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91413



914130



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SUPERVISOR'S USE ONLY

Level 3 Earth and Space Science, 2019

91413 Demonstrate understanding of processes in the ocean system

2.00 p.m. Thursday 28 November 2019
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of processes in the ocean system.	Demonstrate in-depth understanding of processes in the ocean system.	Demonstrate comprehensive understanding of processes in the ocean 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 and clearly number the question.

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

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

Achievement

TOTAL

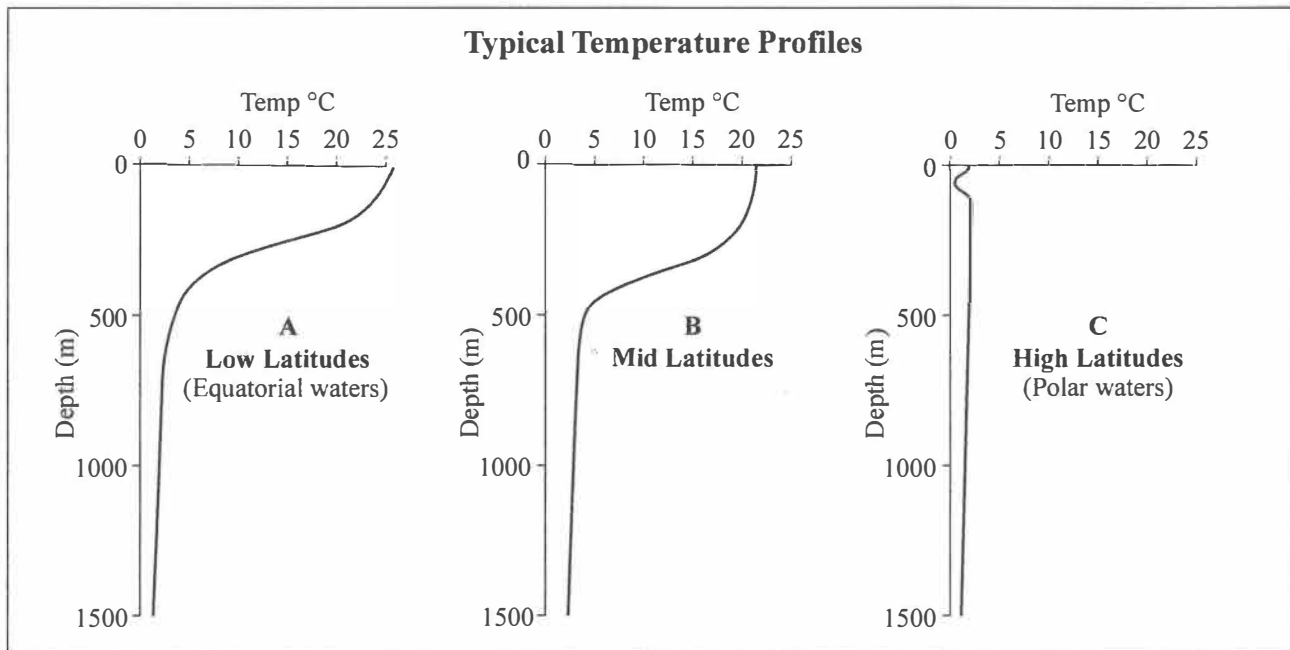
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ASSESSOR'S USE ONLY

QUESTION ONE: THE THERMOCLINE AND SEASONAL VARIATIONS

ASSESSOR'S
USE ONLY

The resource below shows three thermoclines that were sampled in one year in March, in the Southern Hemisphere for equatorial, mid, and polar latitudes.

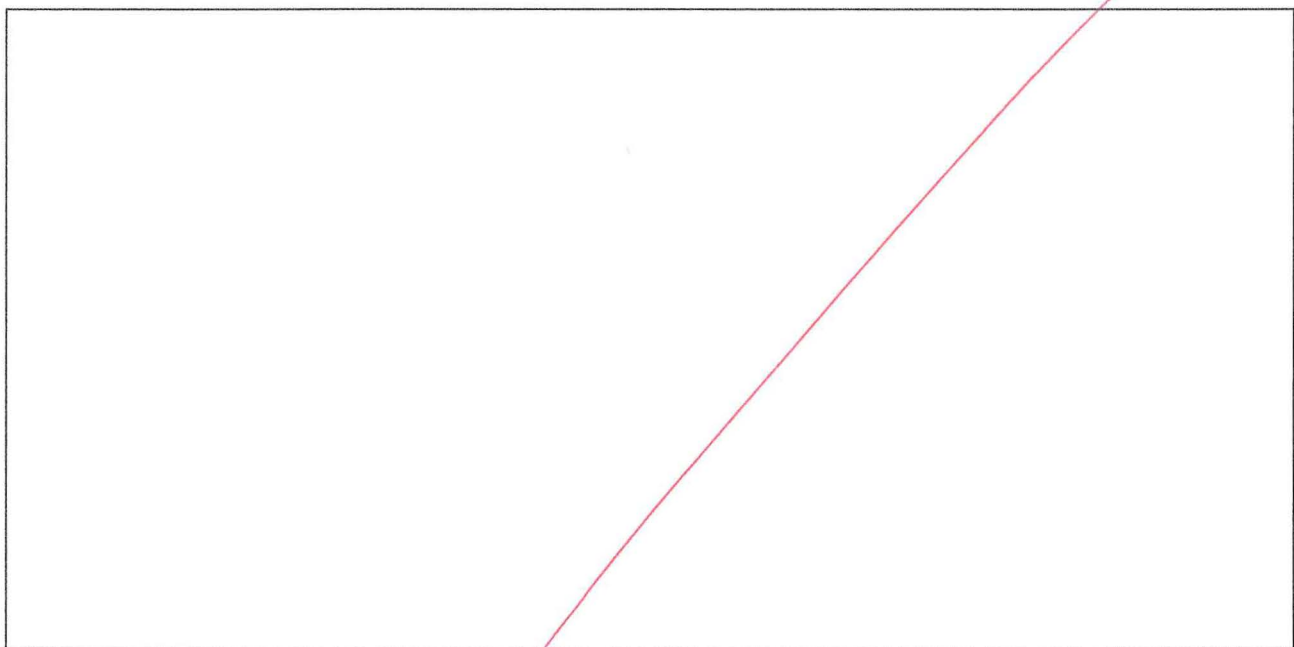


With reference to the above graphs, explain the reason behind the trends shown in the three thermoclines in terms of the thermal energy in the oceans, AND explain the likely consequences on the thermoclines of further global warming.

In your answer you should consider:

- what a thermocline is
- the links between the layers, latitude, and solar heating for each thermocline
- how seasonal heating can affect the thermocline
- the effect of global warming on the ocean layers.

You may use an annotated diagram to assist your answer.



- A thermocline is the layer ~~be~~ that separates ~~the~~ two bodies of waters of drastically different temperatures. //
- At low latitudes, the angle of the sun is most directly in incidence with ocean waters and the earth's surface. This allows the water to absorb ~~the~~ very high levels of energy in the exposed, surface layer. Because the surface layer has a lot of energy absorbed, it becomes very warm as seen in the diagram. Although ~~the~~ ~~angle~~ sun exposure is high, the deep ocean layers are still a constant cold temperature due to the lack of light reaching down there thus a strong temperature gradient is formed. This gradient forms a thermocline that acts as a barrier stopping the two layers from mixing. //
- At mid latitudes, the angle of the sun light in incidence to the earth ~~is~~ (insolation) is ~~more~~ lower and thus the surface waters cannot absorb as much energy as equatorial waters and is a result cooler (-5°). Similar to before, the deep ocean layer is still cold and unaffected by the sunlight as it barely reaches that deep. This difference in temperature forms a thermocline that ~~has~~

There is more space for your answer to this question on the following pages.

prevents the two layers from mixing. ~~as~~
~~seen in the Graph above~~ At High latitudes,
~~the~~ insolation is very low as the Sun is
at a much more oblique angle to the surface,
this results in much less sunlight exposure
and thus less energy absorption in the surface
layer. As energy absorption is considerably less,
so is the temperature as the particles have
less energy. This in combination with the
presence of ice keeps the surface waters
almost as cold as deep ocean waters.
Due to this fact, there is almost no temperature
difference/gradient and thus no thermocline
is present, as seen on the Graph. //

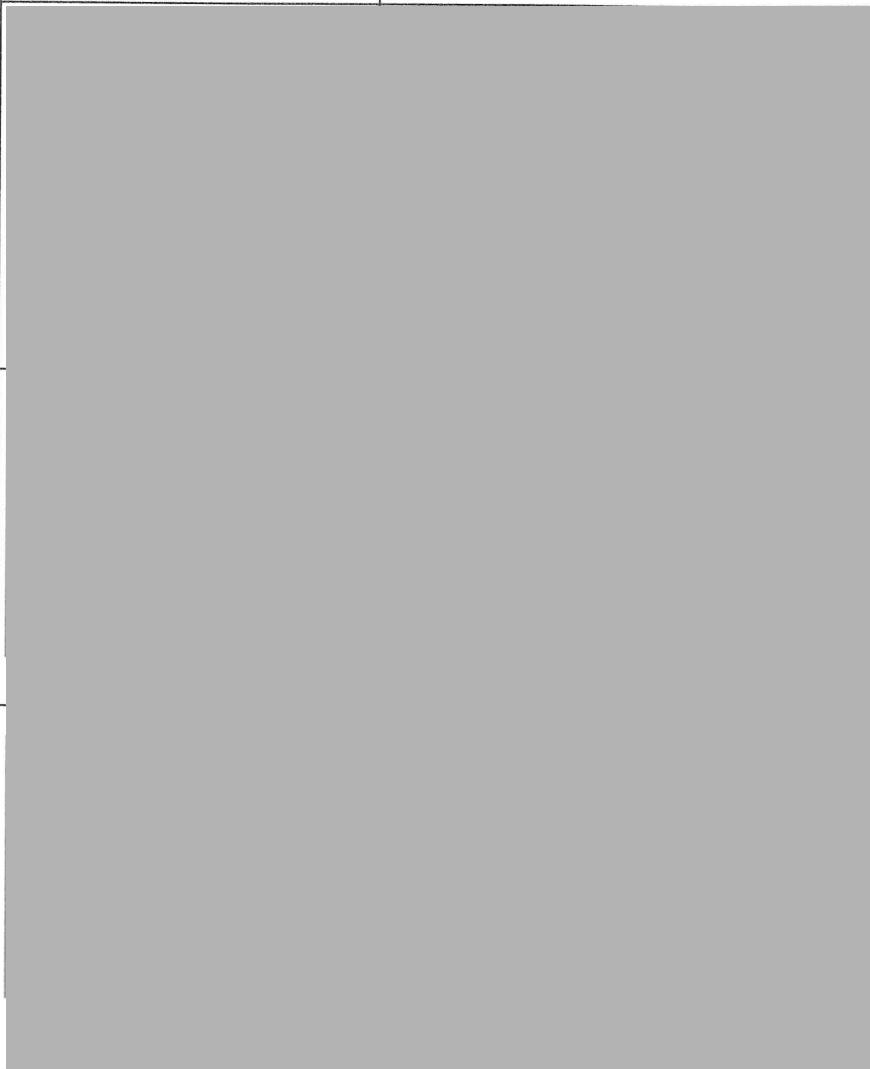
- in Summer, the earth's tilt is more direct
to the Sun and thus experiences more sunlight
and radiation exposure. ~~Due to~~ This results
in all ~~waters~~ surface waters excluding
the poles to increase in energy absorption and
thus temperature. As the temperature of surface
waters is increased but deep ocean layers stay
constant, thermoclines are strengthened, due
to the greater difference in temperature. //

◦ In ~~Winter~~ Winter, the earth's tilt is less direct to the sun and thus experiences less sunlight exposure. This results in all surface waters excluding the poles to decrease in energy absorption and thus temperature. As the temperature of surface waters decreases but deep ocean stays constant, thermoclines are weakened due to the lesser differences in temperature //

A4

QUESTION TWO: CARBON DIOXIDE AND OCEAN ACIDIFICATION

The photographs below show the development and thickness of the shell structure of 13-day-old green-lipped mussel larvae raised in different ocean water acidity conditions.

pH and Acidity Level	Shell	Shell Cross Section Structure (Taken from the area shown by the red square – thickness is shown in micrometres)
<p>pH level 8.0</p> <p>Normal ambient levels of ocean acidity</p>		
<p>pH level 7.7</p> <p>Moderate level of ocean acidity</p>		
<p>pH level 7.3</p> <p>Extreme level of ocean acidity</p>		

Source: J. Ericson, *Effects of ocean acidification on fertilisation and early development in polar and temperate marine invertebrates*, MSc thesis (Dunedin, University of Otago, 2010), p. 117

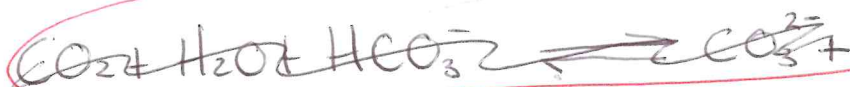
As more carbon dioxide dissolves in the oceans, ocean water is becoming more acidic.

Using the above resource to assist you, explain how the increasing levels of carbon dioxide in the oceans will impact ocean life.

In your answer you should consider:

- the reasons for increasing carbon dioxide in the oceans
- what happens to the carbon dioxide when it enters the ocean; this should include the appropriate chemical equations
- how changes to the ocean's carbonate levels will affect marine life.

You may use an annotated diagram to assist your answer.



- The reason for increasing CO_2 levels in the oceans is due to our production of Greenhouse Gases. Burning fossil fuels releases large amounts of CO_2 into the atmosphere that is then absorbed at the ocean surface, thus more CO_2 produced into the environment, means more CO_2 in the oceans. //

- As CO_2 enters the oceans, it reacts with ~~the~~ the water to produce HCO_3^- and Hydrogen. These two products then further react to form Carbonate ions and hydrogen.

- Many marine life in the ocean requires Carbonate to form shells with Calcium, However the increasing CO_2 levels in the ocean forces the equilibrium to shift and produce more HCO_3^- and H^+ .

There is more space for your answer to this question on the following pages.

Although Carbonate (CO_3^{2-}) is Good for Marine life, the increasing H^+ ions formed can also react with the Carbonate and form Carbonic acid that can ~~be~~ erode Shells of marine life. An increasing H^+ also means that it reacts with water to form H_3O^+ , ~~de~~ decreasing the pH of the ocean and making it more acidic as seen in the diagrams. Overall this increasing CO_2 results in more Carbonic acid, lower pH levels and less Carbonate ions ~~for~~ available making it much harder for marine life to make shells and survive. //

QUESTION THREE: FISHING AND THE CHATHAM RISEASSESSOR'S
USE ONLY

The resources below show the sea floor and ocean currents that circulate off the east coast of New Zealand, and a satellite image of a phytoplankton bloom in 2010 taken by a NASA satellite over the Chatham Islands and Rise.



Source: NASA Aqua satellite 5 December 2010.
<https://earthobservatory.nasa.gov/images/47621/bloom-around-the-chatham-islands-new-zealand>

Adapted from: <https://www.niwa.co.nz/our-science/oceans/bathymetry/download-the-data> and <https://teara.govt.nz/en/map/5912/ocean-currents-around-new-zealand>

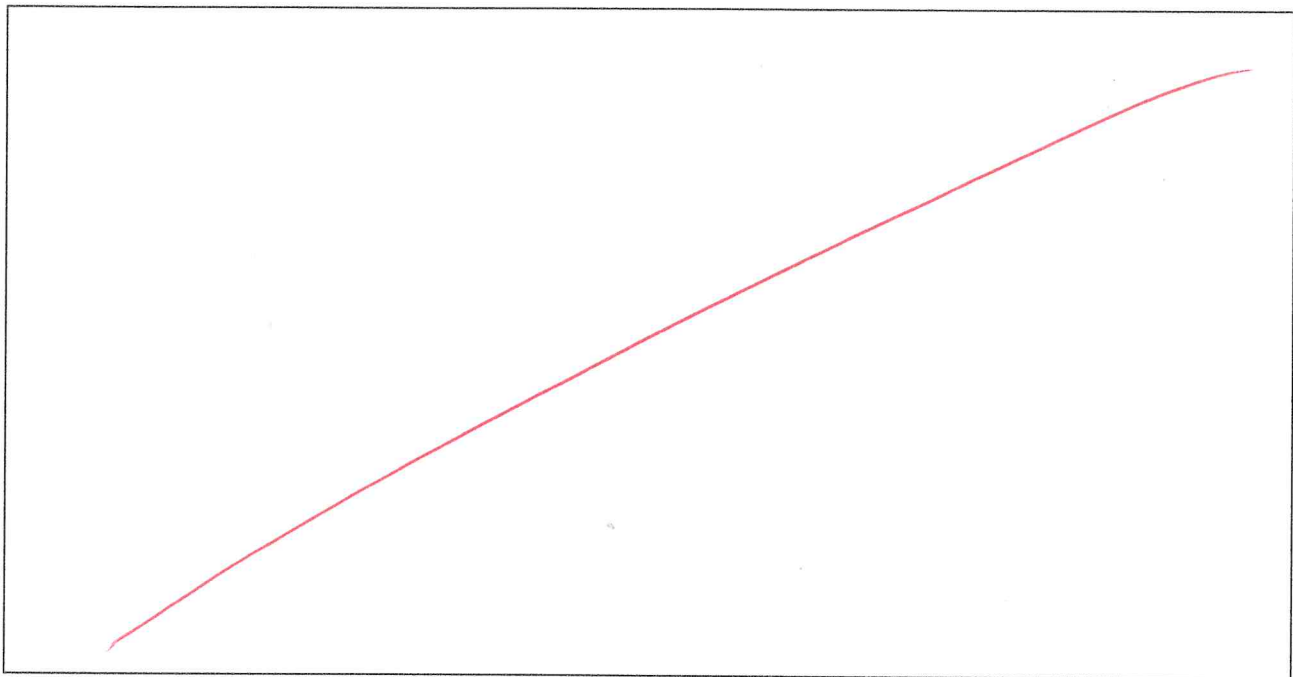
The Chatham Rise is an underwater mountain range that extends from the east coast of the South Island to beyond the Chatham Islands. It is the meeting point of surface and deep-water ocean currents.

Explain how this region of the ocean will have an influence on marine life and human activity.

In your answer you should consider:

- current formation and origin
- reasons for the different temperatures of the currents
- the reason why the two currents meet at the Chatham Rise.

You may use an annotated diagram to assist your answer.



• Currents are formed when the friction of winds pushes the surface water along with it. In this case, the subarctic current is formed due to the friction from the westerlies blowing on the surface layer. Insolation is also higher towards the

the

• The antarctic circumpolar current is much colder than the sub-antarctic current east auckland current as it has travelled from the poles where ~~is~~ insolation is much less and the water gets less sunlight exposure. //

• East auckland current however is travelling down from the equator where insolation, the angle in which the sun strikes the earth, is very high and thus can absorb

There is more space for your answer to this question on the following pages.

more Energy and be much Warmer. //

- East aachland Current is Driven also by Friction of Winds traveling poleward from 30° due to the presence of the Ferrel cell. //

A3

Achievement Exemplar 2019

Subject	L3 Earth and Space Science		Standard	91413	Total score	11
Q	Grade score	Annotation				
1	A4	<p>The candidate shows evidence towards an understanding of the links between solar heating and the warming of the upper layers in areas of low, mid and high latitudes. The thermocline is linked to the change in temperature between the upper and deep ocean layers. Seasonal changes are linked to the Earth's tilt and its heating effect on Earth's surface.</p> <p>The candidate has used bullet points in answering the question, but has the potential to achieve at a merit level if answers has been planned as a discussion.</p>				
2	A4	<p>The candidate links the source of carbon dioxide in sea water to increased emissions. The subsequent chemistry is described, linking the pH change to less carbonate ions being available. Equations are given but not linked to the discussion.</p> <p>A planned explanation with use of equations in the discussion would show potential to achieve at a merit level.</p>				
3	A3	<p>The candidate links the current sources to solar heating, i.e. the Antarctic waters being deep water and surface current to the equator.</p> <p>Little other evidence is given.</p>				

Confirmation of check	Y / N
This exemplar has been checked for similarities with current online exemplars.	Y