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MANA TOHU MĀTAURANGA O AOTEAROA

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SUPERVISOR'S USE ONLY

Level 3 Earth and Space Science, 2013

91413 Demonstrate understanding of processes in the ocean system

9.30 am Tuesday 26 November 2013
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 space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 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.

TOTAL

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QUESTION ONE: OCEAN SURFACE CIRCULATION

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Discuss how winds and the Coriolis effect result in ocean surface circulations, and how these circulations result in the transfer of matter AND energy in the ocean system.

Your discussion should include:

- a description of how the Coriolis effect impacts on surface circulation
- an explanation of how winds AND the Coriolis effect result in the surface circulations in the Northern and Southern Hemisphere
- a discussion of the effects of the transfer of matter (water and nutrients) and energy on the ocean system overall.

Include a labelled diagram(s) in your answer.

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

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QUESTION TWO: CARBON CHEMISTRY

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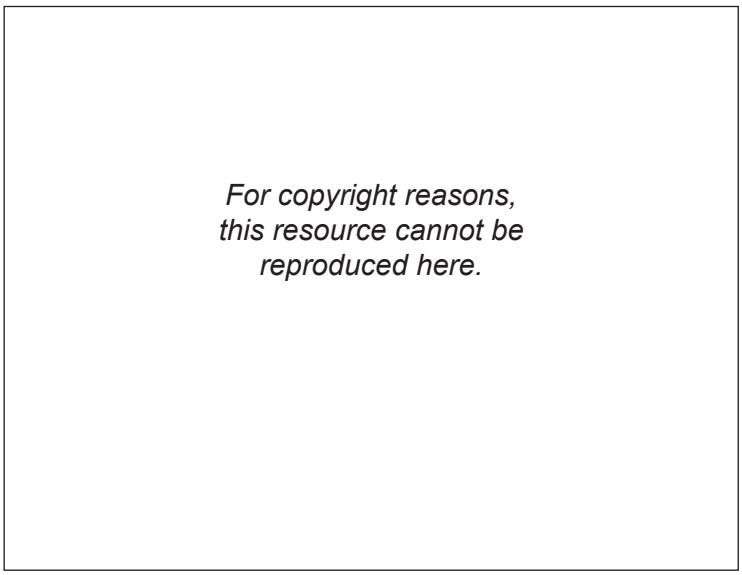
At the ocean surface, carbon dioxide enters the oceans as a dissolved gas. Carbon dioxide gas can also be released from the ocean surface into the atmosphere. In the ocean, some dissolved carbon dioxide reacts with water to form carbonic acid.

The graph below shows how atmospheric CO_2 has changed at Baring Head (southeast of Wellington), 1970 – 2006.



Adapted from: www.mfe.govt.nz/environmental-reporting/atmosphere/greenhouse-gases/atmospheric-levels.html

Discuss the effect of rising atmospheric carbon dioxide levels on ocean acidity.

Your discussion should include:

- a detailed discussion of the relationship between atmospheric carbon dioxide and oceanic carbon dioxide
- equations for any reactions of carbon dioxide involving ions present in an $H_2O / CO_2 / H_2CO_3$ solution
- a discussion of why ocean acidity was relatively stable in the past, but is now increasing more rapidly than at any time in the past.

Include a labelled diagram(s) in your answer.

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QUESTION THREE: LAYERING IN THE OCEAN

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Generally thermoclines (layers that sharply separate regions in fluids differing in temperature) have seasonal variation, which means that they change over the year. The diagram below shows the seasonal changes in the thermoclines off the west coast of Mexico. (Note: Mexico is in the Northern Hemisphere, where the seasons are the reverse of those in New Zealand, ie July is summer.)

For copyright reasons, this resource cannot be reproduced here.

Adapted from: www.sciencedirect.com/science/article/pii/S0967064500000175

Discuss the seasonal changes in thermoclines over a year.

Your discussion should include:

- an explanation of the temperature layers in the ocean
- details of the transport of matter (water) and energy (heat)
- an elaboration of how and why thermoclines change over a year.

Include a labelled diagram(s) in your answer.

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

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

QUESTION NUMBER

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