SUPERVISOR'S USE ONLY

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

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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Earth & Space Science 2023

91193 Demonstrate understanding of physical principles related to the Earth System

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of physical principles related to the Earth System.	Demonstrate in-depth understanding of physical principles related to the Earth System.	Demonstrate comprehensive understanding of physical principles related to the Earth 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 DO NOT WRITE). 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 10

QUESTION ONE: HEAT DISTRIBUTION AROUND EARTH

Global Surface Currents

Source: https://serc.carleton.edu/eslabs/climate/4a.html

(a) Describe the role of the wind in the formation of surface ocean currents.

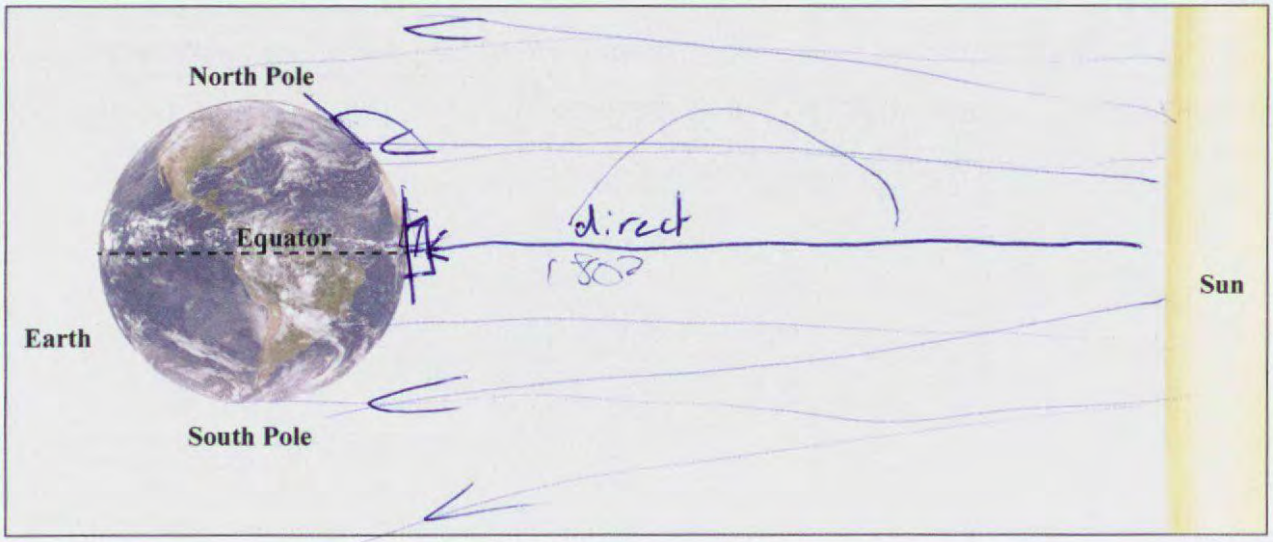
The wind helps move the surface of the water by pushing it and creating waves / currents

(b) Explain, in detail, why ocean and land temperatures at the Equator are significantly higher than at the poles.

In your answer you should consider:

- the angle of the incoming radiation
- the curvature of the Earth.

Fully annotate the diagram below in support of your answer.



Sources: https://a-z-animals.com/blog/how-does-the-sun-produce-energy/
https://solarsystem.nasa.gov/planets/earth/overview/

At the equator the suns radiation is ~~coming directly at~~ the most direct as the suns radiation is hitting at a 90° ~~to~~ from the surface therefore the solar radiation is intense heating up the ocean and land.

At the poles the solar radiation is hitting the surface at an obtuse angle as the earth is curved away from the sun and as the solar radiation isn't as intense the ~~heat is reflected~~ so the land and ocean temperatures are lower

The earth tangent at the poles is at a greater angle from the suns radiation at the poles.

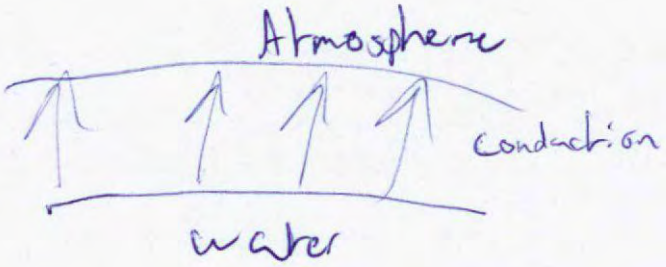
As you go to higher latitudes the curvature of the earth away from the sun is greater.

(c) Explain, in detail, how heat is transferred from the ocean to the atmosphere, as the ocean currents move away from the Equator towards the poles.

In your answer you should consider:

- methods of heat transfer
- the heat capacity of water.

An annotated diagram may assist your answer.



water has a very high heat capacity meaning it needs alot of heat energy to increase by 1°C Heated water from the equator moves towards the poles through ocean currents.

The heat from the water is then transferred to the atmosphere through conduction.

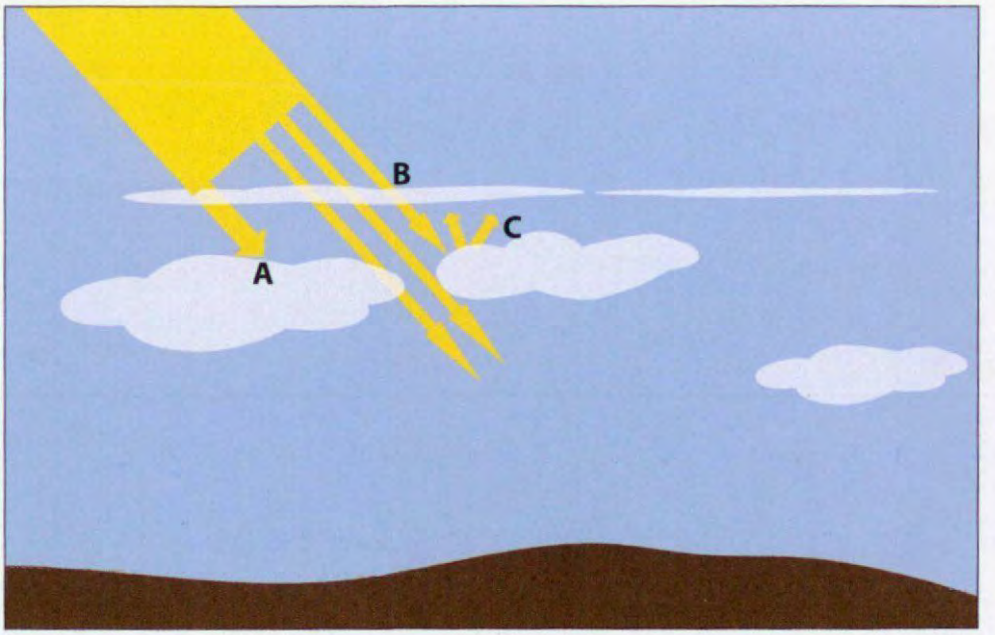
QUESTION TWO: CLOUDS

Cumulus clouds

Source: https://commons.wikimedia.org/wiki/File:Cumulus_humilis_Sch%C3%B6nwald_im_Schwarzwald_20180810.jpg

Clouds affect the amount of light that reaches the Earth's surface. Many clouds appear white in colour and can reach from the Earth's surface to heights of up to 20 km.

(a) As light travels through the atmosphere, different interactions can take place between the light waves and clouds. The letters A, B, and C represent three of those processes.



Complete the table below, labelling the processes that are taking place as light travels through the atmosphere.

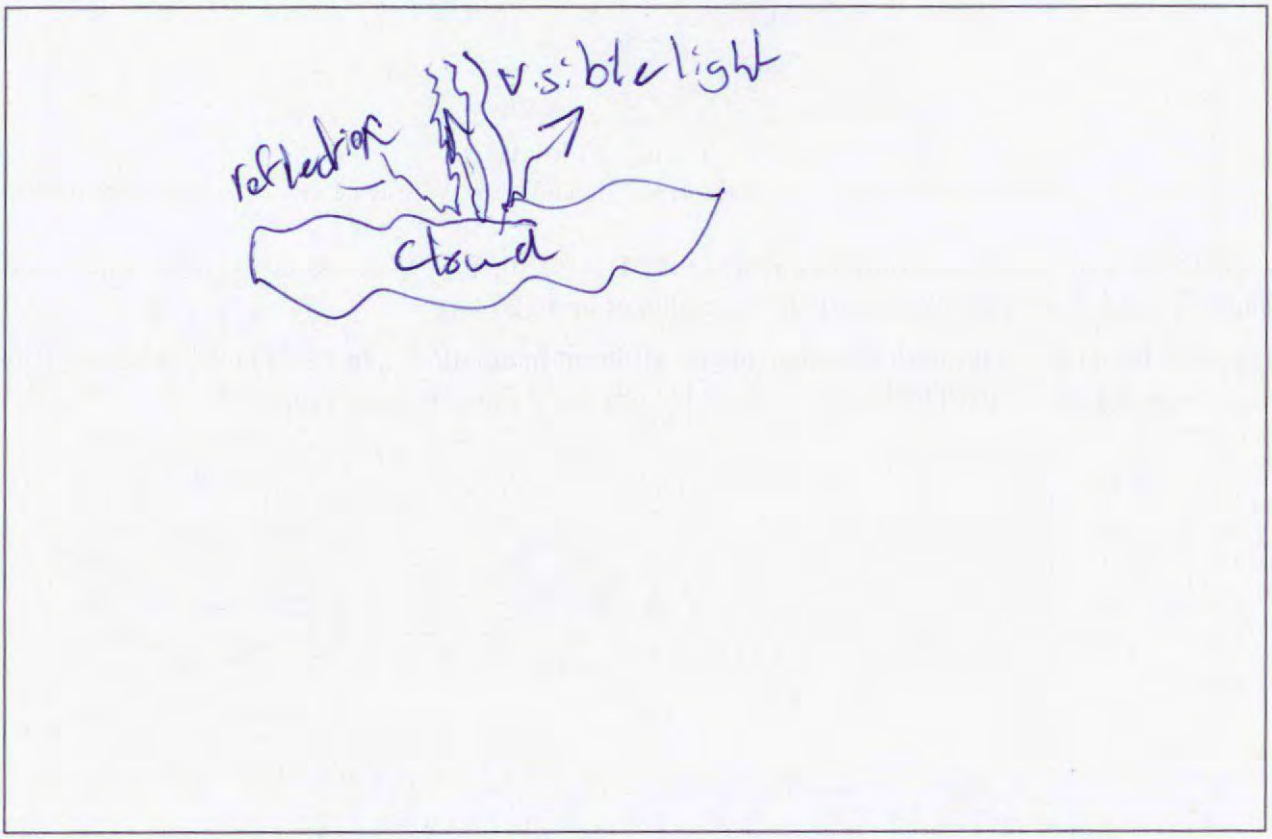
A	Absorbtion
B	
C	Reflection

(b) Explain, in detail, why cumulus clouds appear white from below.

In your answer you should consider:

- the visible light spectrum
- what clouds are made up of
- what happens to light as it travels through clouds.

An annotated diagram may assist your answer.



Visible light is on the electromagnetic scale and consists of waves the colour something appears is based off of what colour/frequency of light is reflected off that object and what is absorbed.

Clouds are highly reflective this is why they appear white from below because as they reflect all light and all colours of visible light combined make white light the white light that is reflected makes it to the human eye therefore making the cloud

Appear white in colour

The white light is reflected of the water molecules of the cloud making it appear white.

(c) Rain is often associated with dark grey cumulonimbus clouds. These clouds can contain six times more water than cumulus clouds.

Cumulonimbus clouds

Source: https://www.weatherwatch.co.nz/content/how-to-spot-a-thunderstorm-in-the-making

Explain, in detail, why cumulonimbus clouds usually appear dark.

In your answer you should consider:

- what happens to light as it travels through the cloud
- why the clouds appear dark grey or black when viewed from the Earth's surface.

An annotated diagram may assist your answer.

As light travels through a cumulonimbus cloud the light is still reflected off the water molecules.

But since the water is more concentrated and there are more molecules to interact with more light is absorbed and when white light is absorbed it appears black.

So the water heavy cumulonimbus clouds appear dark grey or black from the earths surface as alot of the light is absorbed.

QUESTION THREE: VOLCANIC ERUPTIONS AND GREENHOUSE GASES

Source: www.climate.gov/news-features/feed/eruption-provides-rare-opportunity-study-volcanic-gas-and-ash-injected-0

Volcanoes release greenhouse gases, such as carbon dioxide and water vapour, into the atmosphere when they erupt.

(a) Describe what is meant by a greenhouse gas.

Greenhouse gases prevent heat from the earths surface leaving the atmosphere.

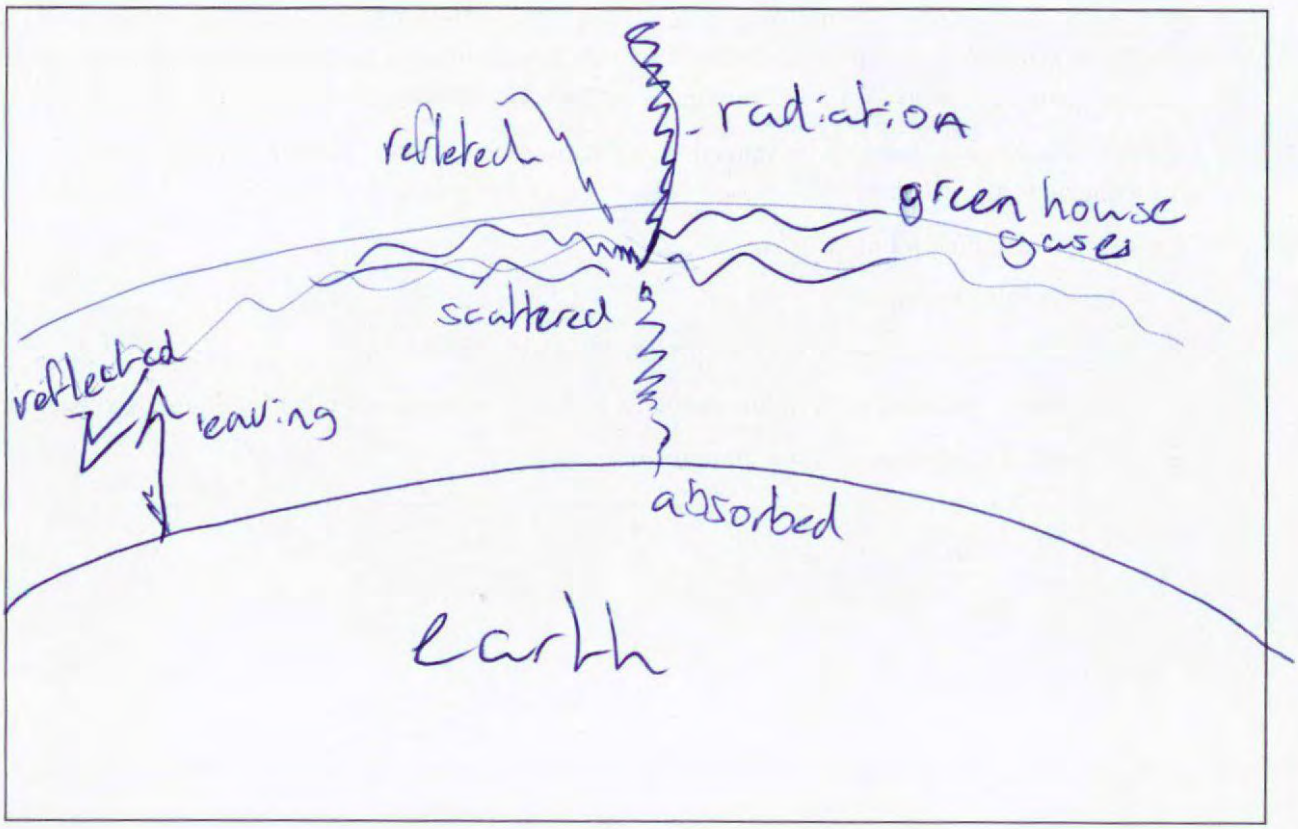
(b) Explain, in detail, the role of greenhouse gases in regulating the Earth's temperature.

In your answer you should consider:

- the wavelength of incoming radiation
- what happens to incoming radiation once it reaches the Earth's surface
- the natural greenhouse effect.

An annotated diagram may assist your answer.

UV radiation or solar radiation has a very small wave length on the electromagnetic scale and high frequency this means it is more likely to be scattered by the greenhouse gasses in the atmosphere staying up there some of it will however reach the earths surface increasing temperature but only a small amount so greenhouse gases work well at guarding the earths surface from radiation



Though too much greenhouse gases prevent excess heat from leaving the earth by ~~a~~ radiated out as the gases will reflect it back to the earth surface increasing the surface temperature of the earth gradually.

Question Three continues on the next page.

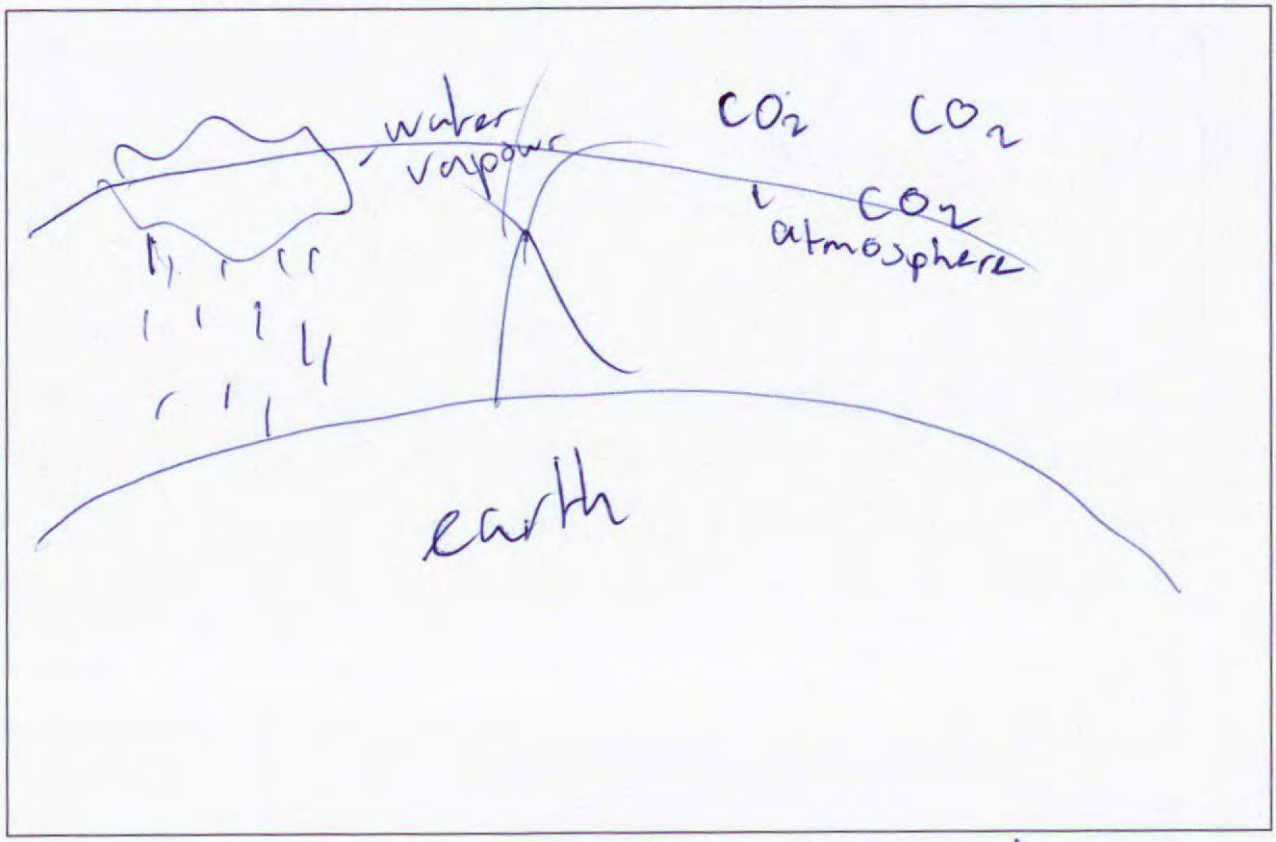
(c) The 2022 volcanic eruption in Tonga released approximately 45 million tonnes of water vapour into the atmosphere, and increased atmospheric carbon dioxide concentrations near the volcano by the equivalent amount of a whole year's carbon dioxide emissions on Earth.

Compare the likely effects of increased water vapour and carbon dioxide emissions on atmospheric temperatures.

In your answer you should consider:

- the greenhouse effect
- the differences between the two greenhouse gases involved
- whether the effects on temperature will be long- or short-term for each greenhouse gas.

An annotated diagram may assist your answer.



The greenhouse effect is what both heats and cools (prevents from heating) the earth

water gets rained out of the atmosphere so is short term

CO_2 stays long term.

Earth is cooled in short term due to less radiation reaching the surface

and warmed in the long term as radiation cannot escape

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

QUESTION NUMBER

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QUESTION NUMBER

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Achievement

Subject: Earth & Space Science

Standard: 91193

Total score: 10

Q	Grade score	Marker commentary
One	A4	The candidate describes the heating of the Earth's surface in terms of direct and indirect heating. The angle of radiation is related to the curvature of the Earth. Heat capacity of water is linked to the movement of warm water away from the Equator to the poles.
Two	A3	Reflection of all visible frequencies / colours is linked to the white appearance of clouds. Absorption of light is linked to the increased water content of the cloud and hence dark colour.
Three	A3	Combined with the annotated diagram the statement describes greenhouse gas behaviour on climate. The effect of water as a greenhouse gas is partially discussed.