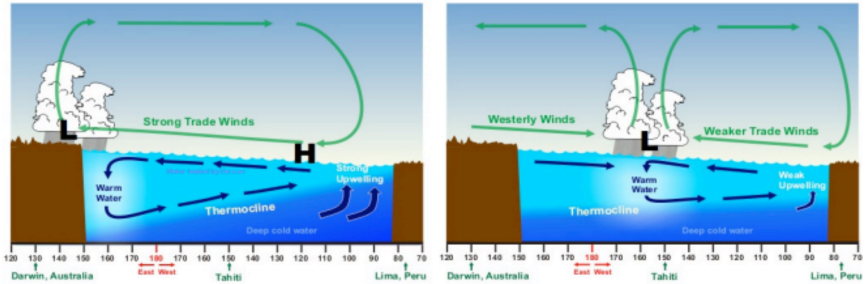
Assessment Schedule – 2024

Earth and Space Science: Demonstrate understanding of processes in the ocean system (91413)

Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE	The top layer of the ocean is called the mixed layer, as it has fairly uniform temperature and salinity with depth because the wind and waves mix the top layer of the ocean. Also, the surface layer absorbs solar energy from the sun, making it the warmest, and therefore least dense, layer of the ocean. The deep layer of the ocean has a relatively stable temperature as it does not receive solar energy nor mixing. This layer receives most of its water from the cold polar regions, which add salt and remove heat, resulting in cold, dense water feeding the cold, stable deep layer. This salinity doesn't vary much, as it doesn't mix with the upper layers, and the density is high, resulting in stable conditions. Salinity is highest and temperature is lowest, making this the densest bottom layer. The transition layer is also referred to as the pycnocline (rapidly changing density), the thermocline (rapidly changing temperature), or the halocline (rapidly changing salinity). This is the transition zone between the warm, low density surface layer and the colder, high density deep layer. At the Equator, the surface layer is constantly heated by intense solar radiation, reducing its density and making it very buoyant. While rainfall is high, evaporation is also very high around the Equator. Mixing is restricted, as winds are gerenally low in the doldrums around the Equator, which results in a thin surface and transition layer, and brings the deep layer closer to the surface. In the mid latitudes, the winds result in large surface waves and currents resulting in significant mixing in the surface layer, making it deeper in this area through friction with water below the surface. The depth and characteristics of the surface layer will vary depending on the season (as solar radiation increases and decreases with season), and factors such as varying evaporation, precipitation, and storms vary. At high latitudes near the poles, there is significant heat loss to the cold atmosphere as well as surface ice reflecting much of the solar energy. Therefore, there is no warm surface layer or transition layer due to heat loss, leading to the temperatures being very similar to the deep layer. Salinity is also increased as surface ice is formed in the winter, building up salt in the surface layer. This cold, salty water sinks at the poles, leading to a uniform transistion of density with depth.	Describes with understanding: • states properties of two layers • warm surface layer with low density is mixed due to waves and wind • deep ocean layer is stable / uniform as there is no mixing or solar heating • transition layer where temperature, salinity, and density rapidly change between surface and deep layers • links depth of the surface layer to winds / evaporation and precipitation • no surface / transition layer near the poles due to cold temperatures • pycnocline / transition layer as a barrier / boundary between layers.	Explains: • properties of at least two layers, including temperature, salinity, and pressure / density • how the depth of the mixed layer (latitude or season) is linked to strength of winds / currents / heating • why there is no surface and transition layer at the poles (loss of heat OR limited solar absorption OR ice formation) • shallow depth of surface layers around the Equator, due to temperature / density and low winds limiting mixing • mixed / transition layer as rapidly changing (cline) that forms a barrier between the deep and surface layers.	Explains comprehensively: • properties of all three layers in terms of temperature, salinity, pressure, and density including the cline layer as a barrier • varying depth of the surface and transition layers with latitude, due to solar heating, winds, and ice formation • how these processes alter the density of each layer causing variation in their depth.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE point from Achievement.	TWO points from Achievement.	THREE points from Achievement.	FOUR points from Achievement.	TWO points from Merit.	THREE points from Merit.	ONE point from Excellence.	TWO points from Excellence.

<table>
<tr><th>Q</th><th>Evidence</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr>
<td rowspan="2">TWO</td>
<td rowspan="2">During La Niña of the past three years, stronger easterly trade winds resulted in a greater movement of surface water along the Equator to the west, causing a greater build-up of warm water in the western Pacific. This causes the thermocline to deepen and higher sea levels along the coasts of eastern Australia as the strong currents push up along the land masses there. In turn, this causes the warm surface waters to be pushed south towards New Zealand due to gravity.

La Niña El Niño
El Niño results from a breakdown in the easterly trade winds, which means surface water is not dragged to the western Pacific as strongly. Sea level and the thermocline across the Equator become more level reducing southerly currents towards New Zealand. In the western Pacific, drier conditions may result due to reduced surface ocean temperatures.
During El Niño, New Zealand tends to experience stronger or more frequent winds from the west, which can encourage dryness in eastern areas, and more rain, especially along the west coasts. During El Niño, cooler ocean surface temperatures prevail around New Zealand as less tropical water is pushed south from the Equator.
North-easterly winds tend to become more common during La Niña events, bringing moist, rainy conditions to north-eastern areas leading to flooding of the North Island and reduced rainfall to the lower and western South Island. Warmer than average air and sea temperatures can occur around New Zealand during La Niña. Some areas, such as Otago and South Canterbury, can experience drought in both phases.</td>
<td rowspan="2">Describes with understanding:
• change in trade winds leading to La Niña / El Niño
• flow of equatorial surface ocean related to La Niña / El Niño
• change in thermocline due to La Niña / El Niño
• change in sea surface temperature in western Pacific due to El Niño
• change in sea surface temperature in western Pacific due to La Niña
• one accurate condition around New Zealand due to El Niño
• one accurate condition around New Zealand due to La Niña
• one accurate sea level statement.</td>
<td>Explains:
• formation of La Niña including wind and equatorial surface currents
• formation of El Niño including wind and equatorial surface currents
• thermocline OR sea level AND surface ocean temperature during El Niño
• thermocline OR sea level AND surface ocean temperature during La Niña
• conditions around New Zealand due to El Niño OR La Niña.</td>
<td>• Explains comprehensively:
• detailed explanation of the formation and conditions during La Niña including wind / equatorial surface currents / surface ocean temperatures / sea level / upwelling/thermocline (at least FOUR out of six)
• detailed explanation of the formation and conditions during El Niño including wind / equatorial surface currents / surface ocean temperatures / sea level / upwelling/ thermocline (at least FOUR out of six)
• discussion of how the conditions in New Zealand are likely to change due to the transition from La Niña to El Niño (including at least TWO of winds, precipitation, temperature).</td>
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<tr><td colspan="2">Answers should refer to western Pacific.</td></tr>
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NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE point from Achievement.	TWO points from Achievement.	THREE points from Achievement.	FOUR points from Achievement.	TWO points from Merit.	THREE points from Merit.	ONE point from Excellence.	TWO points from Excellence.

Q	Evidence	Achievement	Merit	Excellence
THREE	As the Marshall Islands are very low lying, anything that has an effect on sea levels could increase the flooding risk to the Marshall Islands disproportionately. As the Earth's atmosphere becomes warmer due to climate change, sea levels are likely to increase, due to both melting of ice caps on land masses such as Greenland and Antarctica (but not sea ice) and thermal expansion of the ocean. As the oceans heat up due to climate change, the water particles move faster and cause an increase in volume, and therefore sea levels to increase. This will mean that high tides will be higher than in the past, and there is increased flooding risk. Tides are mostly caused by the gravitational pull of the Moon on the oceans; however, the Sun also has an effect. When the Sun and the Moon are in line with one another relative to the Earth, their gravitational pulls work together to increase the amplitude of the tidal wave, making high tides higher and low tides lower. This is known as a spring tide, which will increase the risk of flooding to the low-lying Marshall Islands. Additionally, as the orbits of the Sun and Moon are not circular but elliptical, when these bodies are closer to each other the spring-tide effect becomes even greater (perigean and perihelion spring tides). Warming oceans are also likely to lead to increases in frequency and severity of tropical storms. High tides can be increased further when it occurs during an extreme low-pressure system such as a tropical storm. Low atmospheric pressure, along with strong onshore winds can cause increased wave size, as well as causes water to pile up against land masses, which massively increases the risk of flooding, especially in low-lying islands such as the Marshall Islands during high tide. Combining of factors in the future is likely to lead to much more severe flooding events in places such as the Marshall Islands. Sea level rise combined with a tropical storm during a spring or even more extreme spring tide event is likely to result in extreme flooding events in the future for many Pacific Islands and coastal areas.	Describes with understanding: • sea level rise due to climate change (either melting of land ice or thermal expansion) • spring tides when the Moon and Sun are in alignment • effect of tropical storms on flooding (e.g. low pressure or wind) • storm surge due to winds pushing water up against the land • climate change increases the intensity and frequency of storms • perigean or perihelion spring tides.	Explains: • sea level rise due to thermal expansion (particle movement) increasing volume • sea level rise due to ice caps melting (not sea ice) increasing volume • spring tides due to alignment of Earth-Sun-Moon increasing the gravitational effects • perigean (or perihelion) spring tide, where the effect of the Moon (or Sun) closest point to the Earth increasing gravity effects • storm surges due to low atmospheric pressure / strong onshore winds.	Explains comprehensively: • how factors combine to increase the flooding risk in the Marshall Islands linked to: • sea level rise due to thermal expansion / ice cap melting • causes and effects of spring tides • causes and effects of perigean / perihelion spring tides • increased risk of storms and therefore storm surges (wind or low pressure).

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE point from Achievement.	TWO points from Achievement.	THREE points from Achievement.	FOUR points from Achievement.	TWO points from Merit.	THREE points from Merit.	ONE point from Excellence	TWO linked points from Excellence

Cut Scores

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