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NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2012
Science

2.00 pm Monday 19 November 2012
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 2–19 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.

Question	Mark
ONE	
TWO	
THREE	
FOUR	
TOTAL	/32

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You have three hours to complete this examination.

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QUESTION ONE: GENETIC ENGINEERING TO CONTROL POSSUMS

Possums are a pest that threatens New Zealand's native plants and animals, and can spread tuberculosis (TB) to farm animals. Eradicating possums is difficult because most live in dense bush or mountainous areas. Traditional extermination methods, such as trapping and poisoning, have had variable success. Research is now focusing on controlling fertility by interfering with possum fertilisation.

For a possum sperm to fertilise an egg, it must first attach to three specific proteins on the egg coat. One proposed method of controlling fertility is to trick the possums' immune systems into producing antibodies against these three egg coat proteins, blocking the proteins' action.

This could be done in two ways:

- The transgenes coding for each protein could be inserted into a possum-specific virus. The virus would make the egg coat proteins, which possums' immune systems would now consider to be foreign, and produce antibodies against them. Consequently, sperm could not attach to, and enter the egg, and fertilisation would not occur.
- The same transgenes could be inserted into plants, which would then produce the egg coat proteins in leaves, fruits and seeds. The transgenic plant could either be eaten directly by possums or harvested and processed to make a bait.

Compare and evaluate the production and use of genetically modified viruses and plants to control possums.

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There is more space for your answer to Question One on the following page.

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The examination continues on the following page.

QUESTION TWO: CARBON ISOTOPES AS CLIMATE INDICATORS

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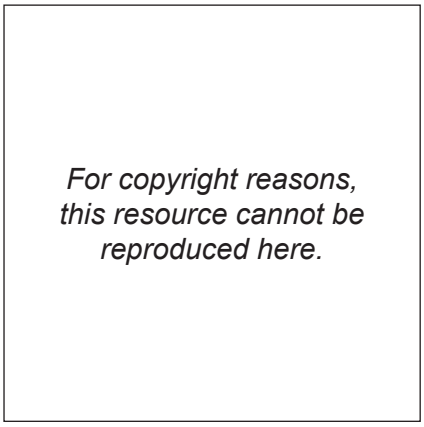
Carbon can be found in various forms, such as carbon dioxide, organic matter and inorganic calcium carbonate.

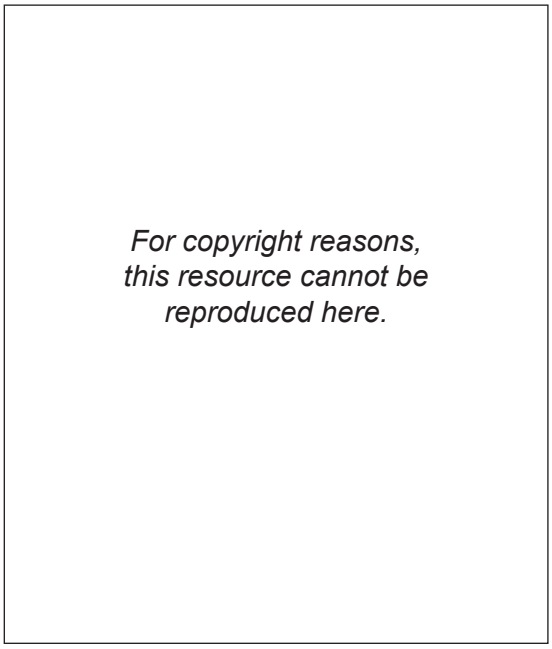
Carbon has two important stable isotopes, C-12 and C-13, which do not decay. The relative proportions of C-12 and C-13 isotopes can vary over time. These proportions are preserved in sediment and rocks, and can be used to find out about past climates.

Photosynthesis increases the ratio of C-12 to C-13 in the carbon stored in plants, affecting the proportions of these two isotopes in the atmosphere. Carbon dioxide is dissolved in the ocean at the C-12 to C-13 ratio of the atmosphere at that time. Minute plankton use this carbon dioxide to form calcium carbonate platelets. The platelets eventually become part of the ocean sediment and are fossilised to form limestone.



Emiliania huxleyi, a widely found photosynthesising plankton, showing calcium carbonate platelets.

http://en.wikipedia.org/wiki/File:Emiliania_huxleyi_coccolithophore_(PLoS).png



www.teara.govt.nz/en/sea-floor-geology/8/2

The ocean around New Zealand has very thick layers of sediment, which can store carbon for long time periods. Sediment cores can be analysed to find out about past climate, using fossilised plankton platelets and other buried organic matter such as pollen grains. The light grey areas of the sediment core shown contain fossilised plankton, and the darker areas contain ash deposits from eruptions in the Taupō region.

(a) Discuss how the analysis of the relative amounts of C-12 and C-13 in sediment can be used to determine whether the climate was warmer or colder in the past.

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(b) Discuss how geological features and processes in and around New Zealand deliver thick layers of sediment to the bottom of the ocean.

Consider in your answer how the Taupō ash deposits would help date a sequence of layers, as shown in the sediment core on page 6.

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QUESTION THREE: SURFACE TEMPERATURES OF VENUS, EARTH AND MARS

The surface temperatures of Venus, Earth and Mars are influenced by many factors.

Using the data in Table One, discuss and evaluate why the three planets have different surface temperatures from each other.

Include in your answer the role of volcanic activity and the role of water.

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Venus Earth Mars

www.myninjaplease.com/green/http://green.myninjaplease.com/wp-content/uploads/2007/09/mars-earth-venus.jpg

Table One: Comparison of Venus, Earth and Mars

	Venus	**Earth**	**Mars**
Average distance from Sun (million km)	108	150	228
Mass ($\times 10^{24}$ kg)	4.87	5.98	0.64
Length of day (in Earth time)	116.75 days	24 hours	24 hours 39 minutes
Atmosphere compared to Earth	100 times thicker	1	100 times thinner
Proportion of CO_2 in planetary atmosphere	95%	0.03%	95%
Average surface Temperature (°C)	450	15	–47
Probable temperature if no CO_2 in atmosphere (°C)	–46	–18	–57
Cloud cover	heavy	medium	light
Albedo (reflectivity)	0.75	0.3	0.25
Amount and state of water	trace of water vapour	liquid, solid and gas	solid
Volcanic activity	hot spot volcanoes	mostly subduction volcanoes	none

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QUESTION FOUR: SONAR AND MARINE ANIMALS IN THE OCEAN

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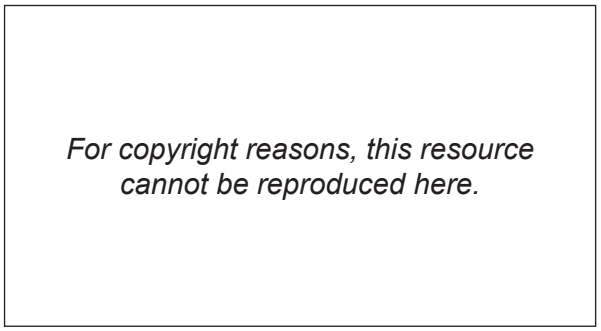
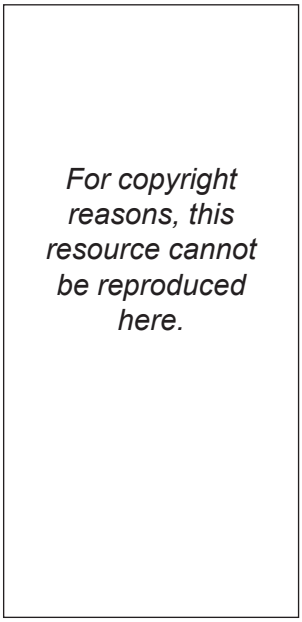
Sonar map showing daily vertical movement of different marine animals



http://www.oceanobservatory.com/projects/fjords1

The echo signatures of the swim bladders of three species of fish



www.dosits.org/people/fishing/identifyfish/

Sonar is widely used, not only to detect marine animals such as fish in the ocean, but also to distinguish between different species. A range of high frequencies, from 20 kHz to 200 kHz, is used.

Sonar reflects off gas-filled organs that many marine species have to aid buoyancy. For example, many fish species have gas-filled swim bladders.

This use of sonar has led to some unusual discoveries. In World War II, submarines became effectively invisible by hiding beneath a layer in the ocean that was opaque to sonar. This layer was called the "false bottom" and when investigated, was found to contain a species of marine animal with a gas-filled organ one millimetre in diameter.

Sonar has also detected a vertical migration of millions of marine animals, which move up through the ocean at dusk to feed on phytoplankton near the surface and descend at dawn to avoid predators. Individual species can be detected within this migration, and this information is used by scientists to monitor fish stocks.

Discuss and analyse how sonar is able to detect marine animals and to distinguish between species.

Consider in your answer:

- how a layer of jellyfish could hide a submarine
- how different marine species would be told apart
- why a range of frequencies would be needed
- the effect of depth on the returning signal.

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There is more space for your answer to Question Four on the following pages.

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

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