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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2007
Science

9.30 am Thursday 22 November 2007
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.

Each question is worth 8 marks.

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 2–17 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.

QUESTION ONE: GENETICALLY MODIFIED ORGANISMS AND HUMAN INSULIN

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The first insulin to be successfully used by human diabetics came from cows and pigs. However, the supply of such insulin could not meet demand, and some patients developed reactions to the foreign protein. As a result, new sources of insulin have been developed.

The human insulin gene can be inserted into many different organisms such as yeast, plants or animals to produce large quantities of human insulin. The addition of a regulator gene means that the insulin gene is switched on permanently and insulin continuously produced. Examples are:

- Genetically modified yeasts that are grown in vats. Vast quantities of insulin are excreted into the fluid medium and extracted from there.
- Genetically modified safflower plants that produce insulin in their seeds. The insulin is extracted from the seeds once the plant has matured.
- Genetically modified cows that produce large quantities of insulin in their milk, from where it can be purified.

Compare and evaluate the use of genetically modified yeast, plants and animals to produce human insulin, especially considering:

- the relative risks of using each organism
- the problems of containment
- the continuity of supply
- any ethical issues.

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QUESTION TWO: NORTH ISLAND VOLCANOES

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Volcanoes in the North Island are formed by two main processes:

- The volcanoes of the Taupo volcanic zone are formed by the eruption of andesite and rhyolite magmas. These magmas are formed as a result of the subduction of the Pacific plate under the Australian plate. This results in the wet partial melting of the upper magma above the subducting oceanic crust. The molten magma forms a giant reservoir about 10 km beneath the surface.
- The volcanoes of the Auckland volcanic zone are formed by the eruption of basalt magma. This magma is formed as the result of the dry partial melting of the upper mantle. The magma comes from a hot spot located about 100 km below Auckland city, and rises very quickly towards the surface. There is no magma reservoir beneath the crust.

Show an in-depth understanding of volcanic processes by discussing the different types of volcanoes in both fields, considering:

- the composition and properties of the magma erupting
- the role of water in the formation of magma
- the differences in the type and shape of the volcanoes
- the role of gas and water in the explosiveness of eruptions of these volcanoes
- any other factors that may affect the type of volcano.

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QUESTION THREE: BIODIESEL

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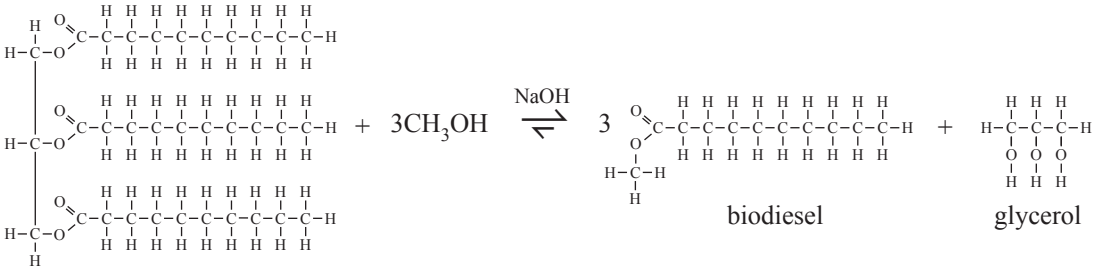
Biodiesel is one of the biofuels being developed to replace fossil fuels. It is synthesised by a process known as transesterification.

The transesterification reaction to make biodiesel is:

$$\text{triglyceride} + \text{methanol} \overset{\text{NaOH}}{\rightleftharpoons} \text{biodiesel} + \text{glycerol}$$



Triglycerides and biodiesel are both esters.

Biodiesel is made in the following way:

1. Heat the triglyceride to about 120°C and then allow it to cool.
2. Add sodium hydroxide and methanol mixture to the triglyceride, adding more methanol than is needed. The methanol must have no water mixed in with it.
3. Heat the mixture to about 50°C for several hours.
4. Once the reaction is complete, remove the glycerol which has sunk to the bottom. Carefully pour off the top layer, which is a mixture of biodiesel and methanol.
5. Purify the biodiesel by washing gently with warm water and allow the biodiesel to dry.

Note: soap is made in a similar way to biodiesel except that sodium hydroxide mixed with water is used instead of sodium hydroxide mixed with methanol. This process is called saponification.

(a) Justify the steps in the above process.

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(b) Many different biodiesels can be made using fatty acid chains of varying length and saturation.

Discuss the relative melting points of such biodiesels, considering the range of temperatures that biodiesels may be used in.

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QUESTION FOUR: ELEPHANTS COMMUNICATING

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http://www.wildlife-pictures-online.com/african-elephant.html

Elephants range over vast areas, and individuals in herds can often be very spread out. They communicate with other elephants in two main ways:

- Low frequency sounds are emitted at around 20 hertz that can travel up to 10 kilometres through the air under ideal weather conditions. Elephants have poor eyesight but acute hearing.
- The low frequency sounds produce a corresponding seismic wave, also at about 20 hertz, which is transmitted through the surface of the ground for at least 20 kilometres.

Elephants sense sounds and seismic waves through large ear bones and specialised cells in their feet and trunk.

Compare and contrast the two long distance forms of communication. Your answer should refer to:

- the frequency of the sound and seismic waves
- the relative effectiveness of sound travelling through air compared with vibrations through the ground
- the relative quality of information carried by sound and seismic waves
- how elephants could determine how far away something is
- how different bedrock would affect the transmission of the seismic wave
- any other relevant factors.

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QUESTION FIVE: THE SURFACE TEMPERATURES OF VENUS AND MERCURY

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Data on Venus and Mercury

	Venus	Mercury
One rotation	243 Earth days	59 Earth days
One orbit	225 Earth days	88 Earth days
Atmosphere	Very thick with 95% carbon dioxide	Very thin
Temperature at surface	Relatively even at 464°C	–183°C to 427°C
Surface of planet	Rocky	Rocky
Distance from Sun	108 million kilometres	58 million kilometres

Considering the data in the table above, discuss possible reasons for:

- the temperatures at the surface of each planet
- the comparative temperature variations at the surface of each planet.

Note the following facts:

- Visible light and short-wave infrared are transmitted through carbon dioxide, but long-wave infrared is absorbed by carbon dioxide.
- The Sun is the main energy source for both planets.

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QUESTION SIX: RADIOISOTOPES IN MEDICINE

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Radioactive isotopes (radioisotopes) can be used to diagnose and treat disease in the body by targeting specific tissues or organs. The radioisotope can be localised in the target organ. The thyroid, for example, takes up iodine, and the radioisotope iodine-131 is used to treat the thyroid for cancers and other abnormal conditions such as hyperthyroidism (over-active thyroid). Diagnostic radioisotopes can be used to examine blood flow to specific organs, to assess bone growth, and to show the presence of hormones.

All rapidly dividing cells, including cancer cells, are easily destroyed or weakened by radiation from radioisotopes.

Evaluate the use of radioisotopes in the diagnosis and treatment of disease, considering the following:

- the half-life of the radioisotope
- the suitability of the different forms of radioactive decay for diagnosis or treatment
- the possible effect on genetic material and healthy tissue
- any other relevant factors.

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

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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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