Assessment Schedule – 2019

Scholarship Earth and Space Science (93104)

Evidence Statement

ONE

Evidence	1 – 2	3 – 4	5 – 6	7 - 8
Well-labelled, accurate diagrams are considered as evidence. *At least one well-developed point on the long-term consequences of the methane store is needed for Scholarship.* Key points • As the tundra melts and is not icy for longer periods of time, there is more absorption of light energy, due to a reduced albedo of the thawed tundra compared to the ice. This will lead to heating and more melting of tundra, creating a positive feedback loop. • As the tundra melts, there is a greater release of stored carbon in the forms of methane and carbon dioxide. This then adds to the atmosphere's current ability to absorb heat from the long-wave radiation reflecting off the Earth, and heating the atmosphere, and causing more ice melt and gas release. This is a positive feedback loop, which would lead to more gas release and more heating. • Two positive feedback loops in the same area working towards heating would have a large effect on the local area, which is already affected heavily by current climate trends. • More heating of the Arctic would melt icecaps and large glaciers, which would add large amounts of fresh water from non-subterranean / non tundra sources. This would have significant, but unknown effects on the surrounding area and the large sea currents, such as the thermohaline circulation. • Further research should be carried out to gain a more detailed understanding of how much methane and CO_2 was trapped so that it could be added to current climate models as well as the effect of the decreased albedo, as the current estimates have 'a large degree of uncertainty'. • The use of methane as a fuel has both positive and negative points. It burns very cleanly, producing only CO_2 and water vapour, both of which are less effective greenhouse gases. Methane is 25 times more effective at absorbing sunlight • If the released methane was to be used, then it would be in the place of	Very little understanding of the question with very little development of ideas. Resource booklet copied only.	Shows some application of understanding with some development of ideas. Some synthesis and integration of the processes.	Good application of understanding with good development of ideas. Good analysis, synthesis, and integration of the processes, exhibiting well-developed understanding of the context.	• Thorough application of understanding with excellent development of ideas. • Sophisticated analysis, synthesis and integration of the processes, showing perception and insight applied to the context. • Reflection on the answer resulting in extrapolation. • All aspects of answer expressed with convincing communication.

other fossil fuels that would need to be extracted. This process can be an environmentally damaging process, as well as being less clean burning and creating more pollution than the extracted methane. • The methane is being released by itself, so it would be easy to get and would stop it entering the atmosphere. • It would be very hard to harvest large / commercial amounts of methane, as it would be released as the tundra melts, which would be spread over a large area, as well as being difficult to move heavy equipment in boggy conditions. This might make it uneconomic. • The equipment and industry to collect the methane would be very likely to spread things like mud, soot, and smoke, which would decrease albedo, as well as crushing snow and ice, which would do the same. • Slow-growing tundra plants and low populations of tundra animals would be very vulnerable to disruption by industry. • Other sources of fossil fuels might inhibit the movement towards more renewable sources. • The ownership aspects of the tundra might be an issue also.				

TWO

Evidence	1 – 2	3 – 4	5 – 6	7 - 8
Well-labelled, accurate diagrams are considered as evidence. Key points: • In New Zealand, there is evidence of shocked quartz and glass beads, which means that the effect of the meteor was worldwide. After the glass beads formed, the iridium started to settle out, which formed the iridium layers that are found at various locations around the world. The atmosphere was also heated so much from the impact, that it caused forest fires across the world, and again evidence for this is found in New Zealand. This generated a massive amount of smoke, which rose into the atmosphere, blanketing the globe, and therefore cooled down the planet by blocking out the sun. This cooling would have led to the dying of some of the plants, due to the lack of sunlight causing photosynthesis to stop. The halting of photosynthesis would also have caused some marine phytoplankton to die. Both of these events would have caused food chains to break down. • The smoke would have also collected in the troposphere, where it would have travelled around the world. Rain would have washed out the ash from the forest fires since it is in the lower layer of the atmosphere where all the weather is. There was global darkness, and this can be attributed to the forest fire ash cloud, as well as the material ejected out in the impact. Just like large volcanic eruptions, material from the impact would have been released into the stratosphere, where there is no weather and the air is very still. This means that it would have stayed here for a long time, blanketing the globe, blocking out sunlight and cooling down the planet. • Decreased sunlight through ejecta and forest fire smoke would have caused plant species to die due to the lack of photosynthesis; also, those organisms that are adapted to warmer climates would have also started to die. Both of these would have resulted in food chains breaking down and more organisms dying. • Without photosynthesis and with global forest fires as well as ejecta reacting with oxygen to form new compounds, it is possible that there were decreased levels of oxygen, which may have led to extinctions, especially of large animals with large respiratory needs. • When the target rock was hit by the asteroid, it would have converted the carbon and sulfur into carbon dioxide and sulfur dioxide. The sulfur dioxide would have reacted with water and oxygen in the atmosphere, creating sulfuric acid. This then fell as acid rain, which would also have killed plants and animals.	Very little understanding of the question with very little development of ideas. Resource booklet copied only.	Shows some understanding of question with only some development of ideas. Some synthesis and integration of the processes.	Good understanding of question with good development of ideas. Good analysis, synthesis, and integration of the processes, exhibiting well developed understanding of the context.	• Thorough understanding of question with excellent development of ideas. • Sophisticated analysis, synthesis, and integration of the processes, showing perception and insight applied to the context. • Reflection on the answer resulting in extrapolation. • All aspects of answer expressed with convincing communication. • Must show an excellent sense of geological time. • Must show integration of ideas, e.g. cycles.

• Ocean acidification would also have occurred at a very high rate and could be something that might be preserved in some way to measure. • The target rock also contained carbon, which would have reacted to become carbon dioxide. Carbon dioxide is a greenhouse gas, which would have accumulated in the atmosphere, trapping in infrared radiation, therefore causing global warming. This would have caused organisms that were adapted to cooler climates to die out. • It is important to study past events, as history is the key to the future of the planet. It is believed that we are going through a period of global warming as we are pumping greenhouse gases such as carbon dioxide into the atmosphere. Unless we have a major volcanic eruption, we probably won't experience a period of cooling similar to what followed the asteroid impact. However, the global warming after provides us with clues as to what could happen to us and how it can affect the organisms.				

THREE

Evidence	1 – 2	3 – 4	5 – 6	7 - 8
Well-labelled, accurate diagrams are considered as evidence. *At least one well-developed point on the comparison between planets and moons, as well as an overarching understanding of the interior features of Ganymede, and how they have been deducted is needed for scholarship.* Key points: • Auroras are caused by charged particles from the Sun interacting with particles in the atmosphere of the planet or a moon. They occur near the poles of planets or moons with magnetic fields, because this is where the magnetic field lines, which attract the charged particles, are strongest. The magnetic field lines accelerate the charged particles from the Sun, increasing their energy and concentrating them into a smaller region. The charged particles smash into atmospheric molecules, giving them energy, which they store and then release as light. • Jupiter's magnetic field, which also has auroras, boosts the Ganymede auroras by directing the charged particles through Ganymede via its orbit. Jupiter is large, so it gets hit by lots of solar energy, as well as the very large strong magnetic field, which overcomes the fact that it is a great distance from the Sun and allows it to receive more radiation. This provides more charged particles to both Jupiter's and Ganymede's auroras. • Ganymede has a magnetic field because it has a molten iron core. The movement of the molten iron, an electrical conductor, will set up electrical currents, and currents create magnetic fields. • Draws comparison to the size of the Ganymede including ideas such as SA:V ratio. Should use the data in the table to compare it to Venus, Mars, and Luna. Comparing to Mars, which is a larger celestial body, where the core has cooled and lost its magnetic field, meaning that it does not have strong auroras. The ratio for surface area to volume ratio, and therefore cooling, is $\frac{1}{r}$, meaning that the smaller planets and moons will cool faster (ratio not required, but added for understanding). • Ganymede's molten core and liquid oceans are most likely formed	Very little understanding of the question with very little development of ideas. Resource booklet copied only.	Shows some understanding of question with only some development of ideas. Some synthesis and integration of the processes.	Good understanding of question with good development of ideas. Good analysis, synthesis, and integration of the processes, exhibiting well-developed understanding of the context.	• Thorough understanding of question with excellent development of ideas. • Sophisticated analysis, synthesis and integration of the processes, showing perception and insight applied to the context. • Reflection on the answer resulting in extrapolation. • All aspects of answer expressed with convincing communication. • Must show integration of ideas, e.g. auroras to liquid salty sea.

due to tidal flexing and heating of interactions with Jupiter and other moons. Convection currents must be present, as shown by the recent tectonic surface features. This means there must be a liquid underneath the ice. • Aurora formation on Ganymede is linked to interacting of the magnetic fields of Jupiter and Ganymede. • Water reduces the rocking in auroras. Water under the surface of Ganymede reduces the rocking of its aurora from 6 degrees to 2 degrees. The conductive nature of the water and the inner core causes / affects the magnetic field and, in turn, the rocking of the aurora. Fresh water is a poor conductor and so would not have this affect, so we can assume these internal oceans must be saline. • As it seems there was more tidal flexing and heating in the past, there is the possibility that over long periods of time, the core of Ganymede may cool as well as the ocean. This would be shown as a decrease in the rocking of the auroras, due to the ocean no longer interfering, or the decreasing or disappearance of any of the moons' aurora, as a solid core would mean there would no longer be a magnetic field to produce one.				

Cut Scores

Scholarship	Outstanding Scholarship
13 – 18	19 – 24