Assessment Schedule – 2022

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

Evidence Statement

Question One

	Expected Coverage	Achievement	Merit	Excellence
(a)	The visible spectrum comprises different wavelengths, ranging from the short wavelengths (high frequencies) of violet and blue, to the longer wavelengths (low frequencies) of red and orange.	Describes: • blue light is the short wavelength radiation (higher frequency) • red light is long wavelength radiation (low frequency)	Explains:	• Explains comprehensively:
(b)	When visible light reaches the atmosphere, it interacts with the particles and molecules in the atmosphere. In the upper atmosphere, the wavelengths interact with much smaller nitrogen and oxygen molecules. The interaction scatters the wavelengths, and blue being the shorter wavelength is scattered the greatest. This scattered light gives the sky the blue appearance. Further into the atmosphere, the light interacts with clouds and water droplets. The upper-level clouds are thin and allow transmission of visible light. They can also reflect some light back into space. Lower-level clouds, being thicker, will reflect visible light back into space, or absorb the light as it penetrates the cloud mass. Water molecules being larger than visible light's wavelengths, will scatter all wavelengths of light randomly. This gives clouds their white appearance, and the haze associated with humid summer days.	• atmosphere is transparent, allowing transmission of visible light • visible light can be scattered when it enters the atmosphere • blue light is scattered more than other wavelengths in the atmosphere • light can be reflected back into space by clouds • light can be absorbed as it travels through clouds	• the link between blue sky and scattering of the short wavelengths by gas molecules (nitrogen and oxygen) in in the upper atmosphere (Rayleigh scattering) • the link between scattering of all wavelengths by water particles creating haze or white appearance of clouds • the link between clouds and reflection of visible light back into space	• the behaviour of light as it passes through the atmosphere, including scattering by water and gas particles, reflection by cloud layers and transmission

(c)	At sunset, the Sun is at a very low angle to the Earth, meaning all colours of the visible spectrum must travel further through the Earth's atmosphere. The Earth's atmosphere is full of particles such as dust and gas, and these particles scatter light rays in different directions. The amount of scattering caused depends on the wavelength of the light, the number of particles in the atmosphere, and the distance the light travels through the atmosphere. The longest wavelength red light in the visible spectrum is affected the least by these particles, and as a result is transmitted through the atmosphere. The shorter wavelength blue light is scattered the most by dust and gas particles in the sky. At sunset, as the light's path is longer due to the low angle of the Sun relative to the Earth, shorter wavelength colours of the visible spectrum (violet, blue, green) are scattered out, leaving a greater proportion of the longer wavelength light (red, orange, yellow) to penetrate the atmosphere. As a result, at sunset the sky is illuminated red.	• sun at low angle to Earth at sunset • light has further to travel through the atmosphere at sunset • particles in the atmosphere scatter light in different directions • longer wavelength light is scattered the least OR short wavelengths are scattered most	• setting Sun has a low angle to the Earth and therefore light from the Sun has a longer path through the atmosphere travelling through more particles • dust and gas particles scatter shorter wavelength blue light, leaving longer wavelength red light to be transmitted through the atmosphere • the closer the size of the wavelength to the size of the particles the greater the scattering.	• that as light travels further in the atmosphere due to the low angle of the sun relative to the earth, short wavelength colours in the visible spectrum are scattered out more by dust and gas particles due to their size, leaving red long wavelength light to be transmitted through the atmosphere making the sunset appear red.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or response does not relate to the question.	Describes ONE partial point at the Achievement level.	Describes ONE point at the Achievement level.	Describes TWO points at the Achievement level.	Describes THREE points at the Achievement level.	Explains ONE point at Merit level.	Explains TWO points at Merit level.	Explains comprehensively ONE point at Excellence level, or TWO with minor omissions.	Explains comprehensively TWO point at Excellence level.

Question Two

<table>
<tr><th></th><th>Expected Coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>(a)</td><td>Ice is a good reflector of solar radiation, i.e. a high albedo, but a poor absorber.
Water is a good absorber of solar radiation, but a poor reflector.
<table><tr><th></th><th>Reflection</th><th>Absorption</th></tr><tr><td>Ice</td><td>Good</td><td>Poor</td></tr><tr><td>Water</td><td>Poor</td><td>Good</td></tr></table></td><td>Describes:
• completes the table correctly</td><td>Explains:</td><td>Explains comprehensively:</td></tr>
<tr><td>(b)</td><td>Shortwave radiation is absorbed by the Earth’s surface and re-emitted as longer-wavelength infra-red radiation warming the atmosphere as it is absorbed by atmospheric gases.
An ice sheet being white acts as a reflector, reflecting approximately 80 percent of the short-wave radiation that would otherwise heat the Earth back into space. This effectively acts to cool Earth’s climate by preventing surface absorption by the surface and warming of the atmosphere by the re-emitted infra-red radiation. The greater the ice sheet the greater the reflection of incoming radiation and hence greater atmospheric cooling.</td><td>• solar radiation absorption by Earth’s surface
• atmospheric heating by the land
• ice reflects solar radiation/energy back into atmosphere/space
• reflection of radiation by ice maintains cooler temperature on Earth</td><td>• the link between incoming shortwave radiation reaching Earth’s surface and heating of the atmosphere
• the link between the ice sheet’s albedo and cooling of Earth’s climate</td><td>• the role ice, land and ocean play in maintaining Earth’s climate</td></tr>
</table>

(c)	Earth's temperature is influenced by the albedo effect of the ice caps and the absorption of infra-red radiation (heat energy) by the ocean and land. Earth's surface land and ocean waters, being dark, are effectively a heat sink; 90% of the sun's radiation hitting the ocean is absorbed. The ocean can hold large quantities of heat energy due to water's high heat capacity. As Arctic ice cap reduces in size, it would mean that less solar energy will be reflected back into space, resulting in more energy being absorbed on Earth's surface. Greater exposure of water in the Arctic region results in a much higher proportion of heat energy being retained in the ocean. This effectively puts more heat into the atmosphere, and since oceans move (currents), the extra heat energy is carried to other parts of the Earth, further warming Earth's atmosphere and changing the climate. *Note:* *Evidence may be taken from annotated diagram.* *Evidence may be taken from any section of the question.*	• reduction of the Arctic ice cap causes an increase in atmospheric temperature • increase in water means an increase in absorption of solar radiation • water's high capacity enables it to act as heat sink.	• the link between the disappearance of the Arctic ice sheet and the warming of Earth's atmosphere • the link between the oceans' dark colour OR heat capacity and warming of Earth's atmosphere.	• how the diminishing Arctic ice cap will lead to an overall increase in Earth's ocean and atmospheric temperatures.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
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Question Three

	Expected Coverage	Achievement	Merit	Excellence
(a)	Heat from Earth's core primarily is the result of nuclear decay from radioactive elements and the residue heat from Earth's formation. (Frictional heating does take place as material sinks back towards the core and heat release due to phase change, latent heat, in the outer core.)	Describes: • one heat source	Explains:	Explains comprehensively:
(b)	From the solid inner core, the heat is transferred to the outer core by conduction and radiation. Conduction involves heat transfer through contact between vibrating particles. The heat energy causes particle vibration to increase; this kinetic energy is transferred to neighbouring particles and so heat is transferred from source to a cooler region. Conduction is slow in the core. Radiation also transfers heat from the inner core without the need for material. It is very slow. The outer core is liquid – heat transfer through the outer core is by convection currents. Heat is transferred through to the mantle from the outer core by conduction at the surface boundary. The mantle material is considered a "plastic solid" and is fluid. The heat is transferred through the mantle by convection currents. Material at the core / mantle boundary is heated. As the material is extremely viscous fluid, the movement is slow, but the heat does cause particles to move further apart, the material's density decreases, and the less dense material moves up towards the lithosphere (crust) thereby transferring heat energy. Cooling material becomes more dense, and descends, creating convection currents within the mantle. There is some heating by conduction through direct contact between the particles.	• the rate of heat transfer from the core to the surface is very slow • heat transfer in the solid inner core / surface • heat transfer in liquid outer core / plastic mantle • states heat energy is transferred by conduction / radiation in the inner core • states that heat energy is transferred by convection in the outer core and mantle layers	• the links between the solid inner core and the process of heat transfer to the outer core • the links between the liquid outer core and the plastic mantle with the heat transfer process to the crust	• the heat energy transfer process that brings heat from the inner core to surface and the way they link with each other

(c)	In volcanic areas, ground / rainwater may come into contact with very hot rock heated by magma, or magma itself, which has risen into cracks in the crust from the mantle. In non-volcanic areas, the temperature of rocks within the crust increases with depth, due to conduction from the mantle. If water seeps / percolates deeply enough into the crust, it comes into direct contact with these hot rocks. Ground / rainwater that comes into direct contact with this hot rock / magma will be heated by conduction. As the water becomes hotter, it becomes less dense and rises, while cooler, more dense ground / rainwater sinks. The hot water collects in naturally occurring pools with convection currents acting as a natural circulatory system. *Note:* *Evidence may be taken from annotated diagram.* *Evidence may be taken from any section of the question.*	• source of heat in crust is hot magma or heated rock • heat transfer to the ground water by conduction • convection currents which form the hot pools • conduction of heat from mantle to crustal rock.	• the link between the hot magma / rock deep in the crust and heating ground water by conduction • the link between the hot surface water in the springs and density.	• the continuous cycle of ground water and / or rainwater seeping into cracks in the crust and coming in direct contact with magma / hot rock, heating it through conduction. The density of the water decreases, causing water to rise, forcing water to the surface, and maintaining the hot water in the springs.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 06	07 – 12	13 –18	19 – 24