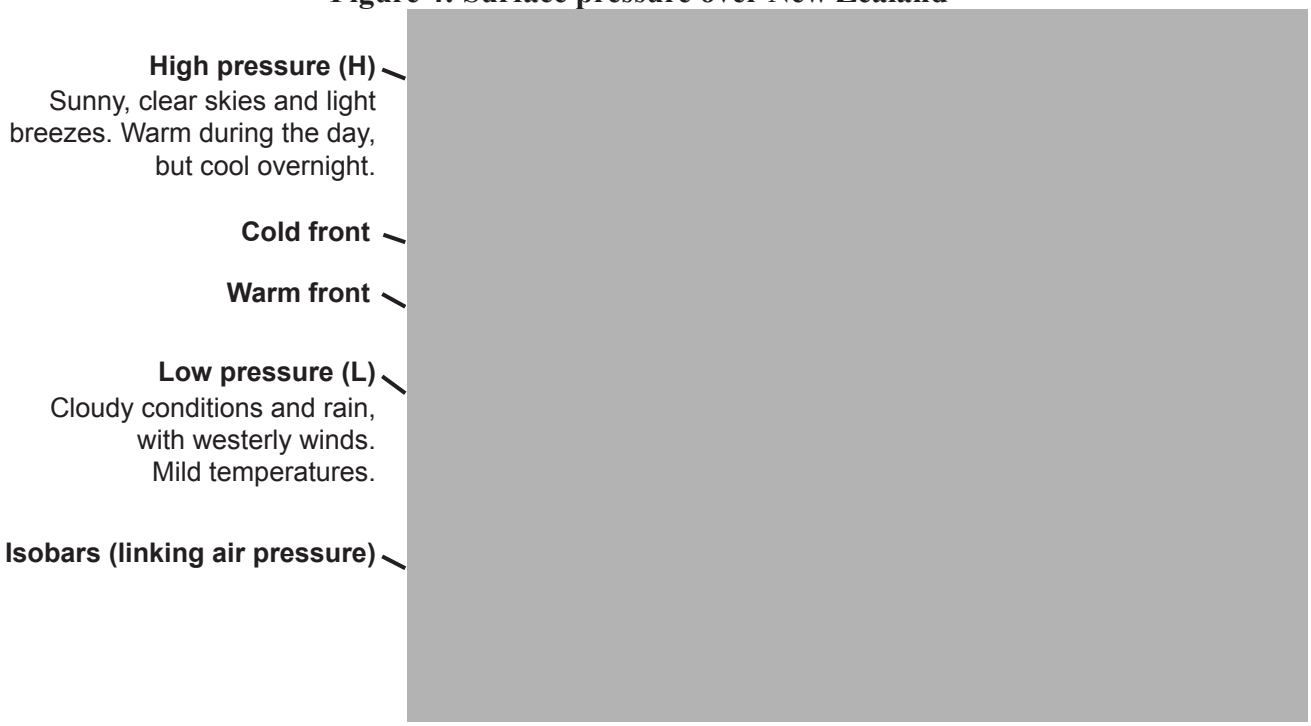
An annotated diagram may assist your answer.

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

QUESTION THREE: NEW ZEALAND WEATHER

New Zealand weather is subject to the movement of high-pressure and low-pressure systems and weather fronts across the country. The surface pressure chart below is associated with different weather conditions as described.

Figure 4: Surface pressure over New Zealand



Adapted from: www.researchgate.net/publication/226969440_A_Study_of_Orographic_Blocking_and_Barrier_Wind_Development_Upstream_of_the_Southern_Alps_New_Zealand/figures?lo=1

Discuss the reasons for different weather conditions experienced over New Zealand in the two types of weather systems. An explanation of atmospheric circulation cells is NOT required.

As part of your answer, explain:

- air flow (e.g. wind direction and speed related to the pressure systems, vertically and horizontally)
- the effects of clouds on solar insolation and temperatures
- how fronts cause changes in local weather conditions.

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

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

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