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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Earth and Space Science 2025

91413 Demonstrate understanding of processes in the ocean system

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.

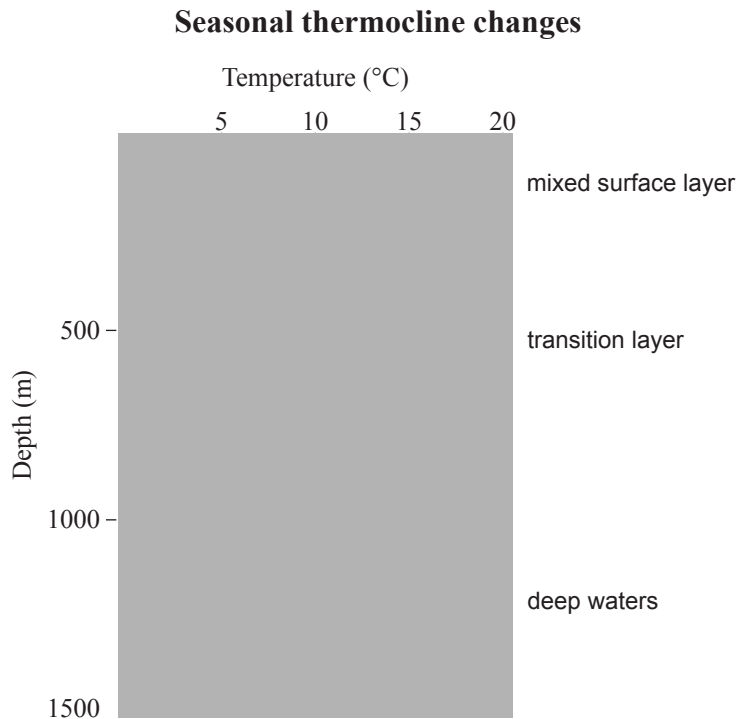If you need more room for any answer, use the extra space provided at the back of this booklet.

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

Do not write in any cross-hatched area (▨). This area will be cut off when the booklet is marked.

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

QUESTION ONE: NEW ZEALAND'S THERMOCLINE

New Zealand is in the mid-latitudes, where surface ocean temperatures vary widely between seasons. The gradient of the thermocline changes as surface temperature changes during the year. This also impacts formation of the pycnocline, which reflects changes in density of ocean water.

Seasonal thermocline changes

Temperature (°C)

mixed surface layer

transition layer

deep waters

Adapted from: www.sciencedirect.com/topics/agricultural-and-biological-sciences/thermocline

Discuss seasonal changes in the thermocline and pycnocline near New Zealand.

In your answer, you should consider:

•   how the thermocline forms

•   formation of the three ocean layers

•   reasons for seasonal variation in the thermocline at mid-latitudes

•   how changes in the thermocline impact pycnocline formation.

An annotated diagram may assist your answer.

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

QUESTION TWO: SOUTHERN OCEAN CARBON SINK

The Southern Ocean plays a central role in moderating the rate of climate change, absorbing approximately 40% of the carbon dioxide (CO_2) that has been produced by humans until now.

Cumulative ocean CO_2 uptake since 1850

Adapted from: https://scx2.b-cdn.net/gfx/news/hires/2022/improving-climate-mode.jpg

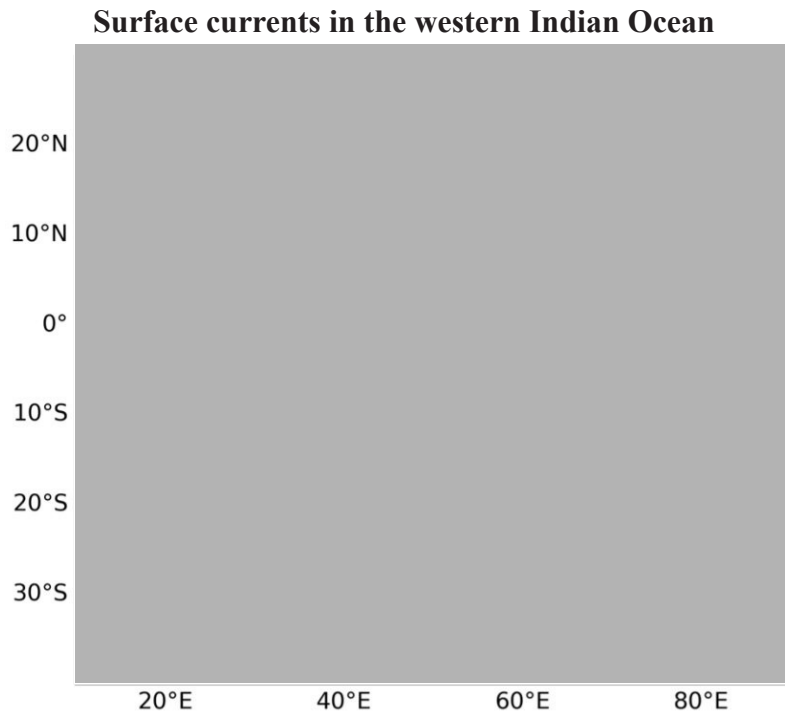Explain how the Southern Ocean absorbs large amounts of carbon dioxide from the atmosphere.

In your answer, you should consider:

*   the biological and physical pumps that take CO_2 into the ocean
*   the effects that storing increased amounts of CO_2 may have on ocean chemistry
*   reasons why the Southern Ocean can absorb such large quantities of CO_2.

QUESTION THREE: SOMALIA SEASONAL UPWELLING

Somalia is a country in East Africa. During the northern hemisphere summer, from June to September, a strong monsoon wind blows from the south-west along the coast. This causes upwelling and very good fishing compared to other seasons.

Surface currents in the western Indian Ocean

Adapted from: https://www.mdpi.com/2073-4425/11/3/278

Upwelling current at the Somali coast during southwest monsoon

Adapted from: https://commons.wikimedia.org/wiki/File:Upwelling_current_at_the_Somali_coast_during_Southwest_Monsoon.png

Compare the seasonal fishing conditions off the coast of Somalia during the summer and winter monsoons.

In your answer, you should consider:

•   the role of wind from the south-west and the Coriolis effect to create strong seasonal upwelling

•   the source of nutrients

•   the effect of strong seasonal upwelling in this area on productivity

•   the conditions that lead to downwelling and poor fishing during the winter monsoon season.

An annotated diagram may assist your answer.

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