

┌

93104



931040

┐

S



SUPERVISOR'S USE ONLY

NEW ZEALAND QUALIFICATIONS AUTHORITY  
MANA TOHU MĀTAURANGA O AOTEAROA

## Scholarship 2011 Science

2.00 pm Saturday 12 November 2011

Time allowed: Three hours

Total marks: 32

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 answer 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 2–22 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.**

There are four questions. You are advised to spend 45 minutes on each question.

### QUESTION ONE: THE DEEP SOUND CHANNEL (8 marks)

In the ocean, low-frequency sounds are able to be transmitted for thousands of kilometres in what is called the Deep Sound Channel (DSC).

The DSC is found at a certain depth, where sound travels relatively slowly compared to the speed of sound at greater and lesser depths. The speed of sound is affected by water temperature and pressure.

Using the information for mid-latitude ocean shown in the table below, discuss fully the transmission of sound in the DSC.

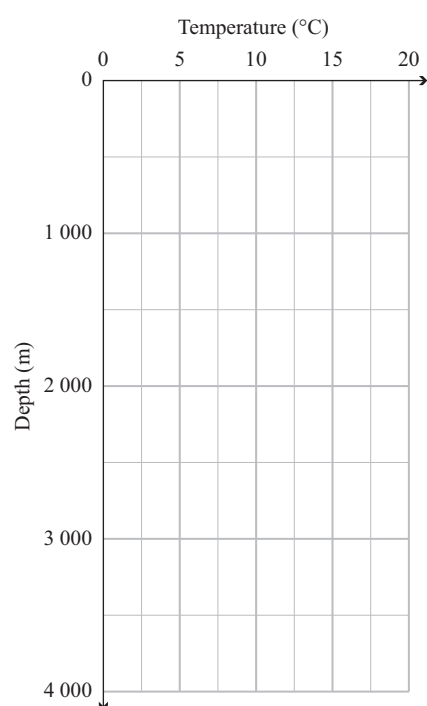
You may wish to sketch the data on the grids provided below to assist your answer.

Consider in your answer:

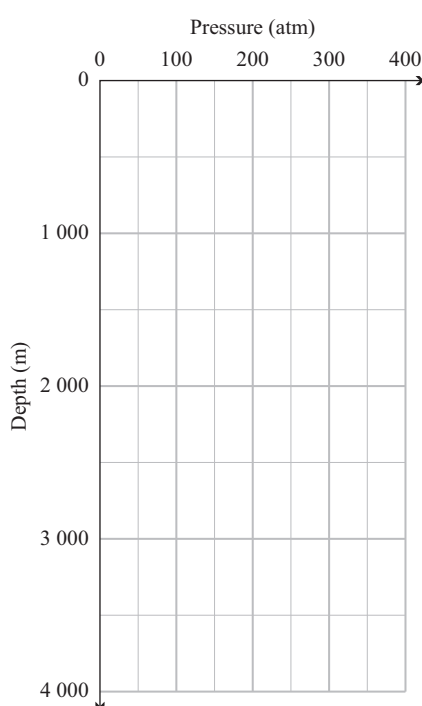
- how the speed of sound in seawater changes with decreasing temperature and with increasing pressure
- the factors that cause the DSC
- how sound would be transmitted for long distances in the DSC
- how the DSC could be used to gather information from the ocean, such as ocean warming and communications between marine mammals.

**Table One: The relationship of depth, temperature, pressure and sound speed**

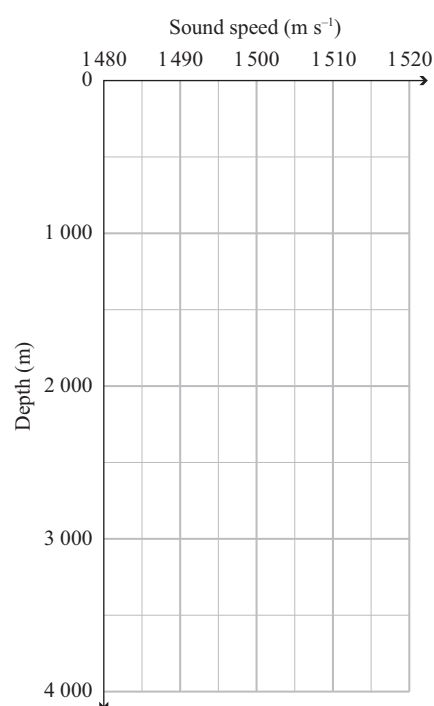
Depth (m)	0	500	1 000	1 500	2 000	3 000	4 000
Temperature (°C)	18	12	4	3	2	2	2
Pressure (atmospheres)	0	50	100	150	200	300	400
Sound speed (m s <sup>-1</sup> )	1 498	1 486	1 482	1 484	1 488	1 502	1 516



**Depth vs temperature**



**Depth vs pressure**



**Depth vs sound speed**







Food irradiation is a food safety technology that uses gamma rays to destroy bacteria that cause food poisoning.

- A diagram may assist your answer.



- (b) The gamma ray source used to irradiate food is cobalt-60 (Co-60). Co-60 has a half-life of 5.3 years, and also releases beta particles.

When not in use, Co-60 is stored in a pool of water. When needed, Co-60 is pulled up out of the water into a chamber with massive concrete walls. Foods to be irradiated are brought into the chamber, and are exposed to the rays for a defined period of time.

Discuss why such strict conditions are necessary when Co-60 is used.

Consider in your answer:

- the safety of the operating personnel over time
- whether the public are exposed to radioactivity by eating such food.





**QUESTION THREE: 18-CARBON FATTY ACIDS (8 marks)**ASSESSOR'S  
USE ONLY

- (a) Margarine is produced by the partial hydrogenation of vegetable oil. This can result in the formation of trans fatty acids.
- From Table Two, choose the fatty acid that is most likely to be a trans fatty acid. Justify your choice by comparing the reasons for the different melting points of the FOUR fatty acids.
  - Discuss why the levels of trans fatty acids in margarines have been reduced as softer margarines have become popular. Consider the health benefits of such a reduction.

A diagram may assist your answer.

**Table Two: Four common 18-carbon unbranched fatty acids found in food**

Name	Formula	mp (°C)
stearic acid	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$	69.6
elaidic acid	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CHCH}_2(\text{CH}_2)_6\text{COOH}$	45
oleic acid	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CHCH}_2(\text{CH}_2)_6\text{COOH}$	13.4
linoleic acid	$\text{CH}_3(\text{CH}_2)_4(\text{CH}=\text{CHCH}_2)_2(\text{CH}_2)_6\text{COOH}$	-11



- Discuss the advantages of a gene being disabled, rather than a new gene being inserted, in the genetic engineering of soya beans.



**QUESTION FOUR:**  
**THE KERMADEC CALDERAS** (8 marks)

Along the western side of the Kermadec Ridge is a line of mainly submerged volcanoes.

Surprisingly, many are rhyolitic caldera volcanoes, rather than the expected andesitic volcanoes. The calderas are between 3 and 10 kilometres in diameter, and some show signs of multiple eruptions.

Between the Kermadec Ridge and the Colville Ridge 100 kilometres to the west, is the three-kilometre-deep Havre Trough. Here the earth is being widened so that the Kermadec Ridge is moving eastwards.

- (a) By considering the tectonic conditions that affect the Kermadec region, discuss fully:
- possible mechanisms that widen the Havre Trough
  - factors in this region that would form caldera volcanoes
  - the consequences for New Zealand of an underwater caldera eruption.

*For copyright reasons,  
this resource cannot be  
reproduced here.*

**Kermadec region**

<http://www.teara.govt.nz/en/sea-floor-geology/5/2>

ASSESSOR'S  
USE ONLY



- (b) Hydrothermal vents are found on and near the Kermadec volcanoes.

Examples are the black smokers, which emit plumes of very hot sulfur-based minerals rich in metals. These minerals are deposited, not only on the crater floors, but also around the vents, resulting in chimney-like structures.

Discuss:

- how hydrothermal vents have formed in these areas
- how the minerals may form chimney-like structures.

*For copyright reasons, this resource cannot be reproduced here.*

**A black smoker**

[http://www.ask.com/wiki/Black\\_smoker](http://www.ask.com/wiki/Black_smoker)

ASSESSOR'S  
USE ONLY





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

ASSESSOR'S  
USE ONLY

QUESTION  
NUMBER

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

ASSESSOR'S  
USE ONLY

QUESTION  
NUMBER

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

ASSESSOR'S  
USE ONLY

QUESTION  
NUMBER

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

ASSESSOR'S  
USE ONLY

QUESTION  
NUMBER

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

ASSESSOR'S  
USE ONLY

QUESTION  
NUMBER







**Assessor's use only.**  
**Keep flap folded in.**

**ASSESSOR'S USE ONLY**

Question	Mark
<b>ONE</b>	(8)
<b>TWO</b>	(8)
<b>THREE</b>	(8)
<b>FOUR</b>	(8)
<b>TOTAL</b>	(32)