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93104

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2006
Science

2.00 pm Friday 1 December 2006
Time allowed: Three hours
Total Marks: 48

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

Answer ALL questions.

Write all your answers in this booklet.

For all questions, the answers should be written or drawn clearly with all logic fully explained.

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 2–18 in the correct order.

You are advised to spend approximately 30 minutes on each question.

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

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QUESTION ONE: RADIATION AND MUTATIONS (8 marks)

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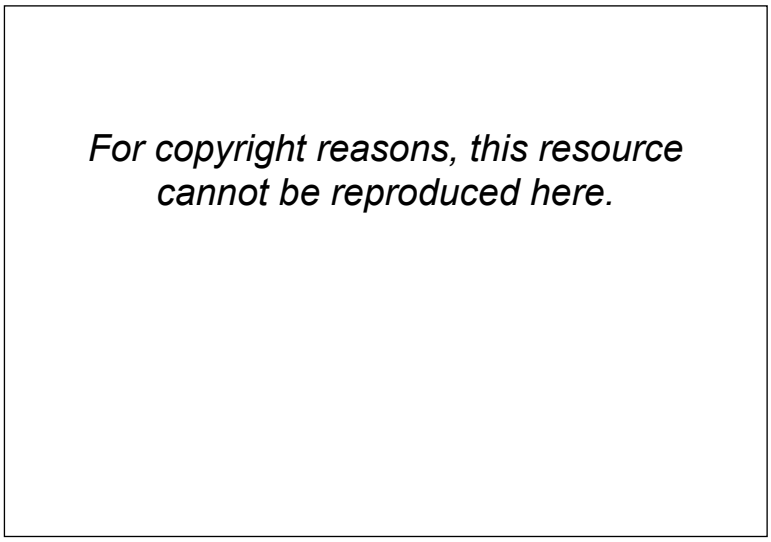

Chromosomal damage caused by radiation (as indicated by the arrows).

http://en.wikipedia.org/wiki/DNA_repair

Compare and contrast the different forms of radiation that can cause permanent alterations in DNA. You may like to consider:

- the different **forms** of radiation and their penetrating ability
- the **properties** of radiation that cause DNA damage
- the **general effect** of radiation on large molecules such as DNA.

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QUESTION TWO: GENETIC DISEASE (8 marks)

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Cystic fibrosis is a genetic disease for which New Zealand babies are tested a few days after birth.

Cystic fibrosis is caused by the mutation of a gene which, in its normal form, codes for a protein called CFTR. CFTR controls mucus production, especially in the lungs. Mucus in the lungs is normally thin and fluid, but becomes thick, sticky, and hard to move in cystic fibrosis sufferers. Different mutations of the same gene, many of them point mutations, can produce a wide range of effects. This gene can have more than 300 different mutations, some causing severe symptoms, some causing mild symptoms, and some no symptoms at all.

Gene Changes in Cystic Fibrosis

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http://www.accessexcellence.org/AE/AEPC/NIH/gene08.html

Discuss why different **point** mutations of the same gene could lead to a range of symptoms for cystic fibrosis sufferers. Diagrams may assist your answers.

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QUESTION THREE: A CURRENT CONTROVERSY (8 marks)

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Blood samples taken from newborn babies are stored indefinitely in New Zealand. The blood is obtained within 10 days of birth to test for cystic fibrosis and 6 other metabolic disorders. The screening is voluntary, but almost 100% of babies born in New Zealand are tested. Each year, 30 to 35 babies out of approximately 55 000 test positive for one or more of the disorders. Cystic fibrosis is the most common condition found, although the test shows up only the most common mutation.

One implication of this widespread testing is that there are now stored samples of the DNA of half of all New Zealanders. The samples are retained after the original testing, so that if a child subsequently develops one of these disorders, the samples are available for re-testing.

Parents can obtain and store these samples if they ask. Other interested parties, such as researchers, courts, police, and health workers can also obtain these samples under certain conditions such as approval from an ethics committee, a court order or a search warrant.

Critically evaluate, with particular reference to the science involved, the ethical issues involved in keeping these DNA samples. You may like to consider:

- why these samples may be retested if a child subsequently develops one of the disorders such as cystic fibrosis
- the possible advantages to **researchers** of retaining this genetic material
- the advantages and disadvantages of **police and courts** accessing these stored samples.

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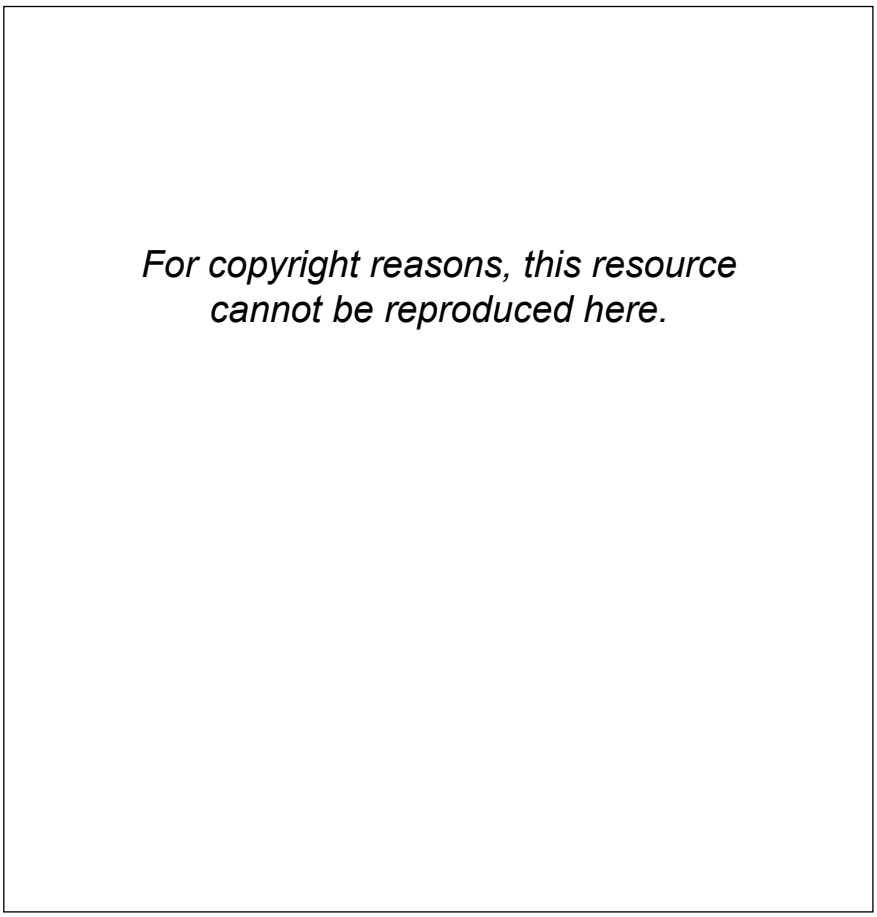
QUESTION FOUR: SLOW EARTHQUAKES (8 marks)

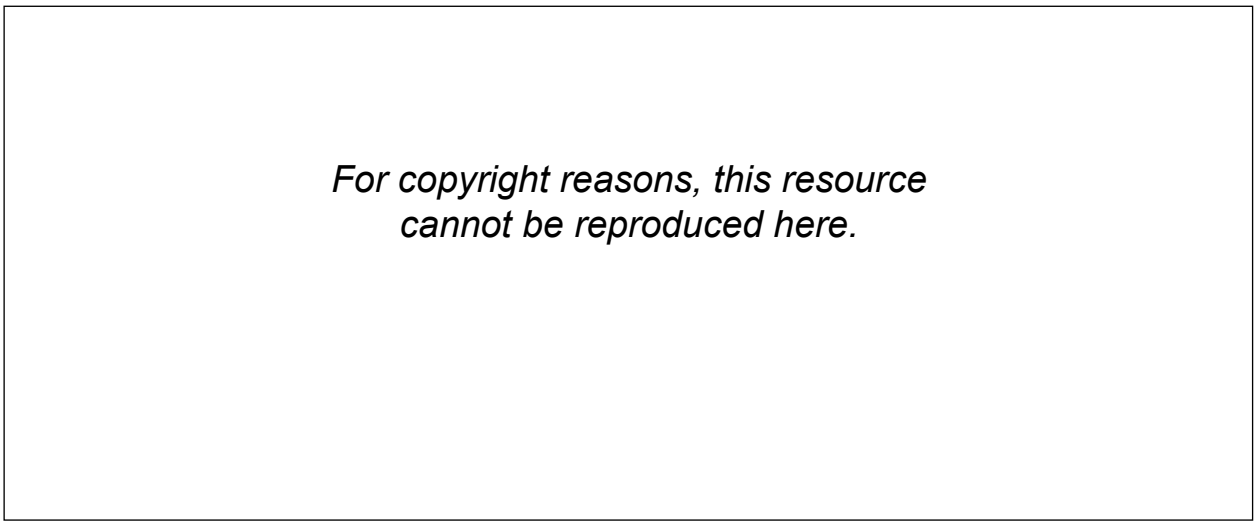
With the advent of Global Positioning System (GPS) equipment, it has been discovered that slow, silent (slow-slip) earthquakes are occurring under New Zealand. A slow-slip earthquake is one that moves ground over a period of days, rather than with a quick, sudden movement. Up to seven slow-slip earthquakes have been recorded since 2002.

In October 2002, one slow-slip earthquake near Gisborne unexpectedly moved the ground about 20 mm to the east at a rate of nearly 2 mm a day.

The location of recent slow-slip earthquakes relative to the plate interface



Cross section A – A´ as shown on the above map (not to scale)



adapted from www.gns.cri.nz/news/release/slow.html

Discuss the process of subduction and possible reasons for the occurrence of slow-slip earthquakes. Your answer may include:

- how the process of subduction forms the three zones shown in the cross section on page 8
- the role of water in subduction
- how slow-slip earthquakes may occur
- why slow-slip earthquakes occur.

Note: The temperature of rocks increases by 1°C every 100 metres towards the centre of the Earth.

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QUESTION FIVE: HYDROCARBONS ON TITAN (8 marks)

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Titan is one of Saturn's largest moons and was recently visited by the Cassini-Huygens probe. Titan's thick atmosphere contains methane, ethane, and many other hydrocarbon compounds. The probe also detected methane gas on the surface of Titan, when the heat of the probe landing caused methane trapped just below the surface to evaporate.

It seems that methane below the surface is not dissolved in liquid water, but is locked in methane-rich water ice, called methane clathrate. The water molecules form a cage within which methane molecules are held. However, methane on Titan's surface may be dissolved in other hydrocarbons such as ethane.

Model of methane clathrate

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http://www.giss.nasa.gov/research/features/methane/

(a) Discuss why methane would dissolve in other hydrocarbons such as ethane, but not in water.

(b) Methane is expected to be an important source of **carbon** in the outer solar system.

Why is carbon such an important element?

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Life is possible on the Earth because the Earth's average temperature and air pressure means that water can exist as a solid, liquid, or gas. Water can therefore act as a solvent for many molecules, and be an environment for biochemical reactions.

The surface of Titan has an average temperature of –178°C and pressure of 146.7 kilopascals, which means that methane can exist as a solid, liquid, or gas.

(c) What are the implications for the development of life in the conditions prevailing on the surface of Titan?

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QUESTION SIX: SOUNDPROOFING (8 marks)

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Unwanted noise can occur even in our homes. An example of unwanted noise is loud music being played in a living area that can be heard by people trying to sleep in bedrooms.

Noise can pass from one room to another, either through the building structure itself, or through the surrounding air (airborne noise). Airborne noise is the more common.

Sound is measured by the decibel scale. The decibel scale measures sound pressure, which is related to the amount of energy in a sound wave. The smallest sound (near total silence) is 0 dB. Prolonged exposure to 85 dB is enough to cause hearing loss.

Diagram showing two rooms used for testing the reduction of airborne noise

http://irc.nrc-cnrc.gc.ca/ie/acoustics/floors/airborne_transmission_loss_e.html

An investigation is to be carried out to see how noise can be reduced between the two rooms pictured above. Discuss which variables need to be manipulated or controlled. Justify the use of each variable.

Consider in your answer:

- the experimental set-up
- how you would ensure the accurate measurement of sound in the receiving room
- the physical properties of different materials that may be used.

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Extra paper for continuation of answers if required.
Clearly number the question.

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Question number	

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Question number

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Question Number	Marks
Q1	(8)
Q2	(8)
Q3	(8)
Q4	(8)
Q5	(8)
Q6	(8)
TOTAL	(48)

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Keep Flap Folded In.