SUPERVISOR'S USE ONLY

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91414

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

NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Earth and Space Science 2025

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.

Achievement TOTAL 12

QUESTION ONE: HOW DOES THE ATMOSPHERE PROTECT THE EARTH?

The atmosphere plays an important role in protecting the Earth and making it suitable for life.

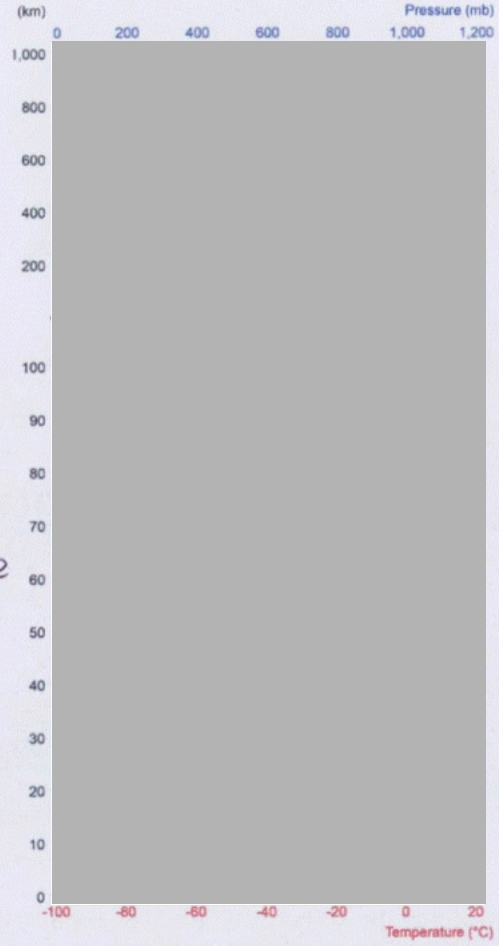
Explain the role that each layer of the atmosphere plays in protecting the Earth's surface from harmful matter and radiation.

In your answer, you should consider:

- the different forms of radiation that enter the Earth's atmosphere
- physical space objects, such as meteors and charged particles
- the reason for the changing temperature for each of the atmosphere's layers.

An annotated diagram may assist your answer.

Layers of the atmosphere



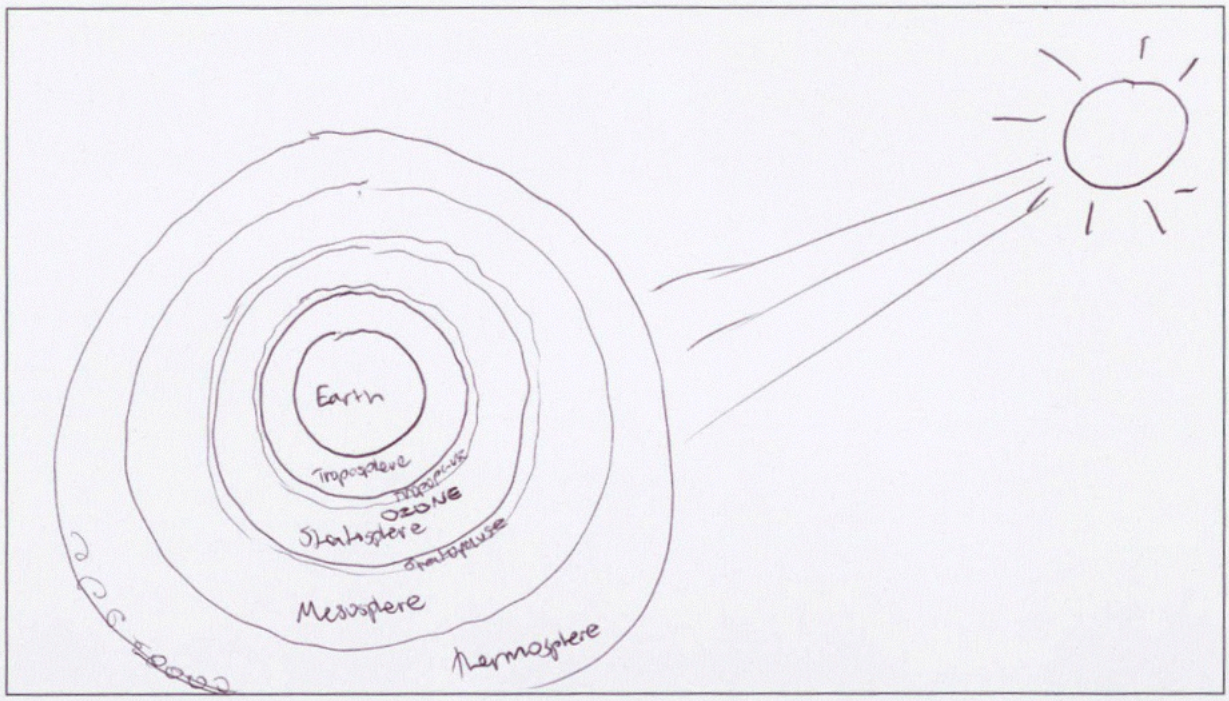
Adapted from: www.severe-weather.eu/wp-content/gallery/weather-maps/winter-storm-bomb-cyclone-gaetan-uk-atmospheric-layers.jpg

the troposphere is the layer of atmosphere closest to the ground. it contains the highest amount of pressure and density. in the troposphere, the temperature decreases with altitude. This is because the ground absorbs short-wave radiation from the sun, and emits long-wave radiation. So the closer to the ground, the warmer. This is the ~~or~~layer with the most weather, as the warm air on the bottom rises and cold air sinks creating convection. The next layer, the stratosphere is the layer with the most ozone (O_3) which absorbs UV radiation and solar from the sun. This brings particles closer together, generating more heat and energy. The stratosphere has no weather as there is no vertical convection movement. (cold air on bottom, hot air on top). The mesosphere, the third layer, has a temperature decrease with the increase in altitude. This is because it recieves little solar radiation and UV rays.

protecting life on earth from harmful sun/solar UV rays.

And acts as a barrier.

heat increases with increased altitude in stratosphere.



the thermosphere / ionsphere has a temperature increase with the increase in Altitude. This is because it recieves a more direct and concentrated amount of solar / UV radiation. Auroras also happen here, and this is also where charged ions attach themself to molecules, generating energy.

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

QUESTION TWO: HEAT TRANSFER

Heat is transferred from the ocean and land into the atmosphere by different processes. These include radiation, conduction, convection, evaporation, condensation, and sublimation.

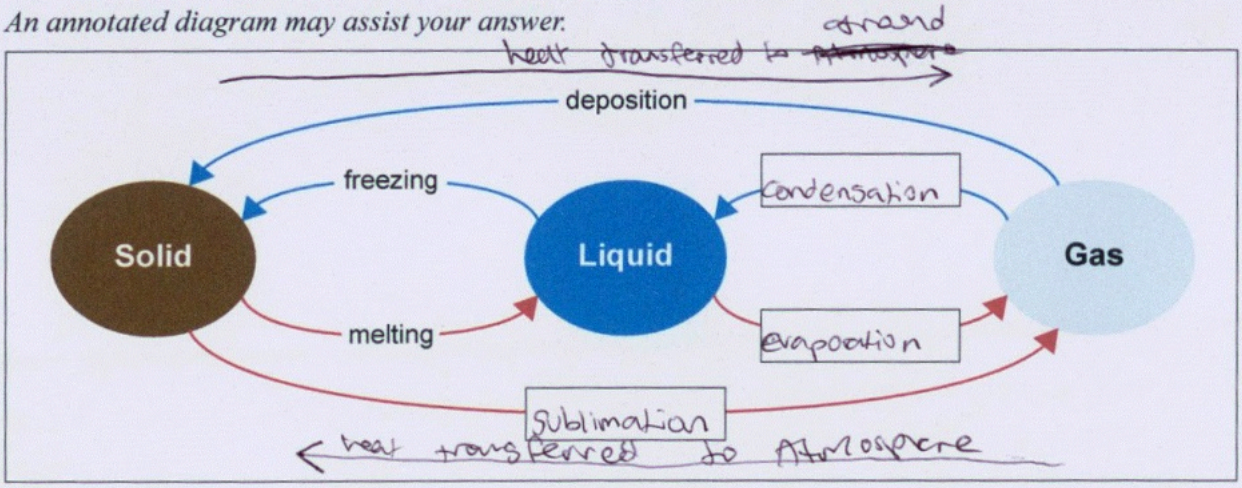
Adapted from: https://earthobservatory.nasa.gov/features/EnergyBalance

Explain, in detail, how heat is transferred from the Earth's surface to warm the atmosphere.

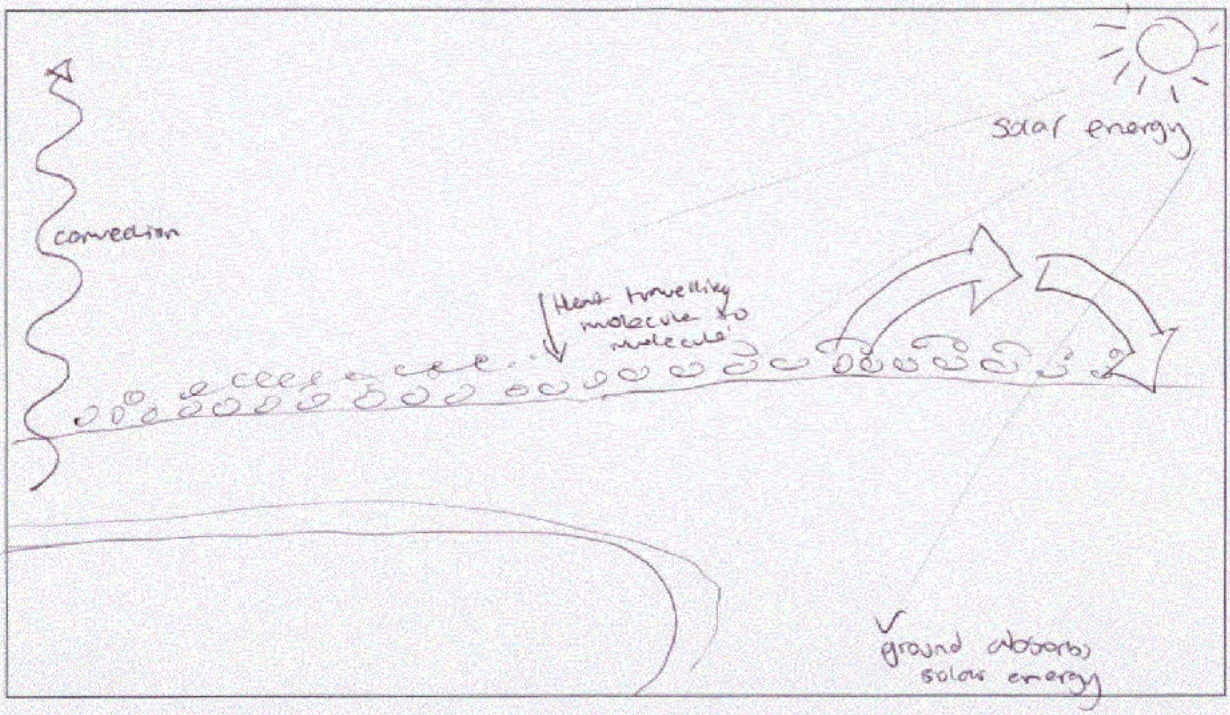
In your answer, you should:

- label processes in the text boxes on the diagram below
- explain three processes that transport heat from land to the atmosphere
- explain how heat is transported through the water cycle into the atmosphere
- explain how latent and sensible heat transfers are linked to the processes.

An annotated diagram may assist your answer.



condensation is a process that brings heat to the atmosphere, because ^ when for example water vapor ~~clouds~~ condenses it brings particles closer together, causing more collisions and heat energy produced.



the atmosphere absorbs this heat. Another process is when the ground absorbs around 51% of short-wave radiation, it emits long-wave radiation back into the atmosphere, right above ground level (conduction) this heat energy travels molecule to molecule generating atmospheric heat. a third process is convection. it carries the heat energy in the air. in the water cycle, heat is transported through water into the atmosphere ~~in many ways~~ by condensation. evaporation cools the atmosphere because the particles are further apart, but as mentioned earlier it brings the particles closer together, the atmosphere absorbing this heat. low level clouds can also warm the atmosphere if the short wave radiation can make it through, whereas high level clouds dont reflect as many solar rays, heating the atmosphere and ground at an increased effect. in the water cycle heat can also be picked up at the equator where there is direct sun and solar rays, so the water heats up & and its higher heat capacity,

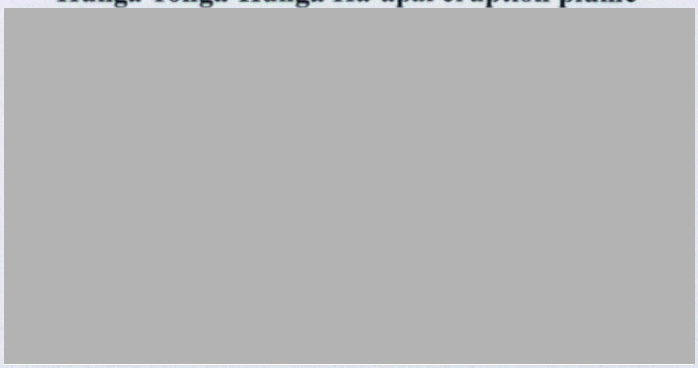
There is more space for your answer to this question on the following pages.

entering a band of low pressure to carry the warm moist air, condense and rain. This carries heat into the atmosphere from the water cycle.

QUESTION THREE: THE HUNGA ERUPTION

On 15 January 2022, the underwater volcano Hunga Tonga-Hunga Ha'apai (Hunga) erupted. This was the largest underwater explosion ever recorded by modern scientific instruments. It launched huge amounts of water vapour and sulphur dioxide into the troposphere and stratosphere, which may impact the climate.

Hunga Tonga-Hunga Ha'apai eruption plume



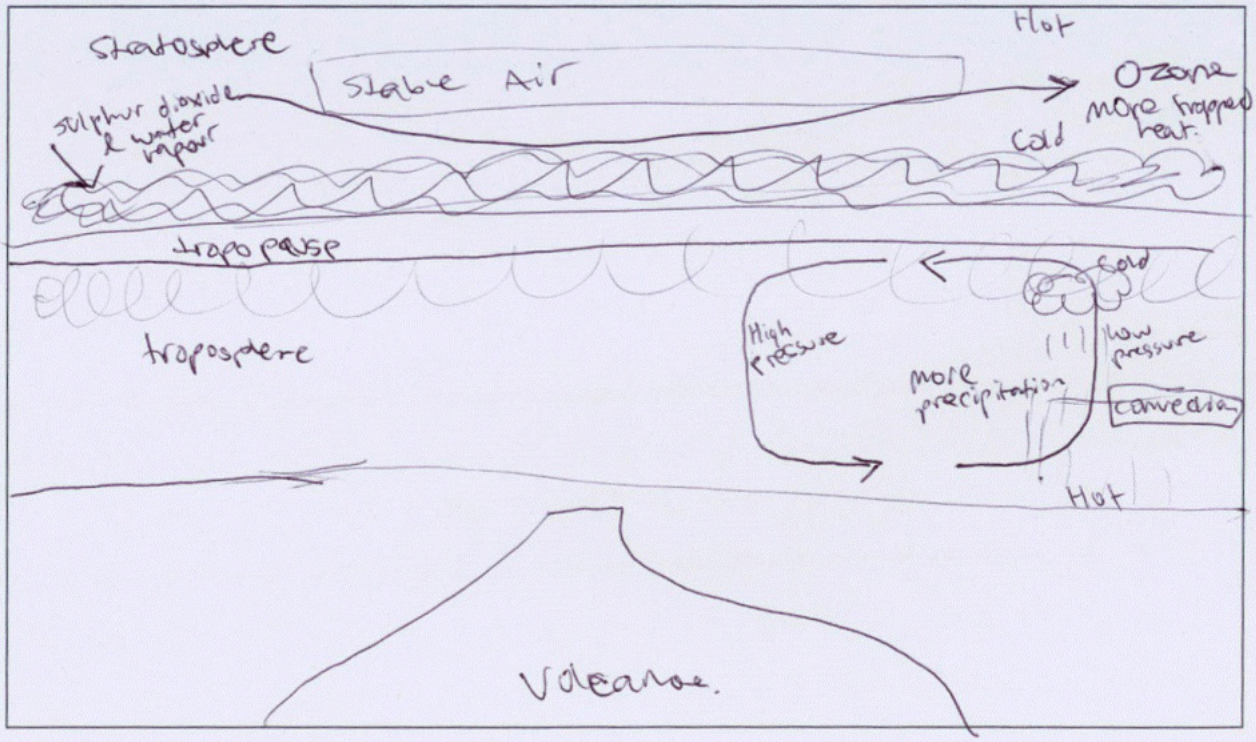
Source: www.qatarday.com/volcano-in-tonga-sends-plume-half-way-into-space

Explain the likely effects of the Hunga eruption on climate.

In your answer, you should:

- consider local effects of the eruption on the troposphere
- consider the effects of the huge increase in stratospheric clouds caused by the volcanic eruption
- consider the effect of large amounts of sulphur dioxide entering the stratosphere
- compare the likely circulation patterns of the water vapour and aerosols in the troposphere and stratosphere.

An annotated diagram may assist your answer.



with increased amounts of sulphur dioxide and water vapour entering our atmosphere (troposphere & stratosphere) our climate would be effected. This is because, with Aerosols suspended in the air - the troposphere, they can be rained out, fall down eventually due to gravity from pressure, wind ect. ~~but~~ however, when an Aersol is suspended in the stratosphere, there is ~~&~~ no weather (rain + wind) to remove them. This has quite the impact on climate. This means massive clouds built of sulphur dioxide and water vapour would stay in the stratosphere for weeks, months etc, creating a blanket cooling effect in the troposphere - receiving little solar radiation needed for photosynthesis, warming the earth and other processes. With large amounts of sulphur dioxide, especially suspended in the stratosphere, the ozone layer would begin to absorb this gas. Naturally, the ozone layers job is to keep earth at a stable temp, with balanced greenhouse gasses, and a re emits heat back into space. However, with more greenhouse gas released into the atmosphere (sulphur dioxide + water vapour) it traps more heat, and allows less heat to leave the atmosphere. This increases the overall global temperature. With more heat = increased evap = increased clouds = increase precipitation.

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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QUESTION NUMBER

91414

Achievement

Subject: L3 Earth & Space Science

Standard: 91414

Total score: 12

Q	Grade score	Marker commentary
One	4	Describes with understanding the formation of aurora and stratospheric ozone absorbing UV radiation, while explaining the temperature gradient for the troposphere.
Two	4	Describes with understanding how solar radiation is absorbed and re-emitted by surface, as well as heat energy being absorbed by water during evaporation.
Three	4	Describes increased tropospheric precipitation, cooling as radiation is intercepted by aerosols, heating as water vapour will retain heat and aerosols remain in stratosphere for longer.