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 & Space Science 2023

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 (DO NOT WRITE IN THIS 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: FLYING HIGH

Pilots of jet aircraft that fly long distances prefer to fly in the lower stratosphere. In the stratosphere, atmospheric conditions have less turbulence which is caused by the vertical movement of air. Aircraft also have better fuel efficiency, as the air is thinner. However, jet engines need sufficient oxygen to work. Sometimes pilots make use of jet streams in the upper troposphere.

Figure 1: Jet stream locations **Figure 2: The stratosphere and troposphere**

Source: www.weather.gov/jetstream/jet Source: https://geoengineering.global/stratospheric-aerosol-injection/

Discuss why pilots prefer to fly in the stratosphere, instead of the troposphere.

In your answer, you should explain:

- differences in density, pressure, temperature, and composition of the troposphere and stratosphere
- atmospheric conditions in both layers, and how this may impact on flights
- how jet streams may help or hinder flights.

An annotated diagram may assist your answer.

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

QUESTION TWO: AEROSOLS

The highest concentrations of sea spray aerosols occur in the lower troposphere near 50 °S. The spray is transported towards New Zealand by strong prevailing westerly surface winds. This contributes to the west coast of the South Island being the wettest area in New Zealand.

Figure 3: Production of sea spray aerosols

Adapted from: www.mdpi.com/2072-4292/13/4/614

Figure 4: Sea-spray concentration at Earth's surface

Source: https://pdfs.semanticscholar.org/8eb9/33a0e3594e9c6f13ad6b17d020acea94b138.pdf?_ga=2.189352232.2063430432.1658545364-1415782361.1658545364

Explain the processes that lead to cloud formation and high rainfall on the west coast of the South Island.

In your answer, you should consider:

- the formation of the Ferrel cell and surface winds around 50 °S latitude
- the production of salt spray aerosols and the role they play in cloud formation.

An annotated diagram may assist your answer.

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

QUESTION THREE: GLOBAL CLIMATE TIPPING POINTS

An estimated 28 trillion tons of ice disappeared from the Earth's surface between 1994 and 2017. Over the same period, the average global temperature increased by 0.7 °C. Climate scientists consider this to be a potential "tipping point", which is a small change in the climate system that could lead to much greater irreversible changes. This is also referred to as a positive feedback loop.

Figure 5: Global change in ice mass (1994–2017)

Adapted from: https://www.researchgate.net/figure/Global-ice-mass-change-between-1994-and-2017-partitioned-into-the-different-floating_fig4_348753744)

Figure 6: Average global surface temperature, (1994–2017)

Adapted from: https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series/globe/land_ocean/12/1/1994-2017

Discuss the causes and effects of a decline in polar ice on the atmosphere and global climate.

In your answer, you should explain:

- the greenhouse effect, including changes due to human activity
- how surface ice regulates atmospheric temperature
- how change in surface ice may lead to faster climate change.

You do not need to discuss sea level change or ocean processes.

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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