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NEW ZEALAND QUALIFICATIONS AUTHORITY  
MANA TOHU MĀTAURANGA O AOTEAROA

## Scholarship 2010 Science

2.00 pm Wednesday 1 December 2010

Time allowed: Three hours

Total marks: 40

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.

Each question is worth 8 marks.

Write all your answers 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 2–22 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.**

You have three hours to complete this examination.

### QUESTION ONE: IDENTIFYING THE ROMANOVs

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[http://upload.wikimedia.org/wikipedia/en/9/9f/The\\_Romanovs,\\_1913.jpg](http://upload.wikimedia.org/wikipedia/en/9/9f/The_Romanovs,_1913.jpg)

In 1918, Nicholas Romanov, the former Czar of Russia, was assassinated, along with his wife, their four daughters and one son. Their bodies were hidden in unmarked graves, and were not found for many years.

About thirty years ago, five bodies were found. Visual examination of their skeletons identified the age and sex of the victims only. Mitochondrial DNA (mtDNA) analysis identified the bodies as the Romanov parents and three of the daughters. Three different laboratories carried out the tests.

Recently, bone fragments were found in another grave. DNA was extracted from the bone fragments, and mtDNA, Y chromosome markers (Y markers) and nuclear DNA markers were used to identify the bodies in the second grave. Three laboratories confirmed that the bones belonged to the son and the remaining daughter.

The bone DNA was also compared with blood stains from a shirt of the Czar's from an earlier assassination attempt. The blood on the shirt has the only other existing nuclear DNA from any of the seven family members.

Discuss how the seven bodies were identified, considering:

- the advantages of using mtDNA and Y markers, compared with nuclear DNA markers
- which techniques would have been used to identify which bodies
- whether the individual daughters' remains could be told apart
- what measures ensured that the results were valid.

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## QUESTION TWO: SEDIMENT AND VOLCANOES

The amount of sediment on the seafloor off the east coast of the North Island has gradually increased over the past few million years because of uplift and erosion of the Southern Alps.

Each year, rivers carry huge quantities of eroded debris from the Southern Alps to the South Island's east coast. This debris is carried by sea currents into the deep Kaikoura Canyon. This canyon opens into the southern end of the Hikurangi Trough, just north of Kaikoura.

The debris accumulating in the Kaikoura Canyon forms an unstable slope which periodically collapses, resulting in huge submarine avalanches. As a result, a dense slurry of sediment separates from the coarser debris and flows into the Hikurangi Trough, travelling in a very wide channel for hundreds of kilometres. The slurry often overflows the channel, just like a river in flood, spreading sediment over the seafloor along the eastern edge of the North Island.

Some of this sediment contributes to the violence of eruptions in the Taupo Volcanic Zone.

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Kaikoura Canyon and the Hikurangi Trough  
[http://www.shiningaspotlight.org.nz/images/home\\_map.JPG](http://www.shiningaspotlight.org.nz/images/home_map.JPG)

Discuss the tectonic processes that result in sediment from the Southern Alps contributing to the violence of eruptions in the Taupo Volcanic Zone.

Include in your answer:

- the interactions between the two tectonic plates and the two types of crust off the east coasts of the North Island and northern South Island
- the tectonic conditions in the Kaikoura region that would cause submarine avalanches
- how the sediment makes the Taupo Volcanic Zone eruptions more violent.

*Diagrams may assist your answer.*

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Oil spills in marine environments are often composed of crude oil, a complex mixture of hydrocarbons of many different chain lengths.

- the use of detergent anions
- natural evaporation
- burning.

*Diagrams and equations may assist your answer.*

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on its right side, suggesting it's resting on a surface.



Weapons can be made from depleted uranium (DU). On impact, DU is dispersed as fine dust into the atmosphere, before settling on the ground and entering water supplies.

However, Geiger counter measurements show radiation from DU dust registering more than 300 times the normal background radiation level. Also, tests on blood samples from individuals exposed to DU dust show genetic damage occurring well above the rate of a control group.

Isotope	Half-life	Decay product	Particle emitted
uranium-238	4.5 billion years	thorium-234	alpha
thorium-234	24.5 days	protactinium-234	beta
protactinium-234	1.14 minutes	uranium-234	beta
uranium-234	246 000 years	thorium-230	alpha

How would you collect valid and reliable data to prove or disprove that DU dust is harmful to humans?

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.





## QUESTION FIVE: SOUND AND THE OCEAN DEPTHS

At the bottom of the ocean, layers of sediment and rock strata contain information useful for activities such as oil exploration.

The layers of the ocean floor may be examined with a technique called seismic reflection, which uses pulsed sound of high intensity (up to 230 decibels) and low frequency (10–50 Hz) to penetrate the ocean floor by up to 10 km. A sound source, such as an airgun, and a row of hydrophones to detect reflected sound are towed behind a slowly moving ship.

The thickness and slope of the layers in the ocean floor, plus some information about the composition of the layers, can be found by using this technique. In analysing the data, scientists assume that the boundaries between the layers are smooth.

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Seismic reflection equipment

adapted from <http://woodshole.er.usgs.gov/operations/sfmapping/images/seisprofile.gif>

### Average velocity of sound

in seawater	1 500 m s <sup>-1</sup>
in sediment	2 000–4 000 m s <sup>-1</sup>
in rock	3 000–8 000 m s <sup>-1</sup>

Discuss how seismic reflection would give information about sediment layers at the bottom of the ocean.

Consider in your answer:

- how the strength and time of returning signals would give information about sedimentary layers
- the advantages of high intensity and low frequency pulsed sound
- the effect of seawater on sound transmission
- the advantage of a row of hydrophones to detect signals
- how the results could be cross-referenced to ensure accuracy.







[illegible]

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

Assessor's  
use only

Question  
number

[illegible]

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

Assessor's  
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**Extra paper for continuation of answers if required.  
Clearly number the question.**

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<b>For Assessor's Use Only</b>	
Question	Mark
ONE	(8)
TWO	(8)
THREE	(8)
FOUR	(8)
FIVE	(8)
<b>TOTAL</b>	<b>(40)</b>

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**Keep flap folded in.**