2023 NCEA Assessment Report

Subject: Earth and Space Science

Level: Level 2

Achievement standard(s): 91191, 91192, 91193

General commentary

Many candidates failed to complete whole questions, instead answering certain sections of questions, reducing their opportunity to achieve at any level. Questions which required application or discussion of a particular concept within a context would often remain blank.

Candidates must realise they need to read the questions thoroughly before committing to their response, and be aware that parts follow on from each other and are linked. Each part builds on from the other, requiring transfer of basic knowledge to a context in the later sections of the question.

Poor examination technique was common for many candidates, with limited construction of sentences and paragraphs, and often illegible handwriting leading to a lack of clarity. Candidates who took the time to plan and clarify their responses provided stronger answers. Many candidates made good use of the space provided for diagrams, using it for either planning or providing well-annotated and labelled diagrams to support their written answers.

Some candidates continue to rely on the use of pre-learned responses from previous examination materials, or text material that has little relevance to the context of the questions or is not appropriate. Candidates are encouraged to identify the key ideas within the question as a starting point for their written answers, rather than look for some similarity to previous questions.

In several cases candidates lacked the fundamental knowledge or vocabulary expected by the Achievement Standards at this curriculum level, and in some cases a lack of appropriate prior learning. Candidates who displayed an understanding of the expected terms and could apply these to different contexts achieved higher grades.

Report on individual achievement standard(s)

Achievement standard 91191: Demonstrate understanding of the causes of extreme Earth events in New Zealand

Assessment

The examination consisted of three questions, of which the candidates were required to respond to all three. Questions 1-3 required the candidates to apply their understanding of the causes of extreme earth events in New Zealand. The questions covered the requirements of the 2023 assessment specifications which were that extreme Earth events are those that are extraordinary or remarkable on planet Earth, but which may occur commonly in parts of

New Zealand (and its continental shelf) due to its position on plate boundaries. The questions required the candidates to apply their understanding of a caldera and dome volcano, earthquake, and tsunami, by explaining the causes of these events in terms of the processes and effects that occur in one or more of the geosphere, hydrosphere, biosphere, or atmosphere.

Commentary

Candidates were familiar with the plate tectonics associated with the formation of magma and rhyolitic volcanoes, and earthquakes, as well as energy transfer in tsunami formed by pate uplift and landslides.

Reference to the correct tectonic plates involved and their relative movement with the extreme Earth event is vital for Achievement at any level. Candidates that referred to P and S waves when referring to earthquakes failed to link them to energy release. For candidates to show their understanding of earthquakes they must relate their responses to energy. Some candidates continue to refer to convection currents in their explanations of volcanos, earthquakes, and tsunami, but they are not relevant to this achievement standard.

To reach a Merit or Excellence grade, candidates need to be able to link ideas to explain the formation and effects of volcanoes, earthquakes, and tsunami in unfamiliar contexts.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- described the plate tectonics associated with rhyolitic magma formation
- stated the characteristics of rhyolitic magma
- described the conditions that form a caldera and a dome volcano
- defined a fault
- described the features of an earthquake
- described the impact of a shallow and a deep earthquake on the surrounding area
- defined the focus and epicentre of an earthquake
- described a tsunami as a large water displacement
- described the energy transfer from a landslide to water
- described the energy transfer from plate uplift into the water above
- described the amplitude and frequency of a wave in a stated location.

Candidates who were awarded **Achievement with Merit** commonly:

- linked plate tectonic movement to the formation of magma
- linked the characteristics of rhyolitic magma to the formation of a caldera or dome volcano
- understood the role of friction in plates becoming stuck, leading to the formation of earthquakes
- linked the amount of energy to the depth of an earthquake or the distance from the epicentre
- explained how a landslide generates a tsunami and the associated energy transfer
- explained the nature of a tsunami formed by seafloor uplift
- explained the nature of a tsunami in deep water or shallow water close to the land.

Candidates who were awarded **Achievement with Excellence** commonly:

- linked plate tectonics to the formation of rhyolitic magma
- linked the characteristics of rhyolitic magma to the formation of caldera and dome volcanoes explained earthquake formation relative to time
- explained how the energy of an earthquake relates to magnitude, depth, and distance from the epicentre
- explained how a landslide generates a tsunami and the associated energy transfer in relation to the size of the area in which it occurs.

Candidates who were awarded **Not Achieved** commonly:

- provided generic statements about magma
- could not identify the relevant tectonic plates and movement involved in an event
- could not identify the stages of an earthquake
- provided generic statements about tsunami formation by a landslide

- did not explain energy transfer in the formation of a tsunami.

Achievement standard 91192: Demonstrate understanding of stars and planetary systems

Assessment

The examination included three questions, of which candidates were required to respond to all three. Questions One to Three required candidates to apply their understanding of stars and planetary systems. The questions covered the requirements of the 2023 assessment specifications, which were an understanding of the role of gravity in the life cycle of stars, and a Hertzsprung-Russell diagram, with temperature on the *x*-axis, and luminosity or absolute magnitude on the *y*-axis. The questions required the candidate to apply their understanding of a Hertzsprung-Russell diagram, star formation and life stages, and planet and moon formation.

Commentary

While many candidates could demonstrate familiarity with the concepts being examined, many lacked understanding of specific terminology such as luminosity and absolute magnitude, with terms such as mass, size, and gravity being often interchanged. In several cases, candidates lacked fundamental knowledge, such as the difference between a star and a planet.

Achievement requires candidates to be able to interpret a Hertzsprung-Russell diagram and use evidence from it to explain observable phenomena. Many candidates were unable to interpret the significance of the numerical values of absolute magnitude and luminosity, and struggled to understand the temperature scale. Star colour was also not clearly understood by many candidates or linked to star temperature or rate of fusion.

To reach a Merit or Excellence grade, candidates needed to apply their understanding to novel concepts or within a familiar context related to star formation and life cycles, and planet and moon formation.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- defined the terms luminosity and absolute magnitude
- identified that nuclear fusion was the energy source for stars
- identified hydrogen fusion in a main sequence star
- related the ‘brightness’ of Betelgeuse to its current life stage and possible future outcome
- defined the term stella nebula
- described the role of gravity in star and planet formation
- linked the size of small hot stars to their eventual outcome as white dwarfs
- described the importance of the frost line to the formation of rocky and gaseous planets
- described the accretion theory of moon formation for moons found close to Jupiter.

Candidates who were awarded **Achievement with Merit** commonly:

- explained the link between surface area and luminosity of a star, and related this to the changes in a star’s life cycle
- explained the changes in nuclear fusion that occur for a star of 3 solar masses as it progresses to a white dwarf
- explained the formation of gas giant planets by linking gravity, temperature, or solar winds
- explained how moons around Jupiter could be formed involving Jupiter’s gravitational forces and the material remaining after planet formation.

Candidates who were awarded **Achievement with Excellence** commonly:

- compared and accounted for the differences in the expected changes in the luminosities of Betelgeuse and Proxima Centauri
- explained comprehensively how stars form from the stella nebula, and their expected outcome in terms of mass and fuel use
- explained in detail the roles of gravity, temperature, and solar winds in the formation of gas giant planets
- justified the reasons for large gas giant planets having moons and rings.

Candidates who were awarded **Not Achieved** commonly:

- confused negative magnitude with mass
- did not differentiate between star size and possible future outcomes
- did not relate star colour to temperature or fuel use
- referred to burning rather than nuclear fusion
- did not understand the difference between a star and a planet
- did not differentiate the conditions needed for rocky and gaseous planet formation
- described the capture moon formation theory for all of Jupiter's moons.

Achievement standard 91193: Demonstrate understanding of physical principles related to the Earth system

Assessment

The examination included three questions, of which candidates were required to respond to all three. Questions One to Three required candidates to apply their understanding of physical principles related to the Earth system. The questions covered the requirements of the 2023 assessment specification, which were sources of both terrestrial and solar heat energy, properties of waves, and the investigation of physical principles in relation to climate change. The questions required the candidate to apply their understanding of physical principles related to heat distribution around the Earth, the processes involved in light travelling through clouds, and volcanic eruptions and greenhouse gases.

Commentary

While many candidates were able to show their understanding of the physical principles examined in the questions, some candidates demonstrated a lack of fundamental knowledge and vocabulary associated with the science concepts being assessed, such as recognising that visible light is made up of a range of wavelengths and that greenhouse gases can be produced through natural events. Some candidates believed that the surface temperature of the Earth relates to how close the Sun is to that location, rather than the curvature of the Earth.

Achievement requires students to describe the physical principles related to the heating of the Earth's surface and atmosphere, how visible light interacts with particles in the atmosphere, and the role of natural events in greenhouse gas emission and temperature. To reach a Merit or Excellence grade, candidates need to understand the link between the Earth's curvature and solar heating at different latitudes, link the wavelengths of the visible spectrum and water droplets to cloud formation, and explain why different naturally produced greenhouse gases have short- or long-term effects on the Earth's climate.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- elated the heating of the Earth's surface to the angle of incoming solar radiation
- described water's ability to store heat energy in terms of heat capacity

- described heat transfer by conduction between the ocean's surface and land
- described how convection currents transfer heat energy within the atmosphere
- described the movement of surface currents
- described the range of wavelengths for visible light
- described how clouds appear white due to random scattering by water droplets or random reflection
- linked the dark colour of clouds to light absorption
- linked atmospheric temperature to the interaction of greenhouse gases with outgoing solar or long wavelength radiation from the Earth's surface
- stated that water vapour acts as a short-term greenhouse gas.

Candidates who were awarded **Achievement with Merit** commonly:

- linked the Earth's curvature and the surface area exposed to solar radiation to the heating of the Earth's surface
- explained the processes involved in moving heat energy from the ocean to the atmosphere
- explained how different wavelengths interacted with water droplets in clouds
- explained the interaction of solar radiation with earth's surface and the emission of longer wavelengths back into the atmosphere
- explained the interaction of long wavelength radiation and greenhouse gases with the warming of the atmosphere
- explained why water vapour has only a short term effect as a greenhouse gas in terms of the water cycle.

Candidates who were awarded **Achievement with Excellence** commonly:

- compared the heating effect of solar radiation at the equator and poles in terms of incoming solar radiation and the earth's curvature
- explained the role of water's high heat capacity in moving heat from warm equatorial waters to cooler regions on Earth, warming the atmosphere by conduction and convection
- explained in depth the interaction between the wavelengths of the visible light spectrum and water droplets in cloud formation
- explained how greenhouse gases maintain the Earth's climate
- discussed reasons for carbon dioxide and water being considered long term and short term greenhouse gases respectively.

Candidates who were awarded **Not Achieved** commonly:

- stated incorrectly that the equator was warmer because it was closer to the Sun
- referred to convection currents warming the ocean rather than the atmosphere
- stated incorrectly that the dark colour of clouds was due to weaker light energy travelling through the cloud
- referred to greenhouse gases interacting with the ozone layer
- confused the wavelength of light being absorbed by the earth and re-emitted
- stated greenhouse gases were warming the Earth's atmosphere due to human activities only.
