Assessment Schedule – 2019

Earth and Space Science: Demonstrate understanding of physical principles related to the Earth System (91193)

Evidence Statement

Question One: The Colour of Clouds

Expected Coverage	Achievement	Merit	Excellence
Light travels from the Sun through space in the form of electromagnetic waves, which is a mixture of all the colours, from longer wavelength red light to shorter wavelength purple / violet light. These waves can travel through a vacuum of space / don't need particles. When these waves meet the atmosphere, they interact with matter / water droplets. Scattering occurs in the lower atmosphere when EM waves interact with matter that has a similar or larger size than the wavelength of the light – in this case, water particles. This means that all wavelengths of light are scattered a similar amount, causing the mixture of all the colours and therefore appearing white. Most of the light is scattered in a forwards direction, meaning much of the light will penetrate the clouds, but will be scattered to appear white. If the cloud is very thick / dense, less light is able to penetrate the clouds, therefore appearing darker.	Describes: • Solar Radiation / light originates from nuclear fusion taking place in the sun. • Light travels as EM waves / solar radiation through space and the atmosphere. • Different colours of light have different wavelengths. • White light is the result of mixing the different colours / wavelengths of the visible spectrum. • The pathway of light rays is altered by water droplets / aerosols in clouds (diagram sufficient). • All of the light entering the cloud is scattered by a similar amount. • The clouds are more dense at the base, which affects light penetration and this is why clouds are darker at the base.	Explains in detail: • That light is a mixture of different wavelengths of EM radiation. • That light waves interact with water droplets, which causes the waves to be scattered (mostly forwards). • Clouds appear white, as the different wavelengths of light are scattered by a similar amount. (diagram evidence sufficient). • As light has to travel through more water droplets to the base of the cloud, more scattering will occur and therefore will appear darker.	Explains comprehensively: • The Sun produces light (and other EM radiation) that can travel through space and reach clouds in the atmosphere, where they are scattered (mostly forwards). As they travel through more water droplets, further scattering makes the cloud base appear darker. • Light is scattered (mostly forward) when the waves interact with particles (water droplets) of a similar diameter or larger than the wavelength of the light. All colours / wavelengths are scattered similar amounts and therefore appearing white.

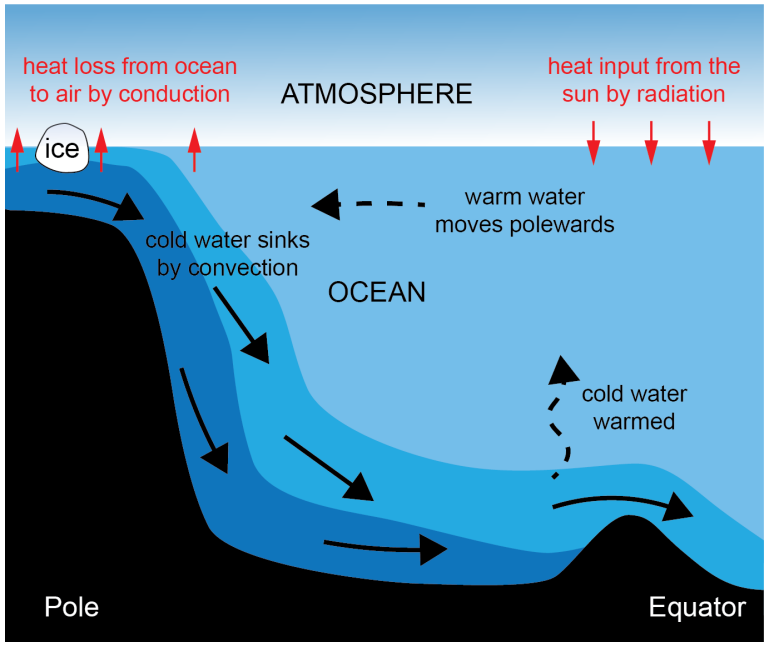
Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response: no relevant evidence.	Partially describes one point.	Describes one point or 2 partial points	Describes two points.	Describes three points.	Explains one point.	Explains two points.	Explains comprehensively one point, or two with minor omissions.	Explains comprehensively two points.

Question Two: Cloud Effects on Earth's Radiation

Expected Coverage	Achievement	Merit	Excellence
The Sun has a very hot surface due to the nuclear fusion in the core generating a huge amount of energy. Therefore, it gives out a lot of relatively short wavelength radiation, which may either be absorbed at different layers of the atmosphere, warming them, be reflected into space, or reach the surface and heat the Earth. As the Earth is much cooler than the Sun, the radiation the surface re-emits back towards space tends to have a longer wavelength. Low, thick clouds will reflect much solar radiation due to its light colour, and have an overall cooling effect on the Earth, especially during the day. However, the clouds may trap longer-wave radiation emitted from the surface of the Earth, which may have a warming effect especially at night. The overall (net) effect will be a cooling one. High, thin clouds allow most short wavelength solar radiation to pass through them (transmit), but they may trap some of the outgoing, longer wavelength (infrared) radiation emitted by the Earth, radiating it back towards the Earth, and therefore having an overall warming effect.	Describes: • How incoming solar radiation has a shorter wavelength. • How radiation from Earth's surface has a longer wavelength. • How low, thick clouds may reduce / reflect solar radiation OR transmit heat emitted (NOT reflected) from the Earth. • How low thick clouds can have an overall cooling effect on the Earth during the day. • How low thick clouds can have an overall warming effect on the Earth at night. • How high, thin clouds transmit solar radiation OR traps infrared / re-emitted radiation from the Earth. • How high thin clouds can have an overall warming effect.	Explains in detail: • How the temperature difference between the Sun and the Earth accounts for different forms of radiant energy. • How low clouds reflect solar energy / radiation from the Sun during the day, which has a cooling effect on the Earth OR trap radiation from the Earth during the night having a warming effect on Earth. • How high clouds allow most solar energy through, but may trap some of the outgoing longer (infrared) energy, having an overall warming effect on the Earth.	Explains comprehensively: • Low clouds reflect solar radiation during the day, but also may trap outgoing radiation (linking to wavelength and source). However, the overall effect is still a cooling one. • High clouds allow high energy (short wavelength energy) through during the day and trap longer wavelength outgoing (infrared) radiation, having an overall warming effect. • The Sun's source of energy is nuclear fusion, which generates a great deal of heat and therefore high energy, short wave radiation, which is the main source of energy that is re-emitted from the Earth's surface (cooler body) with longer (infrared) waves.

Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response: no relevant evidence.	Partially describes one point.	Describes one point or 2 partial points	Describes two points.	Describes three points.	Explains one point.	Explains two points.	Explains comprehensively one point, or two with minor omissions.	Explains comprehensively two points.

Question Three: Ocean Circulation

Expected Coverage	Achievement	Merit	Excellence
Warm ocean currents originate near the equator where sunlight intensity is greatest due to more direct sunlight / less atmosphere to pass through. Up to 90% of the radiant heat from the sun is absorbed by the surface ocean layer causing it to warm. As the warm surface water moves towards the poles, sunlight is less intense, and heat moves to the atmosphere / air by conduction / evaporation, increasing the atmospheric temperature and therefore warming the higher latitudes. This cooler water at the poles is more dense, causing it to sink down to the deep ocean, where it is replaced by more warm surface water (convection). This movement of heat away from the equator helps to regulate the global temperature, making it cooler at the Equator and warmer at the poles. Where warm currents move close to a land mass, conduction of heat into the atmosphere can also warm the coastal areas (e.g. Europe and the Gulf Stream), moderating the region's climate.  	Describes: • How sunlight is most intense / directly overhead at the Equator heating the Earth's surface. • How sunlight is spread over a larger area / less intense at the poles resulting in less surface heating. • How radiant heat from the Sun is absorbed by the surface of the ocean. • How heat is transferred from the Equator to the Poles, resulting in heat being distributed over the planet. • How heat transfers from warm ocean currents to the atmosphere (by conduction). • How cold water sinks at the poles since it is more dense and is replaced by warmer water. • How the movement of cold water / warm water has an effect on climate. *Note: evidence may be taken from labelled diagram.*	Explains in detail: • The Sun is more directly overhead at the Equator, solar radiation is spread over a smaller area and therefore the heating effect is more intense. • Radiation from the Sun is absorbed by the top layer of the ocean and heat is transferred to the atmosphere by conduction as the water moves towards the poles. • The sinking of more dense cold water at the poles moves cold water to the Equator which keeps the conveyor moving heat around the planet. (Could be shown in diagram.) • The moderating effect of the global conveyor belt on the climate.	Explains comprehensively: • The relationship between the transfer of energy on Earth's surface and the Thermohaline current, and the effect this current has on moderating the Earth's climate.

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Cut Scores

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