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Level 2 Earth and Space Science 2022

91193 Demonstrate understanding of physical principles related to the Earth System

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of physical principles related to the Earth System.	Demonstrate in-depth understanding of physical principles related to the Earth System.	Demonstrate comprehensive understanding of physical principles related to the Earth System.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Merit

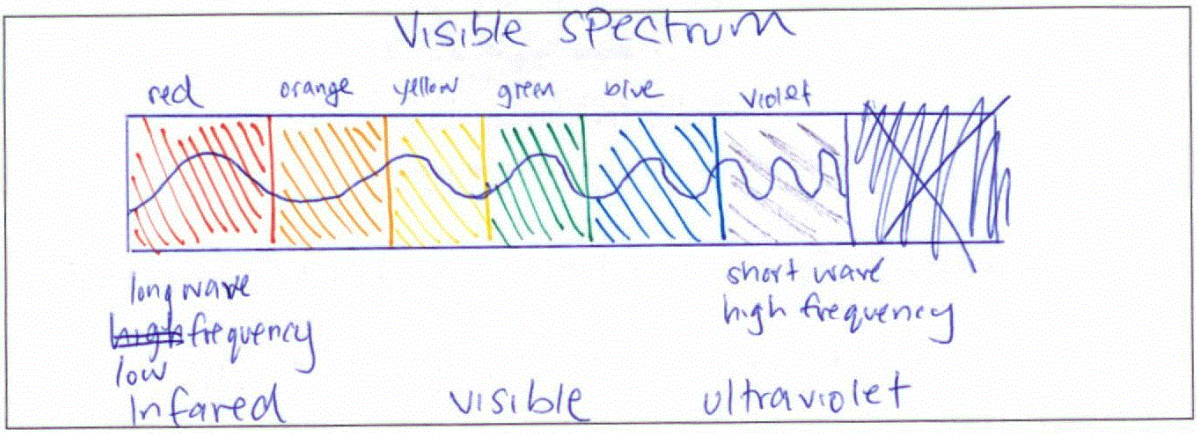
TOTAL 16

QUESTION ONE: VISIBLE LIGHT IN THE ATMOSPHERE

Visible light travels through space to Earth from the Sun.

(a) Describe the visible light spectrum in terms of wavelength, frequency and colour.

An annotated diagram may assist your answer.



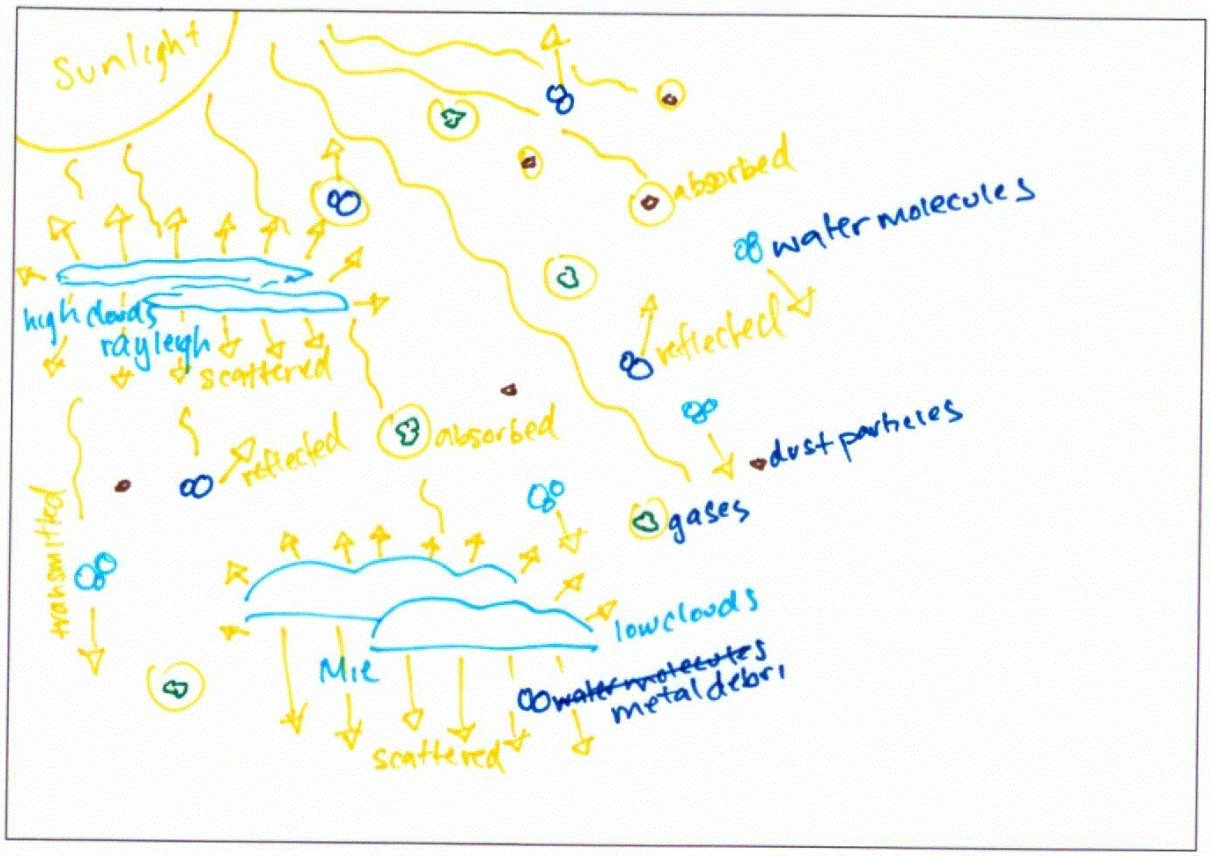
The visible light spectrum ~~are~~ is the only types of light visible to the human eye. Infared light is red and orange, and has a long wavelength and the lowest frequency. Yellow and green is the visible light which has a medium frequency and wavelength ultraviolet is blue and violet and has the shortest waves and the highest frequency.

(b) Explain, in detail, the possible behaviour of visible light as it travels through the atmosphere during the middle of the day.

In your answer, you may wish to consider:

- transmission, absorption, reflection, and scattering
- high/low clouds
- gases and particles in the atmosphere.

An annotated diagram may assist your answer.



Visible light travels from the sun in ~~Ea~~ electromagnetic waves. Infared waves being red and orange, with the longest wavelength and the lowest frequency, visible waves being yellow and green, ~~and~~ with a medium wavelength and frequency, and ultraviolet waves being blue and violet, with ~~a~~ the shortest wavelength and the highest frequency. Once emitted from the sun, light can either be transmitted through transparent or translucent objects such as water molecules in the atmosphere absorbed by dark coloured

There is more space for your answer to this question

and rough surfaced edges such as dirt particles and gases in the atmosphere, reflected by shiny surfaces such as metal debris in the atmosphere, or scattered. Transmission is when light passes through an object and carries on in the same direction. The object must be transparent or translucent like water for the light to pass through. Absorbtion is when light is absorbed by the object, typically dark and rough surfaced objects such as dirt particles. Reflection is when light is reflected back into space, with shinier objects reflecting the most such as metal debris. Scattering occurs when the water molecules making up clouds are the same size as ~~the~~ some or all of the visible light wavelengths. Clouds at a higher altitude create Rayleigh scattering, where the water molecules are smaller than the visible waves, and therefore scatter all the colours in all directions. When all the colours are mixed, it creates white light, which is why high clouds are white. Clouds in lower altitudes create Mie scattering, where the water molecules are the same size as light wavelengths, and scatter the light mainly in ~~the~~ the same direction as the light was travelling also creating a white cloud. During the day, all the colours are emitted from the sun, allowing the clouds to be white. However, if it was night, the sun would not be available to emit light, and the light would come from the different stars, which only emit certain colours, as they have already absorbed colours from the sun, leaving only certain colours to be transmitted and keep travelling through the atmosphere,

Question One continues

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The examination continues on the following page.

(c) The picture below shows a typical sunset over Auckland city.

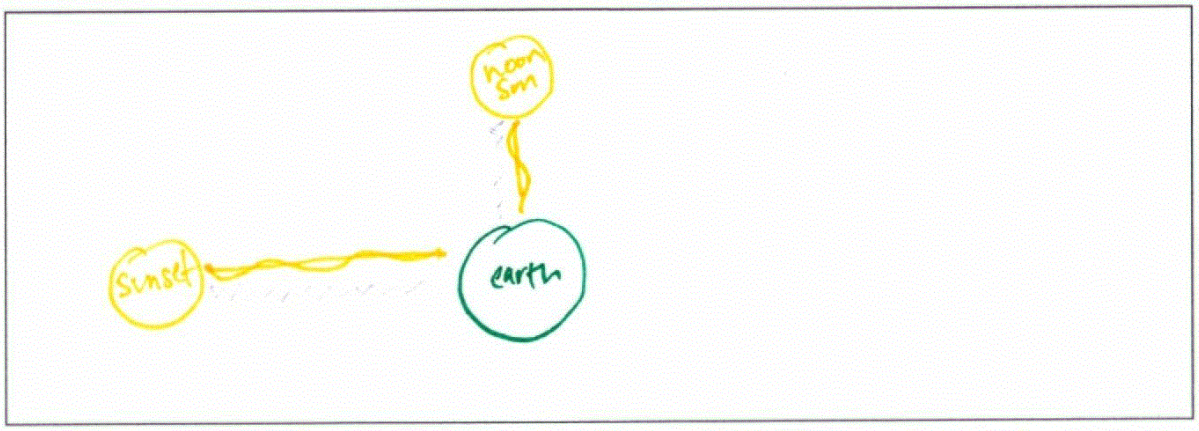
https://www.heletranz.co.nz/red-sunset-auckland/

Explain why visible light from the Sun is seen as a red colour at sunset.

In your answer, you should consider:

- the angle of the Sun relative to the Earth's surface at sunset
- the colours and relative wavelengths of visible light
- what scattering of light depends on.

An annotated diagram may assist your answer.



Visible light from the sun is seen as red at sunset due to the difference in wavelengths of the colours that make up the visible spectrum, and the scattering of light. Scattering depends ~~of~~ on the size of the light wavelengths, and the size of the water molecules the light encounters. The longer the wavelength of light and therefore the darker the colour,

violet are able to pass right through the water molecules, due to their high frequency and therefore high energy. Whereas lower frequency colours such as red has ~~the~~ a longer wavelength and a lower energy, and is therefore scattered by the water molecules. This only happens at night though, because the sun is at a 90° angle to the earth, rather than being directly above it, as shown in the diagram. During the day, the colours are mixed during scattering to create white light. During the night, the light that is left fills the sky, creating a red colour.

QUESTION TWO: EARTH'S CLIMATE REGULATOR:

Earth's climate is partially regulated by the Antarctic and Arctic ice sheets. This is due to the ice sheet's high reflective ability (high albedo).

(a) Complete the table below to compare how well solar radiation is reflected and absorbed by ice and water. You should use the words (descriptors) GOOD or POOR.

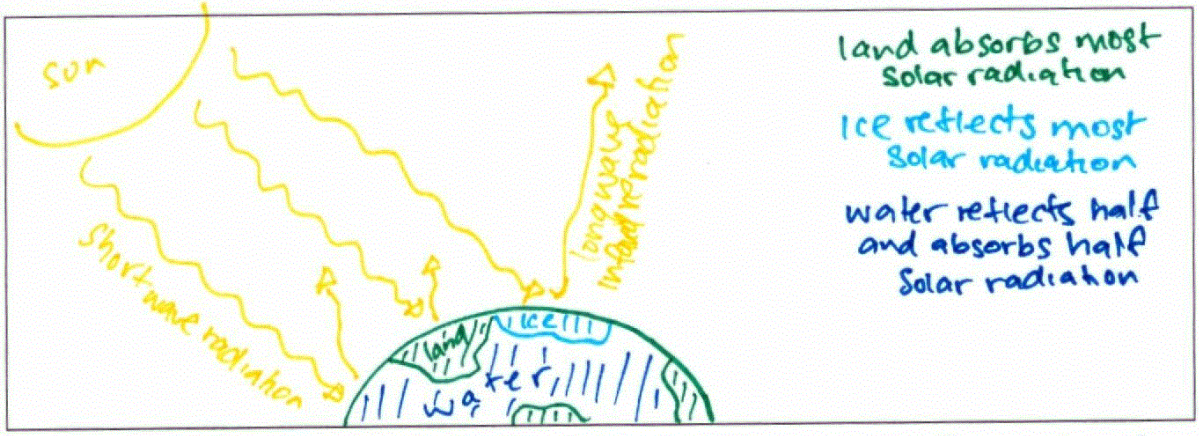
	Reflection	Absorption
Ice	Good	Poor
Water	~~Poor~~ Reflects half	Absorbs half

(b) Explain, in detail, how the high reflective ability (high albedo) of ice sheets regulates the temperature of the atmosphere.

In your answer, you should consider:

- how the Earth's surface is heated by the Sun
- behaviour of solar radiation on ice.

An annotated diagram may assist your answer.



Solar radiation accounts for 99.97% of the total energy put into the earths atmosphere, making it earths largest heat source. Heat energy travels towards the earth in short wave radiation, and if not absorbed or reflected in the atmosphere, it reaches the earths surface, where it is either reflected back into space, or absorbed, which heats the earths surface. Land absorbs more heat than it reflects, due to its rough and mainly

~~the darker~~ half of its received solar radiation, and reflects half, whilth the water at the equator receiving the most heat due to the earths tilt, while water at the poles receives the least direct solar radiation. Ice however reflects nearly all encountered solar radiation, due to its high albedo. The albedo of a surface is the reflective quality, with shinier and smoother surfaces reflecting more than a dark and rough surfaces, therefore giving it a high albedo. As ice is shiny from the thousands of ice crystals its ~~made~~ made up of, and is white in colour, it has a very high albedo, and therefore is very reflective. The ice sheets of the poles regulate the temperature of the atmosphere, because it sends a lot of the solar radiation back into space, wheras if it didnt reflect, the earth would be too hot to survive, and the atmosphere would be too cold to survive.

(c) Scientists monitoring Earth's climate have a major concern over the gradual reduction in the size of the Arctic ice sheet. The image below shows the change in the extent of the ice sheet at the end of the Arctic summer over the last 40 years.

Source: www.sciencealert.com/arctic-sea-ice-could-vanish-in-the-summer-even-before-2050-new-simulations-predict

Explain, in detail, the effect on the Earth's climate of any reduction in the Arctic ice sheet.

In your answer, you should consider:

- changes in the reflective ability of the Arctic
- changes in the ice sheet's extent over the 40 years
- the role of the heat capacity of water.

The reduction of the Arctic ice sheet is caused mainly because the increase of greenhouse gases in the earths atmosphere is trapping the solar radiation reflected from the ice, and is re radiating it back down on the ice, creating ~~an~~ a cycle of increased heat on the Arctic, with no escape for the accumulating solar radiation. As the solar radiation intensifies the ice sheets slowly melt as shown in the diagram above. The reradiation of solar radiation also effects the Arctic ice through the water surrounding it. Water absorbs 50% of solar radiation it receives, but it also has a very high specific heat capacity, which means it takes longer to warm, but also retains heat for a long time. As the solar radiation intensifies, the water around the sea ice heats up, and slowly melts the

ice from the bottom up, while the heat from the sun melts it from the top down. As the ice cap melts, the reflective ability of the Arctic decreases in effectiveness, as there is less reflection of solar radiation taking place than there is absorption. As the reflection of solar radiation decreases in the Arctic, the earths climate will start to heat up, as the levels of reflection and absorption are unbalanced, as well as the earths atmosphere will start to cool down, as less solar radiation is reflected back into space, which will impact the earths hydrological cycle, as well as the weather patterns, which are driven by uneven heating of the earth. Normally, the equator is the warmest ~~as~~ with the poles being the coldest, but with the reflective ice dissapearing, this could change.

QUESTION THREE: NGAWHA HOT SPRINGS

Located near Kaikohe, in the Far North of New Zealand, Ngawha Springs is a geothermal hot pool complex with long historical and cultural links to local Māori.

www.ngawha.nz/uploads/3/2/1/2/32123857/image-file-formats-1-8_orig.jpeg

(a) The source of heat for the hot pools is the Earth's core.

Describe the origins of the heat in the Earth's core.

The four terrestrial sources of heat is gravitational heat, where ~~dugg~~ sinking dense matter creates friction with rising less-dense matter; Residual heat, from the earths forming; latent heat of fusion, created from liquid metal in the outer core solidifying; and decay of radioactive isotopes in the earths core, where unstable nucleus break into smaller nucleuses, to become more stable, releasing a large amount of heat energy.

(b) Explain, in detail, how heat energy from the Earth's core is transferred to the mantle.

In your answer, you should consider:

- methods by which heat is transferred
- the inner core, the outer core, the lower and upper mantle
- how heat is transferred through the layers.

An annotated diagram may assist your answer.

Heat can travel ~~from~~ in three ways. Conduction, which is the vibration of particles, convection, which is the ~~movement~~ rising and falling ~~density within the~~ of different density particles, and radiation, which doesn't need to pass through a medium to transfer heat. Radiation however is a nonimportant heat transfer in the earths ~~core~~ center, because the rock is opaque, which stops the heat from passing through. Heat from the solid inner core is transferred by conduction into the ~~outer core~~ liquid outer core, which heats the bottom layer, causing the particles to become less dense. It then rises, and the dense, cooler material falls. This creates a convection current, as shown in the diagram. Heat from the outer core is then transferred to the lower mantle by convection, which is a solid rock. However the heat is so intense, the ~~be~~ matter in the lower mantle becomes a plastic pliable substance, which is less dense than the still solid rock in the upper mantle. The heated lower mantle then rises due to its decreased density, and is replaced by the cooler, dense matter from the upper mantle, creating what is called a convective cell, as shown in the diagram.

Question Three continues on the following page

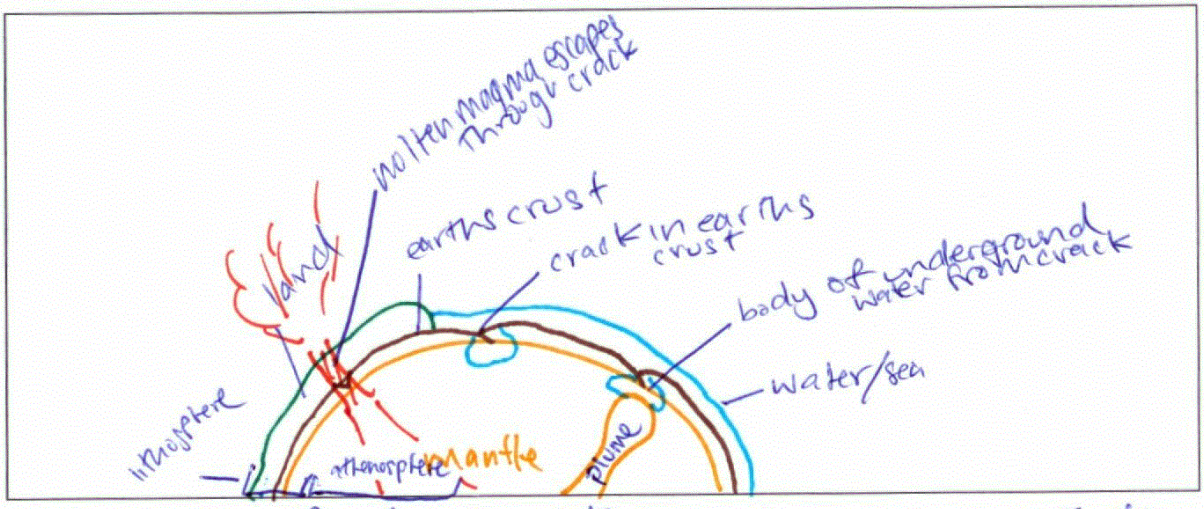
(c) The water source for geothermal springs is rainwater or groundwater that seeps into the crust through cracks.

Explain, in detail, how the water in the geothermal springs becomes heated.

In your answer, you should consider:

- the source of the heat in the crust
- how the heat is transferred from the mantle to the crust
- the role of heat transfer in the water reaching the surface.

An annotated diagram may assist your answer.



Heat is transferred to the earths crust in 2 ways. Firstly, the friction of the hot rocks in the asthenosphere ~~rub~~ vibrating against the cold rock of the lithosphere, creates heat through convection. or, molten magma from the ~~to~~ ~~mantle~~ overcore escapes through a crack in the brittle rock of the lithosphere. Geothermal springs are bodys of water that lie in a crack of the lithosphere, and the resovoire reaches the ~~top of~~ upper mantle, or comes in contact with a plume, as shown on the diagram. Plumes are independent chanels of hot rock stemming from the outer core. A volcano is formed when the plume busts through the earths crust. As the water comes in ~~the~~ contact with the plume or heated mantle, ~~heat~~ ~~the~~ heat is transfered through conduction to the bottom of the water resovoire. The

heated water then rises and is replaced by cooler water from the surface, creating convection currents. The heated water eventually reaches the earths surface through cracks in the lithosphere. The hot water then comes in contact with much cooler air, ~~and~~ forcing it to condense into steam, which can be seen rising from the surface of geothermal springs such as Ngawha hot springs.

* cracks in the lithosphere are formed when the heated mantle moves in convective cells. As the material of the mantle/asthenosphere is much denser ~~than~~ and stretchier than the brittle, thin rock of the lithosphere/earths crust, ~~the~~ bits of the lithosphere sometimes snap and are carried with the moving mantle.

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

91193

Standard	91193	Display ID	Script 61465487. NSN 137502240	**Total score**	16=M
Q	**Grade score**	**Annotation**			
1	M5	The candidate overstates their answer referring to infra-red in the visible yet is clearly able to link other aspects of the visible spectrum to wavelengths. The diagram in part b shows knowledge of scattering and provides a commentary on scattering which although contains errors shows an understanding of the basic principle. Reflection and transmission are accounted for in the commentary.			
2	M5	The commentary and diagram in part b explain the behaviour of land, ocean and ice towards incoming solar radiation. Reference is made with regard to reflection of solar radiation back into space and effect on climate. The melting ice and resulting effect on the ice cap due to water's high heat capacity is described. However, the candidate's statements with reference to the atmosphere needed reviewing.			
3	M6	The candidate has explained the heat transfer process taking place within Earth's interior referencing the properties and behaviour of the materials. Similarly, the links between heat transfer processes and heating of groundwater are detailed.			