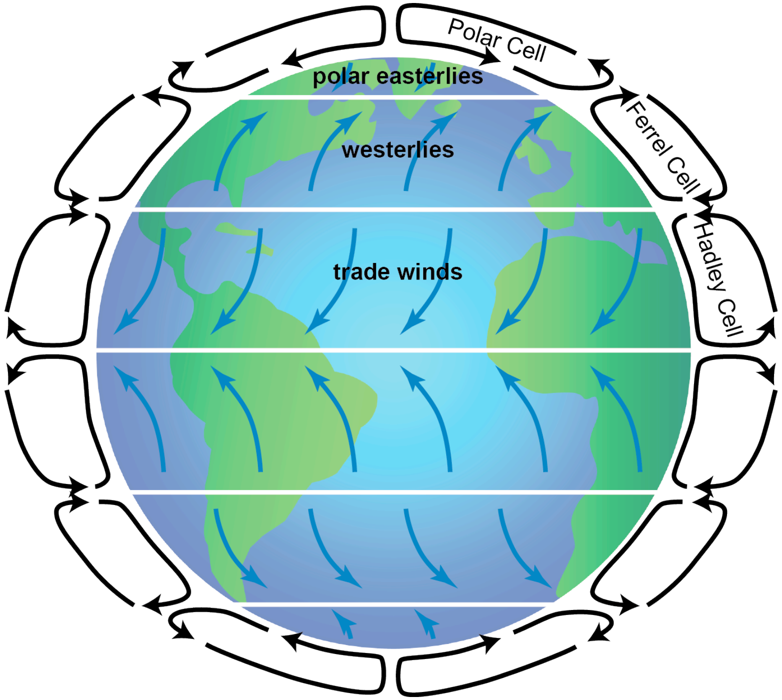
Assessment Schedule – 2017

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

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE	**Convection Cell** A convection cell is a circulation caused by density differences within a body of air (liquid / gas) where warmer less dense air rises and cooler, denser air drops. **Role of solar radiation and Earth's rotation** Air mass movement is driven by the energy from the Sun at the surface, as warm air rises and colder air sinks. Unequal heating of the Earth's surface is the main driver; the Equator receives more heat than the poles, causing the warm air to rise, while the cold dense air at the poles sinks and moves towards the Equator, replacing the warm air that has risen. The rotation of the Earth causes the Coriolis effect, which is the apparent deflection of air currents towards the right in the Northern Hemisphere and left in the Southern Hemisphere. The result of this is to break the air circulation into three convective cells. **Formation of Cells** Hadley – The circulation of air mass closest to the Equator is the Hadley cell. This air mass rises at or near the Equator rapidly due to the intensity of the Sun's radiation on this part of the Earth's surface. This creates a low pressure zone around this region of the Earth's surface, and certain extreme weather events (e.g. thunderstorms, cyclones). The rising air mass spreads and cools moving in higher altitudes until falling in the region of 30 degrees north or south of the Equator. This falling air mass creates an area of high pressure and subsequently moves across the Earth's surface back toward the Equator or towards the higher latitudes (60 degrees North and South). Ferrel – lie between the Hadley and Polar cells (30 to 60 degrees latitude). Some of the sinking air mass at 30 degrees North continues travelling northwards along the Earth's surface towards the pole. This air is still warm as it has originated from the Equator, and at 60 degrees latitude, approaches cold air moving down from the pole. This causes the warm air mass to rise, with some mixing taking place between the two air masses. This is known as the Polar Front, where weather events can originate. At higher altitudes, part of the air mass moves towards the pole, carrying heat energy with it. The heat energy is the result of condensing water vapour (latent heat) that originated from the Equator. The remaining air mass	• Label / annotate a diagram showing the convection cells and air movement. • A description and / or a labelled diagram of a convection cell. • Explains the formation of **one** cell. • Explains the difference between open and closed cells. • Describe the uneven heating effect of solar radiation in heating the Earth. • Describes the effect of Earth's rotation on surface.	• Explanation of how a convection cell forms in terms of heating / density differences. • Explanation of how the unequal heating of the Earth's surface between the equator the poles leads to the formation of the Hadley and Polar Cells. • Explanation of how the Ferrel cell is the result of interaction of air movement between the the Hadley and Polar Cells. • Explanation of how air movement is affected by Earth's rotation. • Explains the difference between the formation of open and closed cells with reference to examples of each.	• Comprehensive explanation of how the three cells are formed AND why the Ferrel cell differs from the Hadley and Polar.

	moves back towards the Equator. Polar – lies between the poles and 60 degrees North and South. These are closed cells. Cold, dense air descends over the poles and the cold air is circulated towards the Equator along the Earth's surface. The air from the poles rises at 60 degrees latitude and some of this air returns to the poles at altitude, completing the Polar Cell. **Differences between open and closed loop cells** Hadley and Polar cells are closed, the Ferrel cell is open. Closed loop cells either have a heat source such as the Equator for the Hadley cell, or a cold heat sink such as the poles for the Polar cells. Either of these things drives convection. The Ferrel cell, which is open, does not have either of these, and as a result air moves in the reverse direction to the other two cells and the cell overlaps with each of the other cells. **Annotated diagram** 			

Not Achieved	Achievement	Merit	Excellence

N0 = no response; no relevant evidence.	N1 = 1 partial point from Achievement.	N2 = 1 point from Achievement.	A3 = 2 points.	A4 = 3 points.	M5 = 1 point explained.	M6 = 2 points explained.	E7 = Point with minor omissions / error.	E8 = Point fully explained.

Q	Evidence	Achievement	Merit	Excellence
TWO	**Aerosols** are minute solid and liquid particles suspended in the atmosphere. **Types of volcanic aerosol and layer they are found in** Volcanic eruptions produce ash, rock fragments, and gases such as sulfur dioxide. Due to its size and mass, volcanic ash rapidly falls out of the atmosphere in rain a few hours or days after the eruption; therefore it does not reach further than the troposphere. If the plume reaches the stratosphere, it may inject sulfur dioxide gas into this layer. When this happens, the sulfur dioxide layer is very quickly converted to droplets of sulfuric acid over the course of a week or several months after the eruption. These sulfuric acid droplets are the aerosol. Once formed, they stay in the atmosphere for approx. two years. **Relationship between type of eruption and layers** Minor eruptions do not extend high enough into the atmosphere to extend beyond the troposphere. Explosive eruptions can send up a plume of aerosol particles into the stratosphere. **Effect on regional and global climates** Volcanic ash released into the atmosphere will cause temporary cooling of the regional climate. This is because these larger aerosol particles fall out of the air quickly. Small ash particles in the troposphere form a dark cloud that shades and cools the area directly below it. These particles do not remain in the troposphere for long, therefore the effect on the climate is very localised and short-lived. (If eruption occurs in the mid to high latitudes, stratospheric aerosols will influence only regional climate, as air is carried only towards the poles.) Stratospheric aerosols influence the global climate system. These aerosols include very fine ash and droplets of sulfuric acid / sulfates, which are formed in the stratosphere. These aerosols form a haze which reflect incoming solar (short wavelength) radiation away from the surface, causing the surface to cool. (They also absorb long wavelength radiation from the Earth's surface). Because these particles stay in the stratosphere for several	• Describes what an aerosol is. • Links a type of volcanic aerosol to correct atmospheric layer. • Links size of eruption to the effect on the atmospheric layers. • Links stratospheric / high level aerosols to global climate variation. • Links tropospheric / low level / short lived aerosols to regional climate variation .	• Explains relationship between type of aerosol particle and the layer it is found in. • Explains the effect of volcanic aerosols on regional climate variation. • Explains the effect of volcanic aerosols on global climate variation . • Explains the relationship between the size of the eruption and the overall climatic effect.	• Comprehensive explanation of how different types of volcanic aerosols affect BOTH regional and global climate.

	years and are moved around by winds in the stratosphere, the effect of the cooling is experienced worldwide. (If eruption occurs at the Equator, global circulation will carry the stratospheric aerosols towards both poles, causing global climatic changes.)			

Not Achieved			**Achievement**		**Merit**		**Excellence**	
N0 = no response; no relevant evidence.	N1 = 1 partial point.	N2 = 1 point from Achievement.	A3 = 2 points.	A4 = 3 points.	M5 = 1 point explained.	M6 = 2 points explained.	E7 = Point with minor omissions / error.	E8 = Point fully explained.

Q	Evidence	Achievement	Merit	Excellence
THREE	**Greenhouse Effect** The Earth’s surface absorbs solar radiation, and then re-radiates infrared radiation back to the atmosphere, where it can be absorbed by clouds and greenhouse gases such as CO_2, H_2O, methane, CFCs, and nitrous oxide. The greenhouse gas molecules absorb the radiation, and as a result gain energy and speed up, leading to a rise in temperature. The gases eventually radiate some of this energy back to the Earth’s surface. **Examples of positive feedbacks on the climate system** Water vapour – warm air can hold more water vapour than cool air can. Therefore, as the temperature increases, the amount of water vapour also increases, causing a greater absorption of solar (short wavelength) radiation, which then leads to a further increase in temperature. Clouds – An increase in cloud cover (due to increased levels of water vapour) causes more long wavelength (infrared / terrestrial) radiation to be absorbed, resulting in an increase in global temperature. Melting permafrost – when permafrost melts due to increased temperatures, it releases large amounts of methane gas, a type of greenhouse gas, into the atmosphere. By increasing the amount of greenhouse gases, the effect of global warming is increased. Warming oceans – cooler water is able to absorb more carbon dioxide than warm water. As temperatures of the ocean increase, less carbon dioxide will be absorbed by the ocean, leading to more carbon dioxide remaining in the atmosphere, amplifying the effect of global warming. Melting sea ice – as temperatures rise, sea ice melts. Sea ice has a high albedo; therefore, as it disappears, more solar radiation will be absorbed, causing the global temperatures to increase. Desertification – loss of carbon dioxide sink **Examples of negative feedbacks on the climate system** Clouds – as cloud cover increases, more solar radiation is reflected back into space away from the surface of the Earth, helping to cool the global climate. Desertification – as temperatures increase, more areas around the Earth will become deserts. Deserts have a high albedo, leading to more solar radiation being reflected away from the surface of the Earth back into space, helping to cool the Earth.	• Annotated diagram showing the greenhouse effect. • Explains that the Earth’s surface absorbs solar radiation and re-radiates heat. • Links increasing greenhouse gases to prevention of atmospheric heat loss. • Links greenhouse gas increases to a particular example of a cause of global warming. • Links greenhouse gas increases to a particular example of a cause of global cooling.	• Explains the greenhouse effect. • Explains how one feedback system works to enhance global warming. • Explains how one feedback system works to negate global warming. • Explains how one further feedback system works.	• A comprehensive explanation of the greenhouse effect and how the feedback loops affect global warming.

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 12	13 – 18	19 – 24