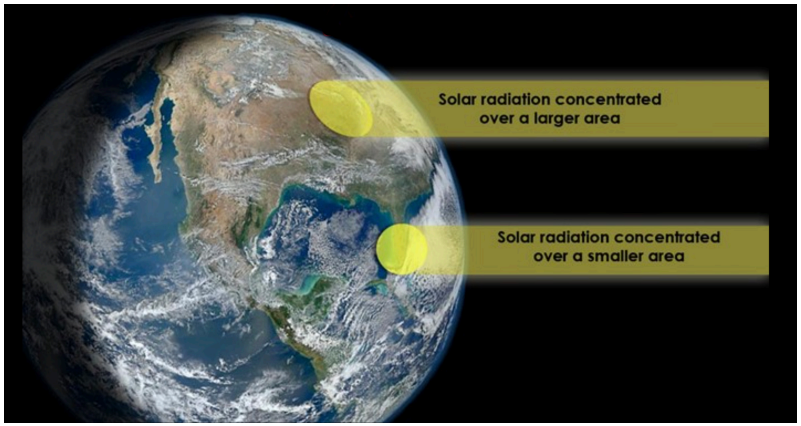
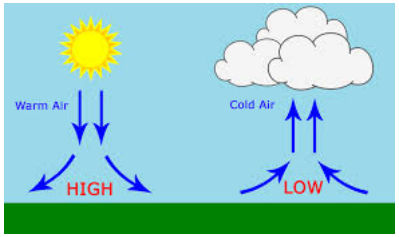
Assessment Schedule – 2021

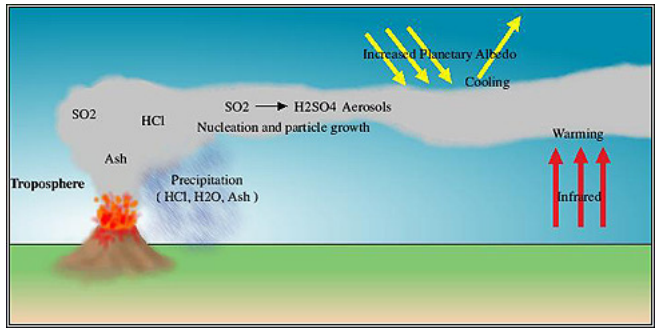
Earth and Space Science: Demonstrate understanding of processes in the atmosphere system (91414)

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE	The low-pressure systems form due to the higher intensity of solar radiation when the Sun is directly overhead. This higher-intensity sunlight is absorbed by the Earth's surface and heats the air directly above, lowering the density and causing the air mass to rise.  https://slideplayer.com/slide/9449769/ The direct sunlight and heat also cause a large amount of evaporation, and the warm air mass can hold a lot of moisture. As this warm, moist air mass rises, the air expands and cools beyond its dew point, which is the point at which the air cannot hold any more moisture. This causes the water vapour in the air to condense forming clouds. Large amounts of moisture and heat in the atmosphere lead to cloudy, rainy conditions. Once this rising air reaches the tropopause (e.g., at 0 and 60° latitude), it will move away as it is replaced by more rising air. This air is now cool and dry, which will cause it to sink, forming a part of a convection cell such as the Hadley, Ferrel, and Polar cells. High-pressure systems develop when this cool, dense air sinks towards the surface from the upper troposphere. For example, these commonly develop at around 30° and 90° latitude. The cool, dry air warms and contracts as it sinks, allowing it to hold more moisture and therefore clouds are not common. This lack of clouds means that the surface of the Earth will cool quickly at night and can lead to morning frosts. Low-pressure systems develop when warm, moist air rises towards the tropopause.	Explains (can come from diagram): • how lower latitudes receive more intense solar radiation / warmer (or converse) • how warmed ground heats air • how high pressure is linked with sinking air • how low pressure is linked with rising air • how formation of high-pressure systems is linked with tropospheric circulation • how formation of low-pressure systems is linked with tropospheric circulation • how rising air is linked to cloud formation / precipitation • how sinking / warming air is linked to calm, clear conditions.	Explains in detail: • difference in solar radiation intensity with latitude • role of differential heating in atmospheric circulation • how atmospheric circulation can lead to areas of high / low pressure • how sinking, warming / contracting air leads to high pressure • how sinking warming / contracting air leads to calm, clear conditions • how rising cooling / expanding air leads to cloudy, rainy conditions • how rising cooling / expanding air leads to low pressure • how Coriolis force contributes to cell formation.	Explains comprehensively: • the role of varying solar intensity with latitude in the formation of atmospheric circulation • atmospheric circulation's role in varying air pressure with latitude • how sinking air leads to contracting / warming air and high-pressure producing calm, clear conditions • how rising air leads to expanding / cooling air and low pressure producing cloudy / rainy conditions.

	These often develop at 0 and 60° latitude due to atmospheric circulation. As the warm, moist air rises, it will cool, and the amount of moisture it can hold is reduced, causing clouds to form and precipitation. As warm and cool air masses meet, warm air is forced up and over the cooler, more dense air, which can give rise to warm and cold fronts.  https://quizlet.com/535125943/stemscopes-heat-transfer-unit-flash-cards/			

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE point from Achievement.	TWO points from Achievement.	THEE points from Achievement.	FOUR points from Achievement.	ONE point from Merit.	TWO points from Merit.	ONE point from Excellence or TWO with minor error / omission.	TWO points from Excellence.

Q	Evidence	Achievement	Merit	Excellence
TWO	 http://www.exobiologie.info/401.pdf Most of the larger particles of ash from Mt Tambora would only reach the troposphere, where they would have short-term, local effects. However, due to the huge size of the Mount Tambora eruption, the plume, especially the smaller ash particles and gases, would have reached the stratosphere. Over the following weeks and months, the sulphur would be converted into sulfuric acid, which is an aerosol. As the stratosphere is more stable than the troposphere (as it is heated from above), there is little vertical circulation and therefore mixing; however, there is a large amount of horizontal mixing with stratospheric winds. This, and the lack of rain in the stratosphere, mean the aerosols and gases would be distributed around the globe due to the rotation of the Earth and the strong stratospheric winds. Although Mount Tambora is in the Southern Hemisphere, it is near the Equator, so these volcanic aerosols could be distributed towards both poles. The fine ash and aerosols released into the stratosphere have an impact on the global climate, raising the atmosphere's albedo and therefore reflecting more incoming solar (short wave) radiation, causing the surface to cool and lowering the global temperatures. This may also produce a visible haze in the atmosphere due to the dust particles present, and vivid red skies in the morning and evening.	Explains: • Larger particles reach troposphere only. • Troposphere experiences short-term / local effects. • The size of the eruption causes material to enter the stratosphere. • Stratospheric winds carry aerosols around the globe. • Aerosols reflect incoming solar radiation. • Increase in atmospheric albedo (due to aerosols / tephra). • Reflection / blocking of sunlight reduces the temperature of the troposphere.	Explains in detail: • Troposphere material causes short-term, regional cooling, as it is quickly washed out by weather. • Volcano releases tephra, ash, and gases such as sulfur, which converts to sulfuric acid / aerosol. • Large size of the eruption causing many aerosols / sulfur to enter the stratosphere. • Vertically stable stratosphere means material will persist for years after the eruption. • Stratospheric winds carry aerosols around the globe due to vertical stability / no weather. • Material released into the troposphere will be quickly washed out by weather. • Aerosols increase albedo of the stratosphere reflecting sunlight / reducing surface / troposphere temperatures. • Coriolis effect responsible for direction / distribution of stratospheric aerosols over Western Europe.	Explains comprehensively: • Massive eruption size causes large amounts of ash and gases to enter the stratosphere where it spread around the globe and remained in the stable / no weather stratosphere for many years. • Ash and aerosols such as sulfuric acid increase albedo of the atmosphere, which reflects more incoming solar radiation, reducing the amount reaching the troposphere and surface, cooling the climate. • H_2S and SO_2 in the stratosphere quickly become sulfuric acid, which increases the albedo of the stratosphere for 1–3 years, while ash and gases in the troposphere are quickly washed out by weather.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE point from Achievement.	TWO points from Achievement.	THEE points from Achievement.	FOUR points from Achievement.	TWO points from Merit.	THREE points from Merit.	ONE point from Excellence or TWO with minor omission.	TWO points from Excellence.

Q	Evidence	Achievement	Merit	Excellence
THREE	The biggest impact humans have had on the atmosphere is the rapid **burning of fossil fuels** like coal, oil, and gas as an energy source. This carbon was trapped as hydrocarbons in the Earth's crust by partial decomposition of living organisms. **Biological processes** **Photosynthesis** can take place in the ocean or on land. Photosynthetic organisms like plankton and grass take in carbon dioxide from the atmosphere and use the Sun's energy to make biological compounds. Human activity has removed a large amount of forest from land, reducing the amount of CO_2 that plants absorb from the atmosphere. Ocean acidification due to increased carbon in the atmosphere from burning fossil fuels may also potentially reduce the photosynthetic plankton in the ocean, which would also reduce the amount of CO_2 being removed from the atmosphere. Organisms in the food web also return carbon to the atmosphere by **respiration** of carbohydrates to release energy for biological processes. For example, microbes in the soil decompose dead organic matter, releasing carbon into the atmosphere. **Physical processes** CO_2 is constantly being exchanged with the **oceans at the surface through diffusion. This process is sped up by cooling** water and wave action. As humans are causing the climate to warm, this could decrease the amount of CO_2 diffusing in the oceans, especially at the poles where it is removed to the deep ocean for thousands of years. **Sedimentary rocks** are constantly being formed over long periods of time, and can trap biological carbon where it can remain forever. However, this carbon can be recycled by plate tectonics, weathering and **volcanic eruptions** which may also add large amounts of carbon to the atmosphere over very short periods of time. Human impacts, by reducing photosynthetic organisms and their habitats, along with burning large amounts of fossil fuels, have led to a rapid increase in atmospheric carbon levels to amounts that have not been recorded for at least 800 000 years.	Explains: • Sources of carbon add CO_2 to the atmosphere, while sinks remove CO_2 from the atmosphere. • If these processes (sources and sinks) balance, then the amount of carbon in the atmosphere remains constant. • One biological process identified as a sink / source. • One other physical process identified as a sink / source. • Some plants live for a very long time and may sequester carbon for relatively long periods of time. • Humans have reduced the removal of carbon from the atmosphere. • Humans have increased the addition of carbon to the atmosphere. • Increased CO_2 in the atmosphere causes warming of troposphere.	Explains in detail: • Fossil fuels take a long time to form, while humans have rapidly returned this carbon to the atmosphere by burning large amounts of fossil fuels as an energy source. • Ocean acidification / deforestation by humans has reduced the potential for photosynthesis to remove carbon from the atmosphere, which has increased atmospheric carbon. • Carbon diffusing into the ocean has been increased due to humans increasing the amount of carbon in the atmosphere, (but not at a sufficient rate to compensate for the increased burning of fossil fuels.) • While formation of limestone removes CO_2, production of cement processes limestone / $CaCO_3$ to produce CO_2. • Human activities are adding carbon to the atmosphere faster than it can be removed by natural carbon sinks / processes,	Explains comprehensively: • Carbon diffusing into the ocean has been increased due to humans increasing the amount of carbon in the atmosphere, but not at a sufficient rate to compensate for the increased burning of fossil fuels. However, increasing global temperatures may reduce the rate of diffusion as oceans warm. • Overall, human activities have increased the amount of atmospheric carbon by increasing carbon sources such as burning fossil fuels, deforestation, and reduced some carbon sinks such as photosynthesis, while not having an effect on some processes like volcanic activity. • If carbon enters the atmosphere at the same rate as its removal, then atmospheric CO_2 remains the same. However, small changes in sinks and sources will cause rapid changes in atmospheric carbon, as it is a relatively small carbon store.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE point from Achievement.	TWO points from Achievement.	THREE points from Achievement.	FOUR points from Achievement.	ONE points from Merit.	TWO points from Merit.	ONE point from Excellence or TWO with minor omission.	TWO points from Excellence.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 13	14 – 18	19 – 24