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91414



914140



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Level 3 Earth and Space Science 2022

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 may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL

22

QUESTION ONE: THE WATER CYCLE

The water cycle is the movement of water through the environment. While the atmosphere contains only a small amount of water, it enables water to cycle and heat energy to flow around the globe.

Explain the role of the atmosphere in transporting water and heat energy around the Earth.

In your answer, you should:

- add detailed annotations to the following diagram of the water cycle, showing water and energy entering and leaving the atmosphere during the water cycle
- explain, in detail, the processes that add water to the atmosphere
- explain, in detail, the processes that remove water from the atmosphere
- explain, in detail, the role of latent heat and sensible heat in transporting energy through the atmosphere.

w/o
phase
change

Source: www.sutori.com/en/story/the-water-cycle--RD4v8GKWCwg6FpiUAHpb1KWc

Processes which add water to the atmosphere include evaporation, where heat energy from the sun is used to change water from liquid to gas (water vapour), which enters the atmosphere and can take the form of clouds. Another process which causes water to enter the atmosphere is transpiration, where water evaporates through the membranes of plants,

thus becoming part of the atmosphere. Water is removed from the atmosphere via precipitation. This occurs when water in the atmosphere reaches its dew point, the temperature at which water vapour condenses, ^{releasing energy it absorbs when evaporating.} forming clouds. The water in the clouds can then be released as, for example, rain or snow, returning water to the ocean or land.

Latent heat is the energy required to change phase of 1 kg of substance without changing temperature, whereas sensible heat is the absorption of heat energy without phase change for the substance. Latent heat causes the evaporation of water, which absorbs the energy as it becomes water vapour from liquid water. The vapour retains this energy and is transported via wind through the atmosphere/around the globe. The water vapour then releases this heat energy when it condenses to form clouds, increasing atmosphere temperature/energy. Sensible heat heats the atmosphere by heating the land and ocean, without causing a phase change in any substances. The land and ocean absorb the heat energy and re-emit it back into the atmosphere as infrared radiation, therefore heating the atmosphere.

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

QUESTION TWO: AUSTRALIAN BUSHFIRES AND CLIMATE



Source: www.theage.com.au/national/victoria/victoria-bushfires-live-homes-lost-as-town-s-defence-breached-20191231-p53ns1.html

The 2019–20 bushfires in Australia injected huge amounts of carbon dioxide and dark-coloured carbon aerosols into the atmosphere. Scientists have recently been studying the effect of these bushfires on the atmosphere.

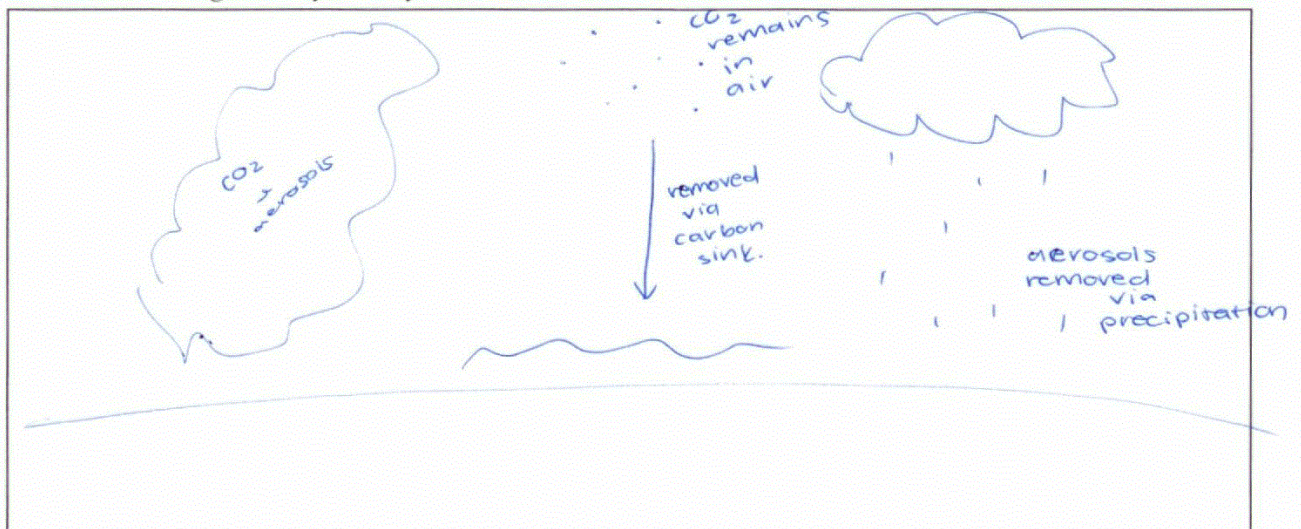
Discuss the effects that both carbon dioxide and dark-coloured carbon aerosols could have on the troposphere.

Your answer should focus on processes within the troposphere only.

In your answer, you should:

- explain what an aerosol is
- explain, in detail, two possible effects that dark-coloured carbon aerosols could have on the troposphere
- explain the effect of excessive amounts of carbon dioxide being released into the troposphere
- explain, comprehensively, the relative length of time that the effects of carbon dioxide and aerosols are likely to last.

An annotated diagram may assist your answer.



An aerosol is a minute solid particle which is suspended in the atmosphere. It can remain there for days to weeks.

Dark-coloured carbon aerosols absorb incoming UV radiation from the sun, causing the layer of the atmosphere, in this case ~~the~~ the troposphere, to be heated, meanwhile the land below it may receive less of this UV radiation and therefore temperatures may decrease. Another effect which this aerosol may have on the troposphere is decreased visibility, as light is mostly absorbed, with some also scattered/reflected by the aerosol, creating a hazy appearance.

With increased amounts of carbon dioxide (CO_2) being released into the troposphere, there is an increase of heat being reflected back down to earth by the CO_2 and an increase in the amount of solar energy being absorbed by the atmosphere, this being known as positive feedback as the temperature of Earth is increasing due to an increase in CO_2 levels in the atmosphere.

As the aerosols are only located in the troposphere, it is likely that the relative time for which the aerosols will be suspended here is only a few days, meaning their effects should only last this long as well, however, factors

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such as wind may cause the aerosols to be suspended for longer and therefore have a larger/longer effect, or rain may cause the aerosols to exit the atmosphere faster.

The effects of the CO_2 should only tend to be localised to the area from which they are released, however, it is likely they will have a longer lasting effect as the CO_2 molecules are not heavy or removed by rain, like the aerosols. These molecules will become part of the carbon cycle and must be removed by carbon sinks, such as the ocean, in order for them to exit the atmosphere.

QUESTION THREE: ATMOSPHERE LAYERS

The Earth's atmosphere can be divided into distinct layers, shown in the diagram below. Temperature, air pressure, and density all vary within and between these layers.



Adapted from: www.visionlearning.com/en/library/Earth-Science/6/Composition-of-Earths-Atmosphere/107

Explain the reasons for the differences in temperature, air pressure, and density between and within the layers of the atmosphere.

In your answer, you should:

- define temperature, air pressure, and density in relation to the layers of the atmosphere
- explain, comprehensively, the reason for the changes in temperature, air pressure, and density with increasing altitude
- compare and contrast the differences within and between the layers of the atmosphere shown in the diagram.

An annotated diagram may assist your answer.

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Each layer of the atmosphere undergoes temperature inversion due to different heat sources. Temperature is the relative energy of particles, ^{air} pressure is the weight of air over a certain area and density is the mass per unit of volume. Density decreases as altitude increases, due to the air molecules becoming more spread out, which causes a decrease in pressure as there ~~are~~ are less air ^{molecules} in an area and therefore it is less heavy.

In the troposphere, the heat source is the ground as it re-emits absorbed solar heat energy as infrared radiation. This means the further from the ground/the higher the altitude, the lower the temperature as the distance from the heat source increases.

The stratosphere is heated by the ozone layer as it absorbs harmful UV radiation and re-emits it as heat energy, meaning that as altitude increases in the stratosphere, so does temperature.

The mesosphere is heated by solar radiation, therefore the closer to the sun, the higher the temperature as more energy is recieved and absorbed at higher altitudes.

The thnermasphere is also heated by solar radiation such as X-rays, however, due to the number of air molecules in this layer being very low,

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layer will feel especially further out, the ~~amount of energy~~ ^{cold} that ~~can be absorbed~~, ~~therefore making~~ the layer, ~~lessens~~ ^{as} ~~the~~ ^{higher} the altitude, however, so temperature ~~decreases~~ ⁱⁿ with higher altitudes in this layer.

The troposphere is the ~~low~~ most dense and ~~most~~ ^{pressure} has the highest ~~temp~~ due to the pull of gravity being strongest in this layer, therefore most molecules are found here. Compared to the thermosphere, which is approximately 80 km away from Earth and therefore has weak gravity holding the air molecules in this layer, resulting in the lowest density and pressure of all the layers.

As well as this, the troposphere has colder temperatures compared to the thermosphere, which can have temperatures ranging between 200°C to 2000°C , but still feels warmer than the thermosphere due to the density of the air molecules in the troposphere layer.

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Standard	91414	Display ID		Total score	-22- E
Q	Grade score	Annotation			
1	8	Candidate integrated explanation of latent heat release and condensation, while also comprehensively explaining process of evaporation, linked to energy, as well as sensible heat (to an extent)			
2	7	E mark awarded for discussion of effects of carbon dioxide as greenhouse gas, trapping outgoing radiation and increasing temperature of troposphere. The explanation of dark carbon absorbing heat and increasing temperature is at merit level as the link is made only to UV radiation captured and not albedo / cooling. Length of stay in atmosphere for aerosols not linked to their role			
3	7	Candidate comprehensively explains the temperature gradient for troposphere, stratosphere and thermosphere, linking to sources of heat energy. They missed the E mark for pressure explanation as general trend is described from troposphere to thermosphere, without detailed reasons for pressure change in each layer linking to composition or density/temperature			