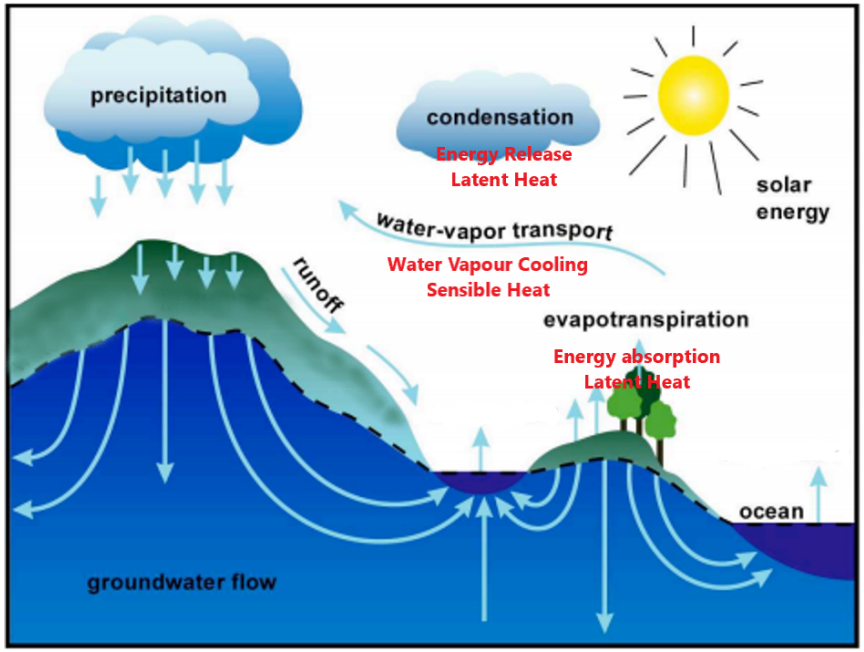
Assessment Schedule – 2022

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

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE	 https://www.slideshare.net/sbvijay2003/unitivhydro-electric-power-plants **Evaporation** is a process whereby liquid water gains enough energy to become a gas. This absorbs energy from its surroundings, for example, by solar energy reaching the surface of a lake and increasing the temperature of the water. When the water has absorbed sufficient energy, it will change state, turning it from a liquid into a gas and carrying the energy into the atmosphere. **Condensation** occurs when gaseous water vapour changes to liquid water droplets. For example, when moist air rises and expands, it will cool, forming clouds in the upper troposphere. As water vapour loses energy (sensible heat), it will reach the dew point, where the air is saturated and forms liquid water droplets. This will add heat energy to the atmosphere as clouds, fog, dew or frost form and release latent heat. **Precipitation** occurs when the water droplets or ice crystals are sufficiently large so	Describes with understanding: OR Water cycle drawn showing: • evaporation, condensation, precipitation (2 of 3) • energy in (evaporation) OR out (condensation) of the atmospheric water cycle • sensible heat as change in temperature without changing state • latent heat as energy change due to change in state • evaporation as liquid water becoming gas • condensation as gas becoming liquid water • precipitation as water / ice falling from the atmosphere to the earth's surface.	Explains: • how water enters the atmosphere through evaporation (OR transpiration) • how water leaves the atmosphere through condensation • how water leaves the atmosphere through precipitation • how energy enters or leaves the water cycle (e.g. latent heat) • how energy enters or leaves the water cycle (e.g. sensible heat).	Explains comprehensively: • how matter / water enters and leaves the atmosphere through evaporation and condensation • evaporation (or transpiration) as the process where energy enters the atmosphere linked to latent heat OR condensation as energy leaving the water cycle linked to latent heat • sensible heat as energy entering and leaving the atmospheric water cycle with no change of state linked to an example of where this may occur.

	that they can no longer be suspended as clouds. This will remove the water from the atmosphere and return it to the ground where the water cycle continues. **Sensible Heat** is when water gains energy, which changes its temperature without changing state. For example, water vapour in the air may absorb energy from its surroundings, increasing the temperature of the gaseous water without it changing state. **Latent Heat** is when the water molecules change state. When water evaporates, it will absorb energy from the surroundings by conduction or absorbing radiation (e.g., solar or IR), which gives the water molecules sufficient energy to turn into a gas. This will carry the energy and water molecules into the atmosphere, where they can be moved both vertically and laterally. When the water vapour cools, it will release heat into the surroundings, and as it changes state back into water, releasing latent heat into the surroundings. In this way, energy can be transferred from one part of the environment to another – for example, from the surface to the upper troposphere, or from the Equator to the poles.			

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 point from Merit.	TWO points from Merit.	ONE point from Excellence.	TWO points from Excellence.

Q	Evidence	Achievement	Merit	Excellence
TWO	Aerosols are tiny particles of matter suspended in the atmosphere. In this case the aerosols are tiny particles of carbon / charcoal that have been released by the bushfires and have entered the atmosphere. The aerosols have then been blown towards New Zealand. An increased number of aerosols released into the troposphere will result in less solar energy reaching the surface of the earth. This will result in less IR radiation being re-radiated back into the troposphere and therefore cooling the troposphere. Conversely, as the bushfire aerosols are black, they have a very low albedo, which means they absorb, and release energy quickly compared to lighter-coloured materials. This will mean that the troposphere that contains the aerosols will absorb more solar energy, which will increase the temperature of the troposphere. This increase in temperature could also increase the amount of water vapour the air could hold and lead to reduced rainfall. Aerosols also act as cloud condensation nuclei. They can also increase cloud formation. This would increase precipitation, as more clouds are formed. The cloud cover would also increase the albedo of the troposphere and reflect more incoming solar energy away from the atmosphere. As aerosols are larger particles in the atmosphere, they are likely to quickly fall out of the atmosphere or become a part of clouds and be rained out, so they are likely to persist only for days and weeks in the troposphere. The carbon dioxide released into the atmosphere is likely to contribute to longer term effects. As the carbon dioxide molecules are much smaller, they will become a part of the increasing amount of CO_2 in the atmosphere. The effect of this is that outgoing, infrared radiation emitted by the surface of the earth is trapped in the troposphere by the carbon dioxide, which increases the temperature of the troposphere. This is a long-term and ongoing effect, as the amount of CO_2 emitted by humans continues to increase. As this in turn contributes to drying out and drought in areas such as parts of Australia, bushfires are likely to become more frequent, resulting in a positive feedback loop for global warming.	Describes with understanding: • aerosols are tiny particles of matter that is suspended in the atmosphere • aerosols shade the surface, leading to cooling • dark aerosols will absorb solar energy • dark aerosols will increase the temperature of the troposphere • dark carbon aerosols are a short-term effect • carbon dioxide is a greenhouse gas • aerosols enable clouds / rainfall to form • clouds can reflect solar radiation / trap outgoing radiation • carbon dioxide is likely to last longer in the atmosphere (or converse). • Aerosols will wash out fast in the troposphere	Explains: • aerosols shade the Earth's surface, leading to less solar radiation warming the surface and therefore cooling (reflect / scatter) • dark / carbon aerosols have a very low albedo and will absorb solar energy • dark aerosols will absorb solar energy, increasing the temperature of the troposphere • water condenses on aerosols (cloud condensation nuclei) increasing the formation of clouds / rainfall • increased cloud formation could reflect / trap radiation and reduce / regulate the temperature of the troposphere • excessive carbon dioxide will increase the greenhouse effect / trap outgoing radiation • aerosols are more likely to be washed out of the troposphere quickly.	Explains comprehensively: • dark aerosols have a very low albedo, absorb solar radiation and release heat into the troposphere increasing the temperature whilst also shading the surface and leading to cooling • water condenses on aerosols (cloud condensation nuclei), increasing the formation of clouds / rainfall, which may reduce incoming solar radiation, reducing temperature (or trap outgoing radiation at night, regulating temperature) • increased carbon dioxide increasing the greenhouse effect by trapping more outgoing / longer wavelength / infrared radiation increasing the temperature of the troposphere • compares length of time aerosols and CO_2 remain in the troposphere relating to the role of each in the troposphere.

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.	TWO points from Merit.	THREE points from Merit.	ONE point from Excellence.	TWO points from Excellence.

Q	Evidence	Achievement	Merit	Excellence
THREE	**Temperature** is a measure of the heat energy within each layer of the atmosphere. The amount of energy will vary according to the layer's composition and energy source. **Air Pressure** is a measure of the amount of force exerted on a surface. Air pressure increases as you get closer to the surface of the Earth as the weight of the air above pushes the air down onto the air below due to gravity. This also increases the density of the air as you get closer to the surface of the Earth. **Density** is the amount of air particles per unit volume, and the air is increasingly thin and spread out as the altitude increases. The **troposphere** is the lowest layer of the atmosphere and contains most (75%) of the mass of the atmosphere due to the weight of the higher layers pushing down on the troposphere. This makes it much more dense with a higher air pressure. The troposphere is heated from below as the ground emits infrared (longer wave) radiation, which is absorbed by matter in the troposphere. Therefore, the further from the surface from the Earth, the lower the temperature of the thermosphere. The **stratosphere** is the next layer of the atmosphere. The stratosphere contains the ozone layer, which absorbs UV radiation from the sun, forming a heat source for this layer. As the heat source is coming from above, the stratosphere increases in temperature with altitude. The top of the stratosphere reaches temperatures of around 0ºC. The **mesosphere** is a very thin layer that absorbs very little solar radiation. For this reason, the mesosphere is the coldest layer of the atmosphere that decreases in temperature with altitude, reaching as low as –100ºC. The **thermosphere** is a layer with very little density and therefore air pressure. However, as one of the highest layers, it absorbs high energy radiation (gamma / x-rays) from the sun and space, causing ionisation for atoms, which releases heat energy into the thermosphere. This may cause it to reach temperatures as high as 1000ºC. As this layer is so thin, it may feel cold even though the air particles are very high in energy.	Describes with understanding: • gas composition of the atmosphere (78% N, 21% O_2, trace gases) • temperature as the amount of heat energy (movement of air particles) • pressure as the amount of force exerted on a surface • density as the amount of matter / air particles in a given volume • temperature as linked to the source of heat in a layer (e.g. troposphere heated from below / stratosphere heated from above) • air pressure is due to gravity / weight of air particles pushing down from above • density higher at the surface due to the increased air pressure • mesosphere coldest due to absence of heat source in the layer .	Explains: • composition of the layers described with difference of ozone / water vapour • thermosphere and stratosphere heated from incoming (solar) radiation, so temperature increases with altitude • troposphere is heated from the surface of the earth (below) so temperature decreases with altitude • the troposphere denser than the layers of the atmosphere above it as the weight of air above is compressing and contains up to 75% of the mass • air pressure depends upon density or air mass and temperature as increasing temperature / decreasing pressure causes air particles to spread out more.	Explains comprehensively: • the reason for differences in temperature in three layers of the atmosphere (sources of heat, type of radiation/processes causing heat retention / absorption) • the reason for differences in pressure for three layers of the atmosphere (linked to density) • the gradients of temperature and pressure and how this relates to density with increasing altitude.

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No response; no relevant evidence.	ONE point from Achievement.	TWO points from Achievement.	THREE points from Achievement.	FOUR points from Achievement.	ONE point from Merit.	TWO points from Merit.	ONE point from Excellence (minor omission OK).	TWO points from Excellence (minor omission OK).

Cut Scores

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