NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2008

LIFE SCIENCES: PAPER III

EXAMINATION NUMBER

Time: 1½ hours 50 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. Write your examination number in the blocks above.
2. This examination consists of 10 pages. Please check to see that your question paper is complete.
3. You have ten minutes to read through this examination before you begin. You are advised to read carefully and spend time planning your work.
4. Perform the tasks with care. You will be assessed on your ability to work independently.
5. Standard time concessions will apply to this examination.
6. Please answer the questions in the spaces provided.

ENZYMES AS BIOCATALYSTS

Catalysts – substances which accelerate the rate of chemical reactions without being used up in the reaction.
Enzymes – protein molecules which catalyse chemical reactions (biocatalysts).
Catalase – an enzyme which breaks down the poisonous substance hydrogen peroxide (which is formed in both plants and animals) to water and oxygen.

CATALASE

Catalase occurs in the cells of many living organisms. Hydrogen peroxide is a substance which is produced as a result of normal metabolic processes in healthy living cells. It is toxic to living cells if it is allowed to accumulate in the tissues of living organisms. Catalase acts on the substrate hydrogen peroxide and converts it into water and oxygen as follows:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Catalase is responsible for speeding up this important reaction which would otherwise be too slow to support life. Catalase is found in cell organelles called peroxisomes. One molecule of catalase can convert 6 million molecules of hydrogen peroxide to water and oxygen each minute. The rate at which the enzymes works is influenced by several factors such as concentration of the substrate (hydrogen peroxide), temperature, pH and the presence of inhibitors or activators. Each different enzyme has an optimal range for each of these factors at which the enzyme activity is at its maximum. Temperatures in excess of 40^0C to 50^0C will denature (destroy) the catalase enzyme and make it useless. Boiling an enzyme would therefore denature it completely.

USEFUL HINT FROM JUNIOR NATURAL SCIENCE

You may remember learning how to test for the presence of oxygen from your Natural Science lessons in Grade 8 and Grade 9.

The simple test involves plunging a glowing piece of wood (called a splint) into a test tube. If the gas in the test tube contains oxygen, the splint will relight and burn with a bright flame.

TASKS

Before you begin your investigation, make sure that you have all of the following items at your workstation:

- 100 ml hydrogen peroxide (20-volume)
- small piece of fresh liver
- 20 ml distilled water
- teaspoon dried yeast
- 50 ml clean sand
- teaspoon of activated charcoal
- cutting tile
- scalpel or sharp knife
- ruler
- 4 identical test tubes in a test tube rack
- forceps
- permanent marker
- filter funnel
- 2 pieces of filter paper
- test tube holder
- wooden splint
- syringe

You must also have access to the following:

- Bunsen burner or camping gas cooker or spirit burner or candle
- pestle and mortar
- wash-up station
- timing device

Samples of liver and yeast are added to test tubes containing hydrogen peroxide. The height of the foam which is formed by the bubbles in the test tubes is measured and recorded. The gas in each test tube is tested using a glowing splint. Follow the steps below very carefully to conduct the experiment.

1. Label three test tubes A, B and C using your permanent marker.

2. Carefully measure out 20 ml of hydrogen peroxide into each of the three test tubes.

3. Cut a small piece of liver about $1cm^3$ in size.

4. Measure an equivalent quantity of dried yeast and place it next to the piece of liver you have just cut.

5. CALL YOUR TEACHER BEFORE YOU CARRY ON WITH ANYTHING ELSE.

6. Add the piece of liver to Test Tube A using your forceps.

7. Add the dried yeast to Test Tube B.

8. Make sure that these two solids drop to the bottom of the tubes.

9. Leave for three minutes exactly.

10. Measure the height of the foam in each tube using your ruler and record in the table below.

11. While waiting for the foam to form in each tube, test the gas produced using a glowing splint.

12. Describe exactly what you saw happening in each test tube and the effect on the glowing splint. Interpret this observation (result).

	Tube A	**Tube B**
Observation		
Effect on glowing splint		
Interpretation		

(6)

13. Complete the following table of results.

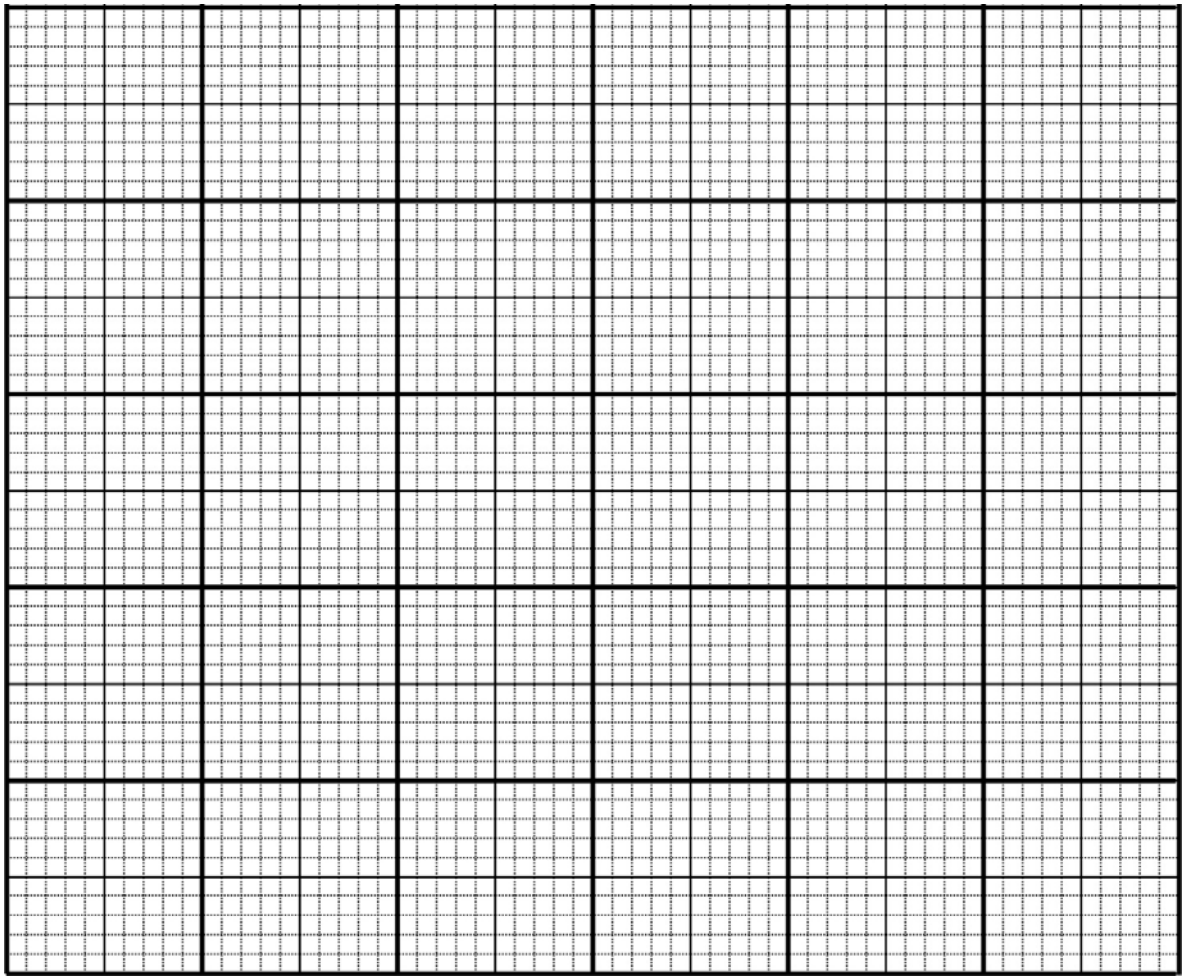
Test tube	**Amount of foam produced (mm)**
A	
B	

(2)

Table Heading: _____

_____ (2)

14. Draw a bar graph on the piece of graph paper below to show the amount of foam produced for each of the two substances.



Graph Heading: _____

_____ (10)

15. Now place a few granules of charcoal (carbon) in Test Tube C and observe what happens.

Could charcoal be an enzyme? Explain your answer.

_____

_____

_____ (3)

16. If we are to assume that both liver and yeast contain an enzyme which splits hydrogen peroxide, is there any evidence that you have gathered from your experimental results to show that it is the same enzyme? What would have to be done to find this out for certain?

(3)

17. If we are to assume that there is an enzyme present in both liver and yeast which breaks down hydrogen peroxide to oxygen and water, how could we construct a control to use in the experiment that you have just carried out above?

(2)

18. When performing this experiment, how did you work carefully to get results that are as accurate as possible? Give THREE examples.

(3)

19. How could the design of this experiment be improved? Describe THREE ways.

(6)

20. Wash out the three test tubes that you have used and place them back in the rack. Now, using all of the apparatus laid out in front of you, design an experiment to see if the enzyme (which we suspect both yeast and liver contain) can be extracted and still retain its properties. The experiment you design must have a control.

NB: You do NOT have to actually conduct this experiment but are most welcome to try your design to see if it works. You can only do this if time allows. Explain your design under the headings on the pages that follow.

20.1 Hypothesis:

(3)

20.2 Aim:

(2)

20.3 The Independent Variable:

(2)

20.4 The Dependent Variable:

(2)

20.5 The Controlled/ Fixed Variables (name THREE and say how they would be controlled):

(6)

20.6 How to make a control:

(2)

20.7 Outline your Method: (NB: Use numbered points or bullet points)

(10)

21. In your opinion, how could the experiment that you have just designed be used in industry? You do not have to think about catalase only. Think about the many other enzymes which could be extracted from living tissues.

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_____

_____ (6)

Manipulative, procedural and measurement skills (3)

Working independently (2/1/0)

Total: 75 reduced to 50 marks