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NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2009
Science

2.00 pm Tuesday 24 November 2009
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 2–16 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.

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QUESTION ONE: BATS AND ULTRASOUND

Bats, which are usually only active from dusk to dawn, use **echolocation** to detect their prey and find their way around in the dark.

Bats emit pulses of ultrasound of varying amplitude and frequency between 20 kHz – 160 kHz. Their highly sensitive ears catch the echoes. The size, shape and texture of objects can be determined, as well as their location, direction of movement and speed.

The echolocation is so sensitive that flying insects can be caught while the bat is flying fast, and even a tiny change in air current due to the wing beat of their prey can be detected.

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http://118.98.213.22/aridata_web/how/b/bat/bat-8.jpg

Analyse the ability of bats to locate prey and navigate using ultrasound.

Consider in your answer:

- how bats determine the shape, size, texture and position of objects
- the Doppler effect
- why bats use ultrasound frequencies
- why ultrasound waves are sent out in pulses.

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QUESTION TWO: THE ALBEDO OF ASTRONOMICAL OBJECTS

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Albedo is a measure of the reflectivity of the surface of a planet, moon, asteroid, or any other celestial body that doesn't generate its own light. The albedos of such bodies provide valuable information about the structure and composition of their surfaces. This is especially useful if the bodies are small and far away.

Albedo is determined by calculating the amount of light that strikes the body and then measuring the reflected light. An albedo of almost 100% indicates a bright surface that reflects most of the light that strikes it, whereas an object with an albedo of almost 0% would absorb most of the light. The albedo will vary over the surface of a body, so an average measure is given.

The albedos of some solar system objects

Solar system object	Earth	Moon	Mercury	Venus	Mars	Jupiter
Albedo (average) %	34	7	6	85	15	41

The albedos of all the different features of the Moon's surface are accurately known. These are used as standard measurements so that measurements from other bodies can be compared.

Discuss fully the factors that will determine the albedo of solar system bodies.

Consider in your answer:

- the presence or absence of any atmosphere
- mineral composition and reflectivity of the surface
- the presence of surface liquid and / or ice
- possible cloud cover
- the importance of the angle the sunlight is shining on the surface
- the relevance of standard measurements.

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QUESTION THREE: THE INFLUENZA VIRUS

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Viruses reproduce by attaching their surface proteins to host cell membranes and injecting their genetic material into the cell, giving instructions to the cell machinery to make more viruses.

The influenza virus is an RNA virus with a very high mutation rate. This means that our immune system and the developers of vaccines are always trying to catch up.

Humans infected with the influenza virus develop antibodies, which bind to the "H" and "N" proteins found on the surface coat of the virus. The antibodies prevent subsequent infection only if the virus remains unchanged. However, if the RNA that codes for either the "H" or "N" protein mutates, then these antibodies will no longer bind.

Usually only one of the "H" and "N" proteins mutates each year. When humans are exposed to the mutated virus the next year, some of the antibodies will bind to the proteins and some will not. Those that bind to the non-mutated protein will still give some protection, but the antibodies against the protein that has mutated will no longer work. The infection will be mild but infect a lot of people. This process of gradual mutation leads to yearly epidemics of influenza.

Discuss fully the consequences of mutations of the influenza viral surface proteins.

Consider in your answer:

- the relationship between mutations and changes in the surface coat proteins
- why antibodies may no longer bind to mutated proteins
- a possible genetic reason as to why influenza is milder some years compared with other years
- why the influenza virus may have such a high mutation rate.

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QUESTION FOUR: FISH AND FATS

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Fish that live in cold water, such as cod, contain a high proportion of highly unsaturated fatty acids in their cell membranes.

Discuss how unsaturated fatty acids ensure that fish swim efficiently in cold water. Refer to the data in the table below. A labelled diagram may assist your answer.

The proportion of different fatty acids in cod liver oil

Fatty acid		
No. carbon atoms	**No. double bonds**	**% each fatty acid**
14	0	4
16	0	12
16	1	17
18	0	3
18	1	24
18	2	2
18	3	1
18	4	3
20	1	8
20	4	1
20	5	6
22	1	5
22	5	1
22	6	13
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QUESTION FIVE: EARTHQUAKES IN NEW ZEALAND

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Map One: Shallow earthquakes, 1990–1999
www.gns.cri.nz/what/earthact/earthquakes/shallowseismicity.html

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Map Two: Deep earthquakes, 1990–1999
www.gns.cri.nz/what/earthact/earthquakes/deepseismicity.html

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Map Three: The rate at which sideways deformation is taking place. The red areas are those that are undergoing the most deformation.
www.gns.cri.nz/what/earthact/crustal/images/sheer_strain_rate_nov2003.gif

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Map Four: The rate at which the surface of the ground is expanding or contracting. The areas expanding are red, the areas contracting are blue.
www.gns.cri.nz/what/earthact/crustal/images/areal_strain_rate_nov2003.gifnov2003.gif

Give justified reasons for the pattern of shallow and deep earthquakes over the whole of New Zealand. Use the four maps on page 10 to inform your answer.

Diagrams may assist your answer.

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

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Question Number	Marks
ONE	(8)
TWO	(8)
THREE	(8)
FOUR	(8)
FIVE	(8)
TOTAL	(40)

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Keep flap folded in.