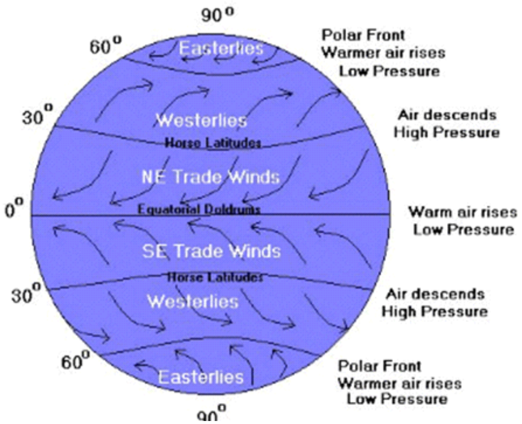
Assessment Schedule – 2019

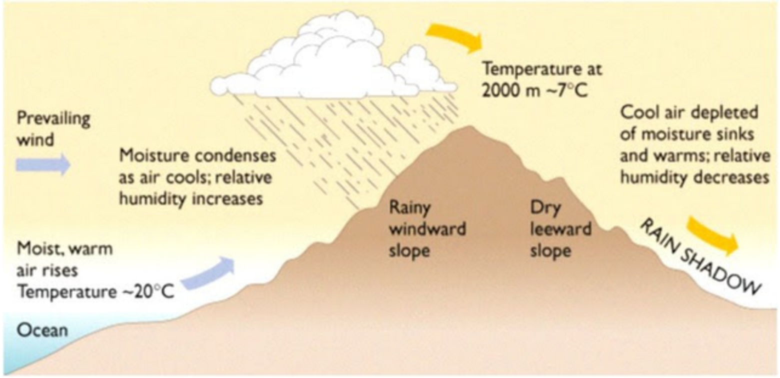
Earth and Space Science: Demonstrate understanding of processes in the atmosphere system (91414)

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE	**Heat source of each layer** Short-wavelength / high-energy solar radiation – thermosphere, mesosphere, stratosphere Long wavelength / low-energy infra-red radiation from Earth's surface – troposphere **Reasons for temperature gradient in each layer** Troposphere – the temperature decreases with altitude because the heat source is the surface of the Earth, therefore as air density decreases further away from the source, and clouds and greenhouse gases absorb infrared radiation, the temperature becomes lower. Stratosphere – the temperature is higher at higher altitudes. This is due to the ozone layer that absorbs UV radiation from the Sun, and re-emits it into the surrounding air, causing it to heat. Mesosphere – the temperature decreases with altitude as the air density is very low and decreases with altitude, meaning there are very few air particles in this layer to absorb solar radiation. Thermosphere – the temperature increases with altitude. The reason for this is that although there are very few air particles in this layer, they are the first to receive solar radiation, and ionisation of the solar radiation occurs helping to heat it. **Effect of changes in seasons and latitude on the height of troposphere** The thickness and boundary of the troposphere are not identical around the globe, varying with season and latitude. Due to the uneven heating of the Earth, in low-latitude regions the top of the troposphere will be higher than at higher latitudes, as low-latitude regions receive sunlight that is more direct. The tilt of the Earth means that as the Earth rotates around the Sun in a year, different locations will be tilted either towards or away from the Sun, altering the amount of solar radiation reaching different locations. As a result, there will be seasonal variations in the height of the troposphere, for example in summer, the Earth is tilted towards the Sun and therefore there is more direct solar radiation reaching the surface, leading to an increase in surface temperature, and therefore the top of the troposphere will be higher.	• Links heat source of layers with types of radiation. • Links decrease in temperature in troposphere to distance from heat source. • Links ozone to increase in temperature in stratosphere. • Links decrease in temperature of mesosphere to air density. • Links increase in temperature in thermosphere to being closer to Sun / ionisation layer. • Links lack of change of temperature in pauses to change in heating of layers. • Links uneven heating of Earth to differences in graph with named latitude. • Links tilt of the Earth with variations in graph with named season.	• Explains how troposphere is heated. • Explains how stratosphere is heated. • Explains how mesosphere is heated. • Explains how thermosphere is heated. • Explains how and why the graph would vary with different latitudes. • Explains why the graph would vary with named seasons.	• Comprehensive discussion of the temperature gradient graph explaining the heat sources of each layer, factors that affect the gradient, and the effect of latitude and the seasons on the troposphere.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	1 partial point from Achievement.	1 point / 2 partial points from Achievement.	2 points from Achievement.	3 points from Achievement.	2 points from Merit.	3 points from Merit.	Excellence with minor error / omission.	Full Excellence answer.

Q	Evidence	Achievement	Merit	Excellence
TWO	**Role of solar radiation on wind formation** All wind is caused because of the uneven heating of the Earth's surface, which sets convection currents in motion. Earth's curved surface causes some parts of the Earth to receive solar radiation directly (eg. Equator). **Role of air pressure on wind formation** Differences in air pressure form winds. When warm air rises, a low pressure system is formed; conversely when cold air drops, it forms an area of high pressure. Air will always move from an area of high pressure to an area of low pressure. In the Ferrel Cell, cold air descends at 30° latitude, leading to a high pressure area being created. At 60° latitude, warmer air rises, leading to a low pressure area. This causes the high pressure air from the 30° latitude to move towards the 60° latitude, forming the westerly winds. **Role of Coriolis effect on wind formation** The Coriolis effect is the apparent deflection of air masses (in this case) because of the rotation of the Earth below. When air moves in a rotating system, it experiences a (pseudo) force at right angles to its direction of motion and the axes of rotation. This leads to the deflection of the wind. In the Southern Hemisphere, the wind is deflected towards the left, causing the southwards moving air masses to be curved westwards.  **Role of Southern Alps on precipitation rates** When the warm, moist air from the Tasman Sea reaches the Southern Alps of New Zealand, the air is forced upwards over the alps (orographic lifting). This causes the air to cool quickly; when it is cool enough for the dew point to be reached, condensation begins, leading to cloud formation and eventually precipitation. The steep sides of the southern	• Links Ferrel Cell to formation of westerly winds. • Links uneven heating of Earth's surface to wind formation. • Links high and low pressure areas to correct latitudes. • Links air movement / wind to air pressure. • Explains Coriolis effect on wind. • Links movement of westerly wind south to Coriolis effect. • Links rising moist air to cloud formation / high precipitation. • Links steepness of Alps to higher than average rainfall.	• Explains the role of solar radiation on the formation of a circulation cell. • Explains how winds are formed in terms of air pressure. • Explains the role of the Coriolis effect on the westerly wind formation. • Explains the high annual precipitation rates on the West Coast in terms of orographic lifting.	• A comprehensive explanation of how the westerly winds of the Roaring Forties are formed AND how these contribute to the high annual precipitation on the West Coast.

	Alps cause this process to happen quickly, leading to heavy precipitation rates on the west coast of the South Island.  			

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	1 partial point from Achievement.	1 point / 2 partial points from Achievement.	2 points from Achievement.	3 points from Achievement.	2 points from Merit.	3 points from Merit.	Excellence with minor error / omission.	Full Excellence answer.

Q	Evidence	Achievement	Merit	Excellence
THREE	**How Earth's temperature affects the water cycle** The water cycle is closely related to the Earth's temperature. The concentration of water in the atmosphere is largely controlled by the Earth's temperature. When the temperature increases, this leads to greater rates of evaporation, which leads to more condensation and cloud formation. An increase in clouds can either increase the air temperature as they act as a greenhouse gas, re-radiating heat towards the surface, or it can cool the air temperature by reflecting solar radiation away from the surface of the Earth. Clouds generally lead to precipitation, so an increase in clouds can also increase precipitation. If the Earth's temperature decreases, this will lead to less evaporation, meaning less cloud formation. As well as meaning less precipitation, this will also mean more solar radiation can reach the surface of the Earth causing an increase in temperature. **Role of carbon cycle in temperature regulation** The addition and removal of carbon dioxide from the atmosphere acts as a natural temperature thermostat for the Earth. Carbon dioxide is added to the atmosphere through respiration, decomposition, combustion, burning of fossil fuels and volcanic eruptions. In the atmosphere, it acts as a greenhouse gas and is able to trap infra-red radiation, warming the Earth to a liveable temperature. In normal conditions, the amount of carbon dioxide in the atmosphere is regulated by the ocean, which absorbs vast quantities, and photosynthesis by plants, maintaining the Earth's temperature. **How humans are changing the cycles (some examples)** The burning of fossil fuels is increasing the amount of carbon dioxide released into the atmosphere at rapid rates, which cannot be compensated for quickly enough by the natural cycle. Carbon stored in fossil fuels would normally remain in the Earth for millions of years and be released slowly. The increase in carbon dioxide levels increases the greenhouse gases, causing global temperatures to warm, affecting the water cycle by increasing evaporation, cloud cover, melting of ice, and eventual sea level rise. Humans are also cutting down and burning forests at alarming rates, leading to a global decrease in the amount of carbon dioxide removed from the atmosphere by photosynthesis. Deforestation means that plants do not release water vapour, leading to a decrease in precipitation, as well as increased run-off and leaching of the land, making it more prone to droughts and floods. A rising population has led to high demand for food meaning higher levels of irrigation,	• Links concentration of water in atmosphere to global temperatures. • Links increased cloud cover to either cooling / heating of Earth's surface. • Links decreased cloud cover to heating of Earth's surface. • Links atmospheric carbon dioxide to greenhouse gases and a liveable temperature. • Links one part of carbon cycle to addition / removal of carbon dioxide from atmosphere. • Links burning of fossil fuels / deforestation to increase in atmospheric carbon dioxide levels. • Links increased temperatures and an effect on the water cycle. • Links deforestation to decrease in amount of carbon dioxide removed from atmosphere and less precipitation. • Links increase in global population / irrigation to depletion of groundwater and droughts / floods. • Links changes to carbon cycle to increased global temperatures and a specific effect.	• Explains the role of carbon cycle in temperature regulation. • Explains how one named human change affects the carbon cycle. • Explains how one named human change affects the water cycle. • Explains the implication of one named change to the carbon cycle on climate change. • Explains the implication of one named change to the water cycle on climate change.	• Comprehensive discussion of the role of the carbon cycle in temperature regulation AND how changes to the carbon and water cycles can influence climate change.

	depleting ground water supplies, and causing more runoff and leaching, making the land prone to droughts and floods. Extreme weather can destroy large areas of vegetation, leading to a reduction in carbon dioxide removal from the atmosphere. Extreme weather also leaves vegetation prone to insect attack, reducing the vegetation, leading to a reduction in carbon dioxide removal from the atmosphere. **Influence of changes on climate change** Although the changes made by humans have happened over a few hundred years, to reverse their effect will take far longer. Currently global temperatures are exponentially increasing, resulting in more catastrophic climatic events. Atmospheric carbon dioxide levels are increasing yearly, leading to an increase in temperature. An increase in temperature leads to more flooding, sea level rise, melting ice caps, more storms, storm surges, droughts, more forest fires and changes to the water cycle.			

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	Some relevant information.	1 point / 2 partial points from Achievement.	2 points from Achievement.	3 points from Achievement.	2 points from Merit.	3 points from Merit.	Excellence with minor error / omission.	Full Excellence answer.

Cut Scores

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