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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.

Merit

TOTAL 17

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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.

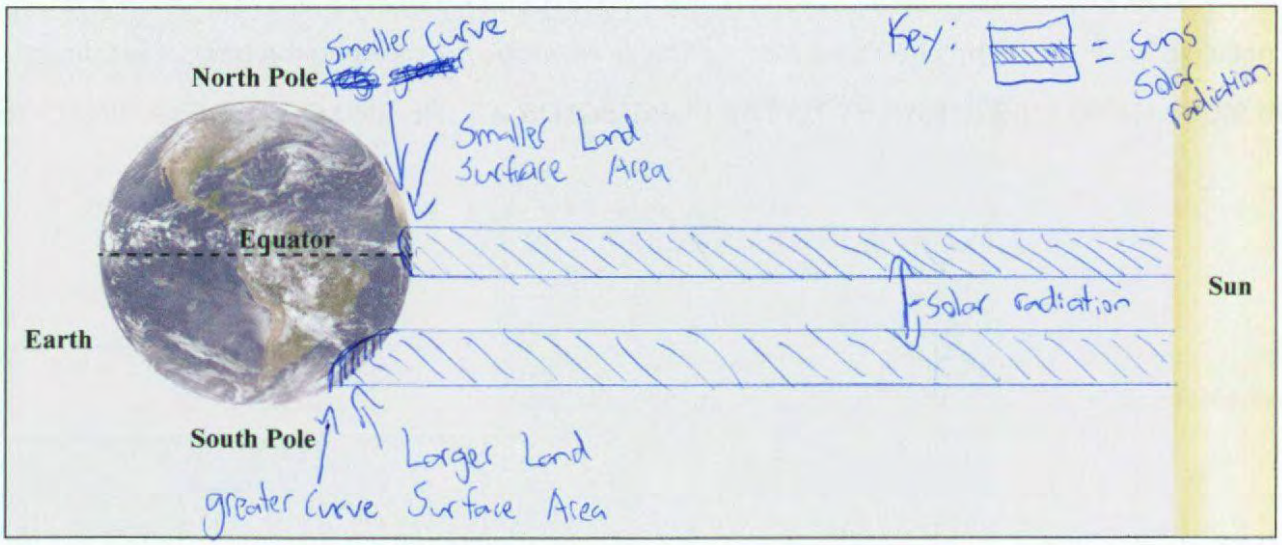
Wind is generated from High and Low air pressures. Wind causes friction on the Ocean generating Surface ocean Currents to form, from friction causing heat energy in Ocean, causing Surface currents.

(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/

Because ~~AT~~ Earth is a Sphere (circle) it gets heated unevenly. At the Equator the Suns Solar radiation is focused on a smaller Surface area, Compared to at the poles, where the Suns Solar radiation is focussed on a Larger Surface area.

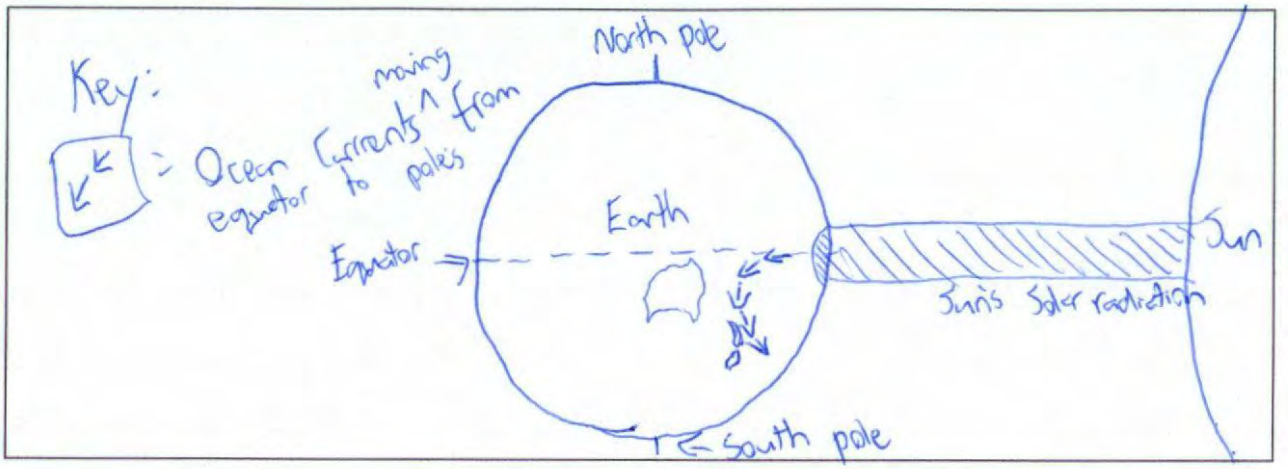
Therefore the temperatures at the Equator are higher, because the heat energy from the Suns Solar radiation is focussed on a Smaller Surface area. The Surface area at the equator is Smaller because, the Surface is more parrell to the Sun. The Suns Solar radiation is more spread out at the poles (nort & south) because the angle of earth is much steeper, less parrell as the equator. This is all because earth is a Sphere, rotating on 2 axis, the north pole and south pole.

(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.



The water near the equator is heated through the Suns Solar radiation. Water has a high specific heat capacity. This means that water can store heat a much longer period of time. As the surface water near the equator is heated by the Suns Solar radiation, it becomes less dense because it takes up less volume. This warm water moves away from the Equator to the poles in surface currents (made from corrolis effect, Wind, Gravity, Solar radiation). Heat is transfered from the Ocean to the atmosphere through conduction, When the cool air molecules/particals come into contact with the warm Ocean particals, they become heated causing them to take up more volume and become less dense and rise, because of convection currents.

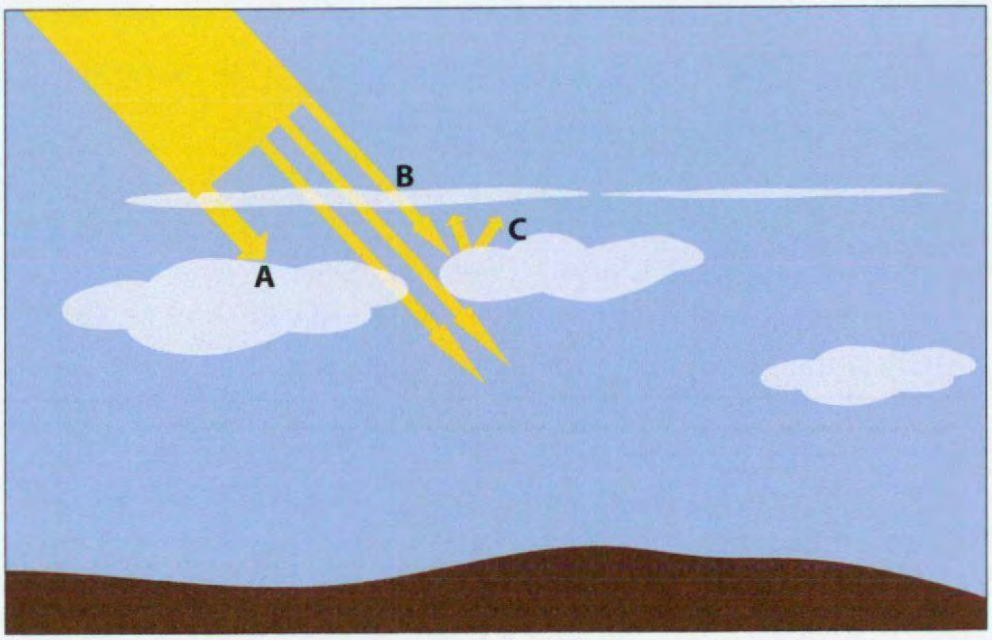
QUESTION TWO: CLOUDS

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.

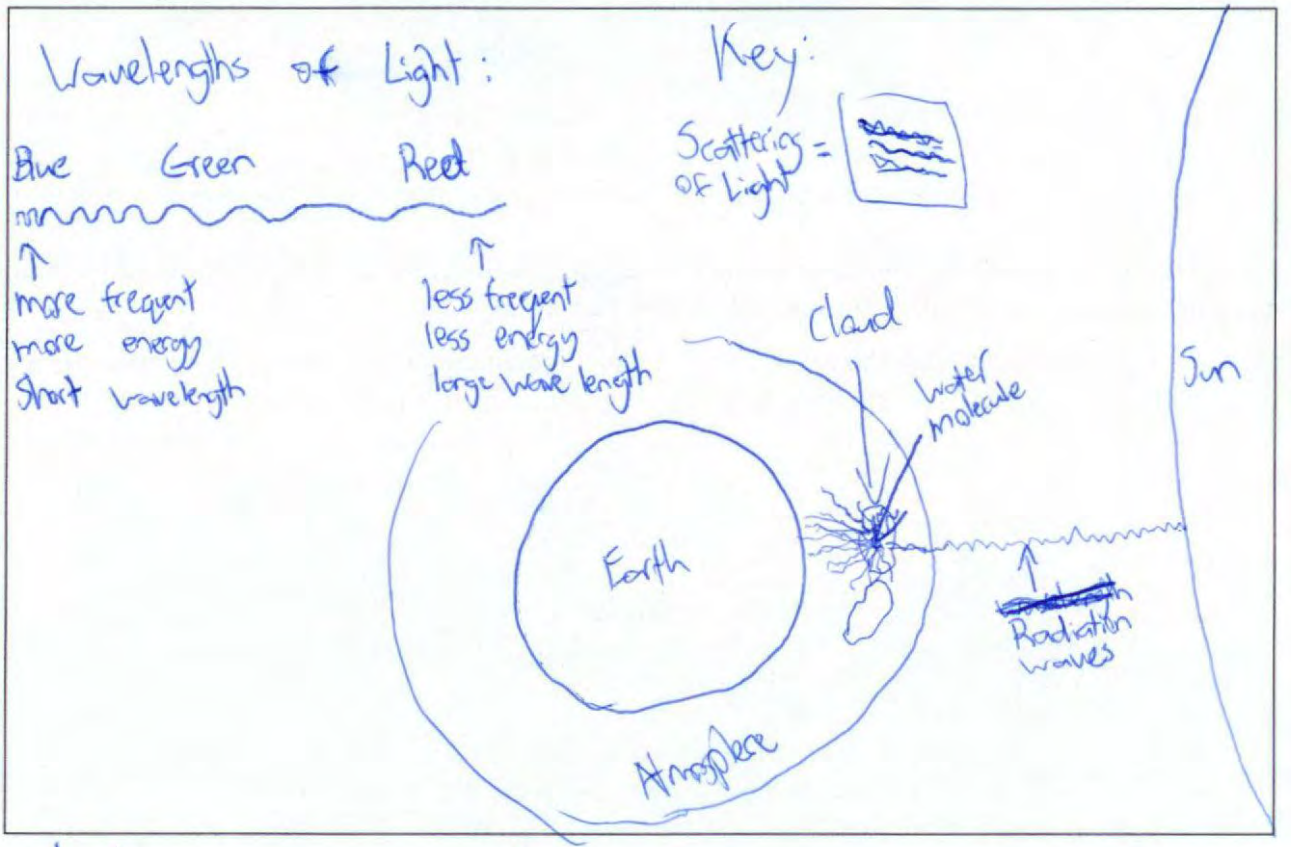
A	Absorbtion
B	Transmission
C	Reflection

(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.



Clouds are made up of water Vapor, with are condensed together forming a cloud. Mie Scattering causes the cumulus clouds to apper white from below. Because water molecules with make up the cloud are larger or ~~the~~ Some size than the wavelengths of Light, Scattering of Light is random, therefore every wavelength of Light is scattered randomly and when each of the 7 ~~colours~~ in the Light Spectrum are combined they apper white for the human eye. Therefore ^ Cumulus Clouds apper white because of Mie Scattering Of Light and water molecules making up the cloud.

We see cumulus clouds as white because of the light of different wavelengths mixing, ~~not~~ because of mie scattering and transmitting through the cloud.

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

Cumulonimbus clouds

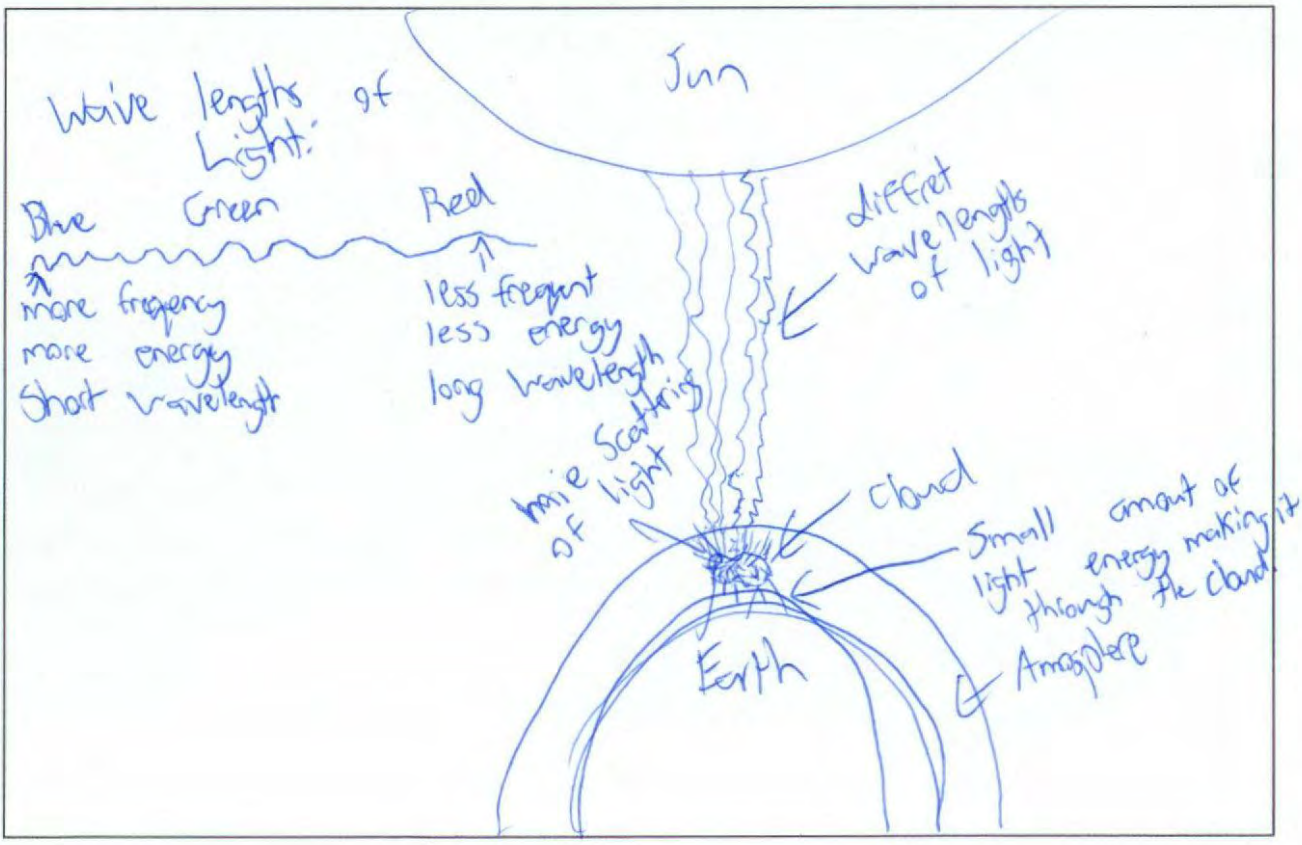
Source: https://www.weatherwatch.co.nz/content/how-to-spot-a-thunderstorm-in-the-making

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.



Because Cumulonimbus clouds have a greater amount of water molecules, mie Scattering of Light energy is increased, Water molecules are larger or Same size as the wavelengths of light therefore it cause light to be Scattered randomly, when all the different wave-lengths of light are combined they create a white light, therefore cumulus clouds apper White, However Because of the increase water molecules the light energy is Scattered more by mie Scattering this causes the ligth to lose energy, therefore the light doesn't transmit through the cloud as much causeing the Cumulonimbus clouds to apperd a dark grey or black, to the human eye, because lack of light transmission.

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.

A greenhouse gas, is a gass that can absorb heat energy and either re-emit heat energy back to earth or radiate it out to space.

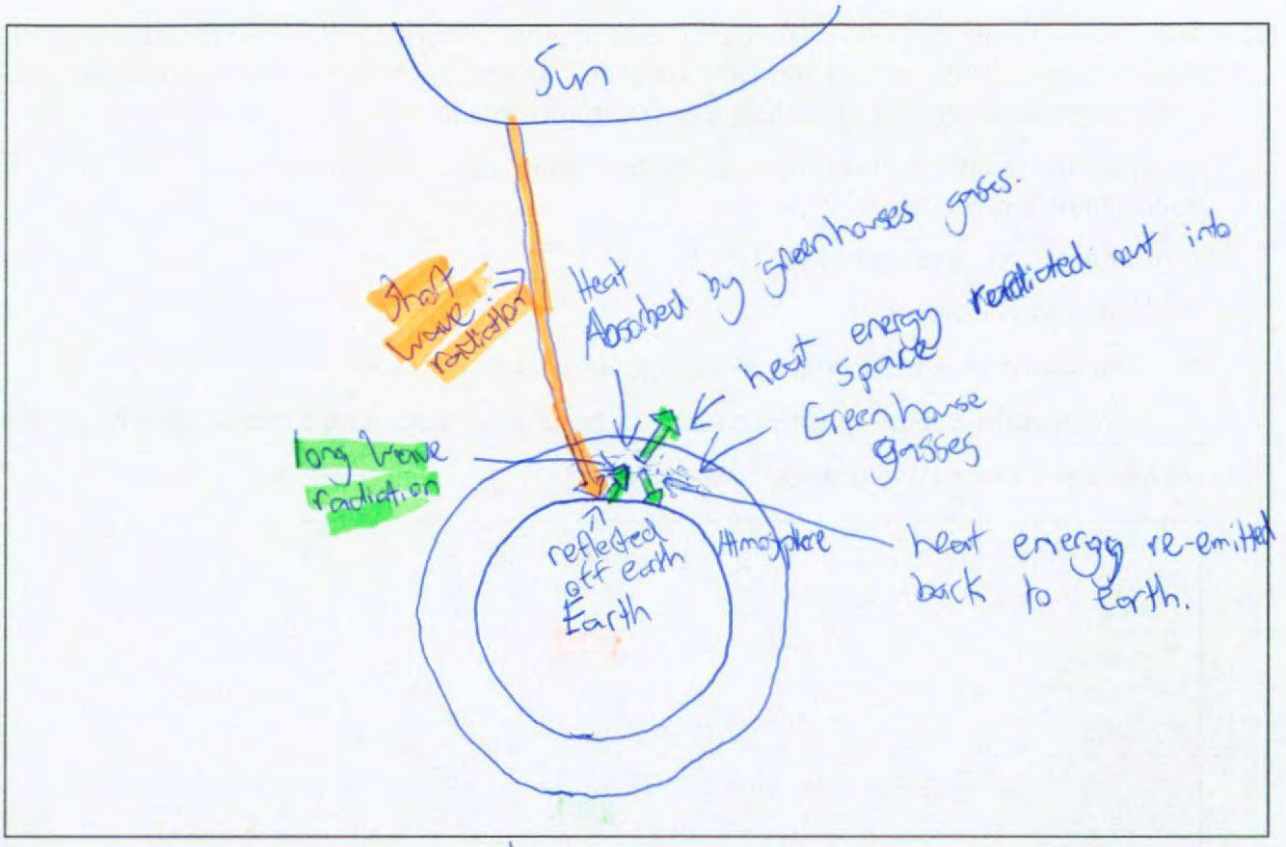
(b) Explain, in detail, the role of greenhouse gases in regulating the Earth's temperature.

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.

Greenhouse gasses such as water vapour, methan, Carbon dioxide etc. absorb the long wave radition (heat energy) reflected off earth, they act as a blanket for earth, increasing the tempature of earth. retaining the long wave radiational heat energy with had previously been reflected off earth. If there were no greenhouse gasses on earth the average tempature has estimated to be



-20°C. Once the green house gasses absorb the heat energy reflected off earth, they can either re-emitt some heat energy back to earth, which can be re absorbed by greenhouse gasses increasing earths temperature. Or the greenhouse gasses can radiate some of the heat energy out to Space.

The short wave radition from the Sun, when it reaches earths surface it can either be absorbed, or reflected. Short wave radiation can be absorbed by e.g Oceans dark surfaces, it can also be reflected by e.g Ice, shinny surface.

Question Three continues on the next page.

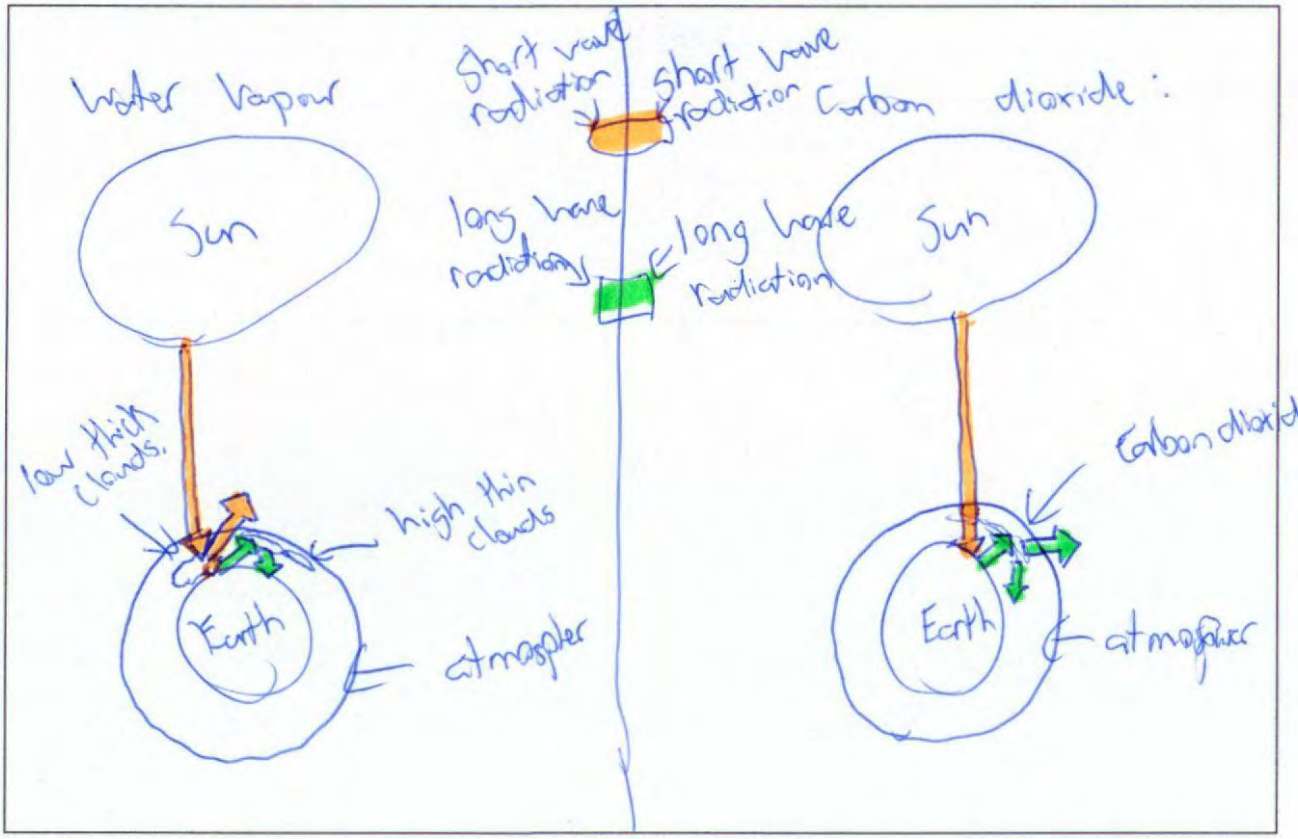
(c) The 2022 volcanic eruption in Tonga released approximately 45 million tonnes of water vapour into the atmosphere, and increased atmospheric carbon dioxide concentrations near the volcano by the equivalent amount of a whole year's carbon dioxide emissions on Earth.

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.



Greehouse gasses increase the temperature on earth, because they absorb the heat energy reflected of earth surface by long-wave radiation. The greehouse gasses can ither re-emit the heat energy back to earth or radiate it out to space.

With Increased water vapour clouds will increase. this will impact the temperature on

water vapour to form clouds. condenses

Because high thin clouds reflect long wave radiational heat energy back to earth creating a warming effect and the larg fluffy clouds reflect the short wave radiation from the Sun back out to Space creating a cooling effect on earth. Therefore ↑ Increased Water Vapour will effect tempature on earth however this effect will be short term, because clouds precipitate once they can't hold their mass. changes State from Gass (water vapor) to liquid.

Carbon dioxide will impact the tempature on earth long term because Once its a gass its State never changes, and it can't escape our atmosphere. unlike water vapour which changes State ither liquid (rain), solid (ice) or Gas (~~water~~ Cloud). Carbon dioxide absorbs reflected heat energy from earth as long wave radiation, it then ither re-emitts the heat energy back to earth where it can be re absorb by other Carbon dioxide or greenhouse gasses warming earth. or it can radiate heat energy out to space. However with more Carbon dioxide gasses more of the earths reflected long-wave radiation, heat energy will be absorbed in our atmospher increasing the tempeture on earth.

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

QUESTION NUMBER

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QUESTION NUMBER

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QUESTION NUMBER

Merit

Subject: Earth & Space Science

Standard: 91193

Total score: 17

Q	Grade score	Marker commentary
One	M5	The candidate describes the difference in the heating of the equator and poles in terms of surface area exposure. The processes linking the transfer of heat from the ocean to the atmosphere is explained as warm water moves away from the equator.
Two	M6	The candidate links the wavelengths that make the visible spectrum to the scattering process in clouds and its random nature producing the white colouration. The increase in cloud density and subsequent scattering is linked to light absorption and the dark colour of cumulonimbus clouds.
Three	M6	The candidate links the behaviour of shortwave radiation with the Earth's surface and re-emitted radiation combined with greenhouse gases impact on climate. The impact of additional gases carbon dioxide and water are explained and in particular why water is considered a short term greenhouse gas.