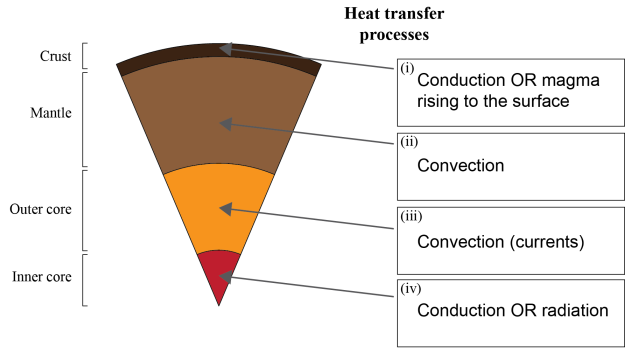
Assessment Schedule – 2020

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

Evidence Statement

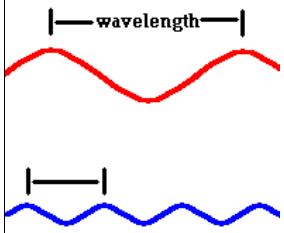
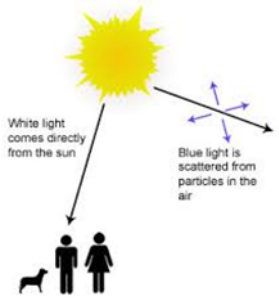
Question One: Geothermal energy

	Expected Coverage	Achievement	Merit	Excellence
(a)		• Identifies THREE heat transfer processes.		
(b)(i)	Heat is able to move by conduction through the solid crust. As the crust is solid, heat causes particles in rock to vibrate more vigorously, which causes adjacent particles to vibrate more, passing the heat (kinetic) energy towards the surface. Heat is also able to reach the surface in molten magma from volcanic eruptions.	Describes: • How heat energy moves from hotter (deep in the Earth) areas to cooler (surface) areas. • How the heat energy transfer from the interior is very slow. • How heat energy can be transferred via conduction. • How the heat energy can be transferred via convection. • How the state of matter is relevant to the heat transfer.	Explains: • The convection process in terms of particle movement (density and buoyancy) and identified with the mantle / the outer core. • The conduction process in terms of particle vibration and identified correctly to the crust / inner core. • Radiation in terms of waves (infrared) and identified correctly to the inner core.	Explains in depth: • TWO heat energy transfer processes that take place in THREE of Earth's layers and how they link together to explain heat transfer from the inner core to the surface.
(ii)	The mantle is also solid (allow fluid), but heat and pressure make the lower mantle (asthenosphere) dense and plastic. This enables particles in hotter rock towards the core to become less dense due to more rapid motion, and buoyancy forces the hotter rock to slowly rise towards the surface creating convection currents.			
(iii)	The outer core is a hot, dense liquid. Heat in the lower layers causes the particles to move faster, becoming less dense and rising in convection processes like the mantle.			
(iv)	Heat in the inner core is transferred by conduction and radiation. However, these processes are extremely slow due to the density of the core.			

(c)	About half of the Earth's internal heat comes from decay of radioactive isotopes, mainly in the mantle. These undergo nuclear fission, changing into more stable isotopes, releasing radiation and producing heat. (Details of radioactive decay not needed.) Residual heat left over from the formation of the Earth is also a source of heat as the hot gas condensed due to gravity, heat was generated, and the Earth is still cooling (at around 100°C per billion years). Friction of sinking, dense material and the liquid outer core changing into a solid (latent heat) are also sources of some of the heat. *Note: Evidence may be taken from any section of the question.*	Describes: • How the decay of radioactive isotopes / nuclear fission releases heat energy. • How residual heat from the Earth's formation releases heat energy.	Explains: • The process of radioactive decay that generates heat energy mainly in the mantle and / or crust. • The source of heat energy in the core from the residual heat from the formation of the Earth (gravitational → heat). • The release of latent (hidden) heat in a phase change, i.e. from liquid to solid. • Frictional forces can create heat energy when dense material sinks during convection.	Explains in depth: • TWO main sources of heat energy linking to where they occur, along with ONE other described process.

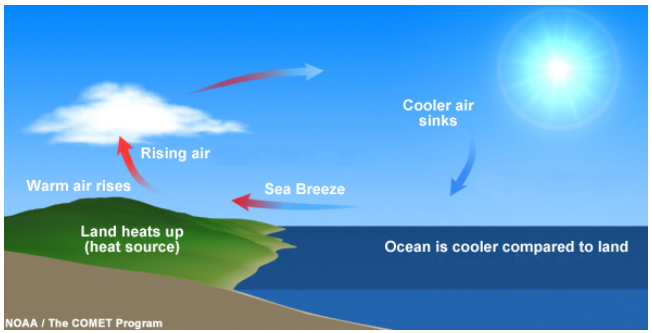
Not Achieved			**Achievement**		**Achievement with Merit**		**Achievement with Excellence**	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or response does not relate to the question	Describes ONE partial idea at the Achievement level.	Describes ONE idea at the Achievement level.	Describes TWO ideas at the Achievement level.	Describes THREE ideas at the Achievement level.	Explains ONE idea at Merit level.	Explains TWO ideas at Merit level.	Explains ONE idea at Excellence level.	Explains TWO ideas at Excellence level.

Question Two: Why is the sky blue?

	Expected Coverage	Achievement	Merit	Excellence
(a)	A: Scattering B: Transmission C: Absorption	TWO correct terms given.		
(b)	 Light energy travels as an electromagnetic (EM) wave. This wave can vary in wavelength. Longer visible light waves appear red in colour. As the wave gets shorter, the colour will be different. Red waves have a longer wavelength and blue waves have a short wavelength. Allow frequency, e.g. higher frequency for shorter wavelength.	Describes: • How different wavelengths will appear as different colours. • How blue light has a short wavelength OR red light has a longer wavelength.	Explains: • Light is a mixture of EM waves with different wavelengths that produce all the different colours, with an example.	
(c)	 Some of the sunlight travelling directly towards us through the atmosphere is not scattered. As this is a mix of all of the different wavelengths, it appears white. However, in the upper atmosphere, dust particles and molecules of gas (e.g. nitrogen and oxygen), which are smaller than the wavelengths of light, scatter shorter wavelengths (e.g. blue) more than longer wavelengths (e.g. red). As blue waves are scattered more than red, more blue light is scattered towards us from across the sky, and therefore the sky appears blue. *Note: Evidence may be taken from any section of the question.*	Describes: • How white light directly from the Sun is a mix of all the colours/wavelengths • How light / waves are scattered as they enter the earth's atmosphere • How blue (and violet) light is scattered more than the other wavelengths • How blue light is higher energy so is more likely to be scattered.	Explains: • Some visible light from the Sun passes straight through the atmosphere, which being a mix of all the colours, means the sun appears white. • Some visible light from the Sun can be scattered, blue more than other colours because of its higher energy, so the sky appears blue. • Blue wavelength scattering is related to wavelength size and size of gas / dust particles.	Explains in depth: • How when light enters the upper atmosphere, scattering will occur when the light is redirected by tiny particles of gas and dust. Not all light is scattered, predominately longer wavelengths pass straight through therefore appearing white. • How blue light has a shorter wavelength (higher energy) than other colours, so it is scattered more as visible wavelengths pass through the atmosphere giving the sky a blue appearance.

Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or response does not relate to the question.	Describes ONE partial idea at the Achievement level.	Describes ONE idea at the Achievement level.	Describes TWO ideas at the Achievement level.	Describes THREE ideas at the Achievement level.	Explains ONE idea at Merit level.	Explains TWO ideas at Merit level.	Explains ONE idea at Excellence level.	Explains TWO ideas at Excellence level.

Question Three: Sea breezes

	Expected Coverage	Achievement	Merit	Excellence
(a)	The Earth's surface is heated by solar / infrared radiation from the Sun.	Identifies: • Solar radiation/ (shortwave) infrared radiation.		
(b)	On a sunny day, radiation from the Sun will pass through the atmosphere and be absorbed by the Earth's surface. Due to water's high specific heat capacity compared to land, the water is able to absorb much more radiation without changing temperature as much, therefore the land will heat up more rapidly than the water.	Describes: • How the same amount of radiation hits both land and sea. • How the land heats up more quickly. • How water has a high specific heat capacity.	Explains: • Water requires more solar radiation / infrared / heat than land for the same temperature change.	Explains in depth: • How water and land both receive the same amount of solar radiation, but since water has a higher specific heat capacity, it requires more solar radiation for the same temperature change.
(c)	As land heats more quickly than the ocean during the day, the air directly above the land will heat by conduction and radiation more than the air over water. The air particles will become more spread out, and therefore less dense than the surrounding air, and rise. This leads to lower air pressure over the land relative to over the cooler ocean. This causes air to move in across the coast to take its place as an onshore breeze.  *Note: Evidence may be taken from any section of the question.*	Describes: • How air over the land is heated by conduction / radiation. • How air is heated above the land to form a convection current. • How air becomes less dense and rises. • How air moves in from above the sea to replace air that has moved / risen. • How air moves from high pressure to low pressure.	Explains: Heating of air above the land via conduction and leads to air above the land becoming less dense / more buoyant and rising. • Heat from land to air causes air particles (to gain kinetic energy and) spread out decrease in density and rise. • Low air pressure over land results in air moving in from high pressure to replace it.	Explains in depth: • The role of heat transfer via conduction / radiation from land to air, which causes air particles to gain kinetic energy and spread out and rise, creating lower air pressure over land, resulting in air moving in from higher pressure over the water to replace it.

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Cut Scores

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