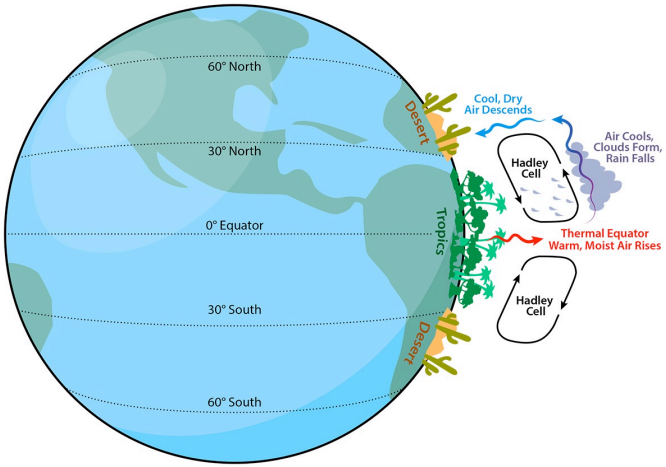
Assessment Schedule – 2018

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

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE	 **Role of solar radiation in circulation cells** The Earth receives uneven heating from the Sun. Direct solar radiation strikes the Equator, causing the surface and air above it to heat up. Indirect solar radiation strikes the poles, leading to cold air above this area. Warm air rises, while cool air sinks. The warm air at the Equator rises, cooling with altitude. This air is then pushed towards the poles by the warm air rising below, leading to the formation of a circulation cell. **Why the deserts and rainforests are where they are** The Equator receives direct sunlight, resulting in warm air; this air is also moisture-laden, as the hot temperatures lead to high rates of evaporation. This warm, moist air rises, and as it climbs higher in the atmosphere, it cools. Cool air can hold less water than warm air. This means that as the air cools, clouds form that release most of the water they hold back to the surface. This causes high precipitation rates above the Equator. Tropical rainforests are found at this latitude, due to the high temperatures and precipitation rates. As warm air keeps rising above the Equator, it forces the cooler air to move away from the Equator towards the poles. This cool air falls back toward the ground around the 30° latitude (north and south) resulting in the formation of the Hadley cells. At 30° latitude, the cool, dry air falls back towards the ground, where it starts to warm up again. The result of this is that the land below it receives little rainfall, leading to the formation of deserts at this latitude.	To demonstrate understanding of processes, the candidate: • Correctly labels diagram or explains Hadley cell / Ferrel cell. Explains by: • Linking the uneven heating of the Earth to the Hadley cell. • Linking sunlight to the air above the Equator being warm and moist. • Linking the air above 30° latitude to being cool and dry. • Linking convection to the formation of Hadley / Ferrel cell.	To demonstrate in-depth understanding of processes, the candidate: • Explains how the Hadley / Ferrel cell is formed in terms of density. • Explains the role of solar radiation in the formation of the Hadley cell. • Explains why there are high precipitation rates above the tropics and links it to the rainforests. • Explains why the air above the 30° latitudes is extremely dry and links this to deserts.	To demonstrate comprehensive understanding of processes, the candidate: • Gives a comprehensive discussion explaining why deserts and rainforests are found at particular latitudes in terms of atmospheric circulation cells (candidates do not need to explain the formation of Ferrel cells for excellence).

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	1 partial point from Achievement.	1 point or 2 partial points from Achievement.	2 points from Achievement.	3 points from Achievement.	1 point from Merit.	2 points from Merit.	Discusses reasons but with minor omission.	Full discussion.

Q	Evidence	Achievement	Merit	Excellence
TWO	The atmosphere protects the Earth and all living things on it from objects in space and radiation from the Sun. Different layers within the atmosphere protect the Earth from different things. **Thermosphere** The thermosphere is responsible for the absorption of X-rays and some gamma rays, and extreme UV from the Sun. High-energy solar photons rip electrons away from gas particles in the thermosphere, creating charged ions in a region called the **ionosphere**. Areas within the ionosphere absorb X-rays and extreme UV from the Sun, helping to protect the Earth. **Mesosphere** Space debris, such as meteors and bits of asteroids, burn up as they enter the atmosphere due to friction between the gas particles in the atmosphere and the object. Most objects will completely burn up in the mesosphere, but some do penetrate further, depending on their original size. **Stratosphere** The stratosphere contains the **ozone layer**, which is made up of ozone molecules. Ozone protects the Earth from damaging UV radiation and acts as a sort of sunscreen. Ozone molecules absorb UV radiation and re-radiate the energy as heat, warming the stratosphere. **Troposphere** Without the troposphere, the Earth's average surface temperature would be too cold for life. Natural greenhouse gases in the troposphere form a layer that acts like a blanket, helping to trap long wavelength infrared heat from the surface by stopping them from escaping out to space. Instead the gases absorb it and then re-radiate the heat back towards Earth. The troposphere helps maintain the Earth's energy budget so that it is in equilibrium. As solar radiation reaches the Earth's atmosphere, it can be: scattered by water vapour, gas molecules and aerosols; reflected back to space; absorbed by water and clouds; reach the Earth's surface. Water vapour and other aerosol particles absorb some of the Sun's radiation, helping to warm the atmosphere. Clouds can either absorb or reflect solar radiation, and therefore help control the amount of solar radiation, so play an important part in heat exchange in the atmosphere by reflecting some of the solar radiation back into space – low-level clouds reflect more than high level clouds.	To demonstrate understanding of processes, the candidate explains by: • Linking the ionosphere to absorption of X / gamma rays • Linking the ozone layer to absorption of UV. • Linking greenhouse gases in the troposphere to maintaining Earth's temperature. • Linking space objects to being broken down in the mesosphere • Linking the troposphere to preventing surface temperature extremes. • Linking clouds to heat exchange.	To demonstrate in-depth understanding of processes, the candidate: • Explains how the ionosphere protects the Earth. • Explains how the ozone layer protects the Earth. • Explains how the mesosphere protects the Earth. • Explains how the troposphere prevents surface temperature extremes in terms of the roles of both clouds. • Explains the greenhouse effect in terms of IR or long wave radiation.	To demonstrate comprehensive understanding of processes, the candidate: • Gives a comprehensive discussion of how different layers within the Earth's atmosphere protect it from different forms of radiation, space objects, and how it maintains the surface temperature.

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THREE	**Effects of increased global temperatures on water cycle** • Warm air can hold more water vapour than cool air. • As the lower atmosphere becomes warmer, evaporation rates increase, resulting in an increase in the amount of moisture circulating throughout the troposphere. • Warmer temperatures have led to increased drying of the land surface in some areas, due to evaporation. • Warmer temperatures have led to earlier snowmelts in some areas, causing changes to water runoff into rivers and streams. • Warmer temperatures have melted polar ice caps and glaciers that would normally not melt for a long time, causing sea levels to increase. • Warmer temperatures lead to warmer oceans, which can lead to more cyclones / hurricanes forming (or stronger ones), resulting in more heavy rain and flooding. It can also cause the sea level to increase due to expansion, leading to coastal inundation due to storm surges. **Impact of changes to water cycle on specific weather events** • The consequence of higher water vapour concentrations is an increase in the frequency of intense precipitation events, e.g. floods, mainly over land; a larger amount of water is falling in a shorter period of time. • Warmer temperatures mean that more precipitation is falling as rain rather than snow, which can lead to flooding. • Earlier arrival of spring-like temperatures is leading to earlier peaks in snowmelts, meaning a reduced availability of water during summer when it would normally be available. • Desert areas of the world are experiencing greater evaporation and reduced precipitation, leading to severe drought conditions. • Rising sea levels due to melting icecaps will lead to low-level areas being more prone to flooding, and some areas will be submerged. • Intense rainstorms, as well as increasing the risk of flooding, lead to increased levels of water runoff, meaning soil moisture does not increase. • Increase in condensation leads to more clouds therefore more insulation, impacting the weather by increasing the temperature.	To demonstrate understanding of processes, the candidate explains by: • Linking warm air to holding more water vapour. • Linking increased evaporation rates to increased global temperatures or vice versa. • Linking warmer temperatures to earlier snowmelts and changed water flow. • Linking increased water vapour levels in troposphere with intense precipitation. • Linking increased global temperatures to less snow and more rain. • Linking increased evaporation / decreased precipitation to low soil moisture levels / drought. • Linking increased temperatures to polar ice melting and sea level increase and / or more flooding.	To demonstrate in-depth understanding of processes, the candidate: • Explains how changes to evaporation rates impact weather. • Explains how changes to precipitation impact weather. • Explains how increased sea levels impact weather. • Explains how unseasonable temperatures can lead to drought. • Explains how the increase in condensation leads to more clouds / insulation impacting weather.	To demonstrate comprehensive understanding of processes, the candidate: • Gives a comprehensive discussion of the processes involved in the water cycle that are affected by increased global temperatures and their possible impact on weather conditions.

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 12	13 – 18	19 – 24