NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2008

LIFE SCIENCES: PAPER III

MARKING GUIDELINES

Time: 1½ hours 50 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

FOCUS OF THE PAPER: LO 1: AS 1, AS 2, AS 3; LO 3: AS 2

Learners will plan an investigation, conduct an investigation and analyse, synthesise and evaluate data. The paper will assess the 8 skill areas (as set out in the SAG document). In addition, the learners will evaluate the use and development of a particular resource and its impact on society.

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

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	Candidate refers to what he/ she actually sees in Tube A, e.g. bubbles, foam, cloudiness, colour change, no change. √	Candidate refers to what he/ she actually sees in Tube B, e.g. bubbles, foam, cloudiness, colour change, no change. √
Effect on glowing splint	Glowing splint bursts into flame OR glowing splint goes out OR no change. √	Glowing splint bursts into flame OR glowing splint goes out OR no change. √
Interpretation	Oxygen is being produced OR gas produced is not oxygen OR no gas produced. √	Oxygen is being produced OR gas produced is not oxygen OR no gas produced. √

(6)

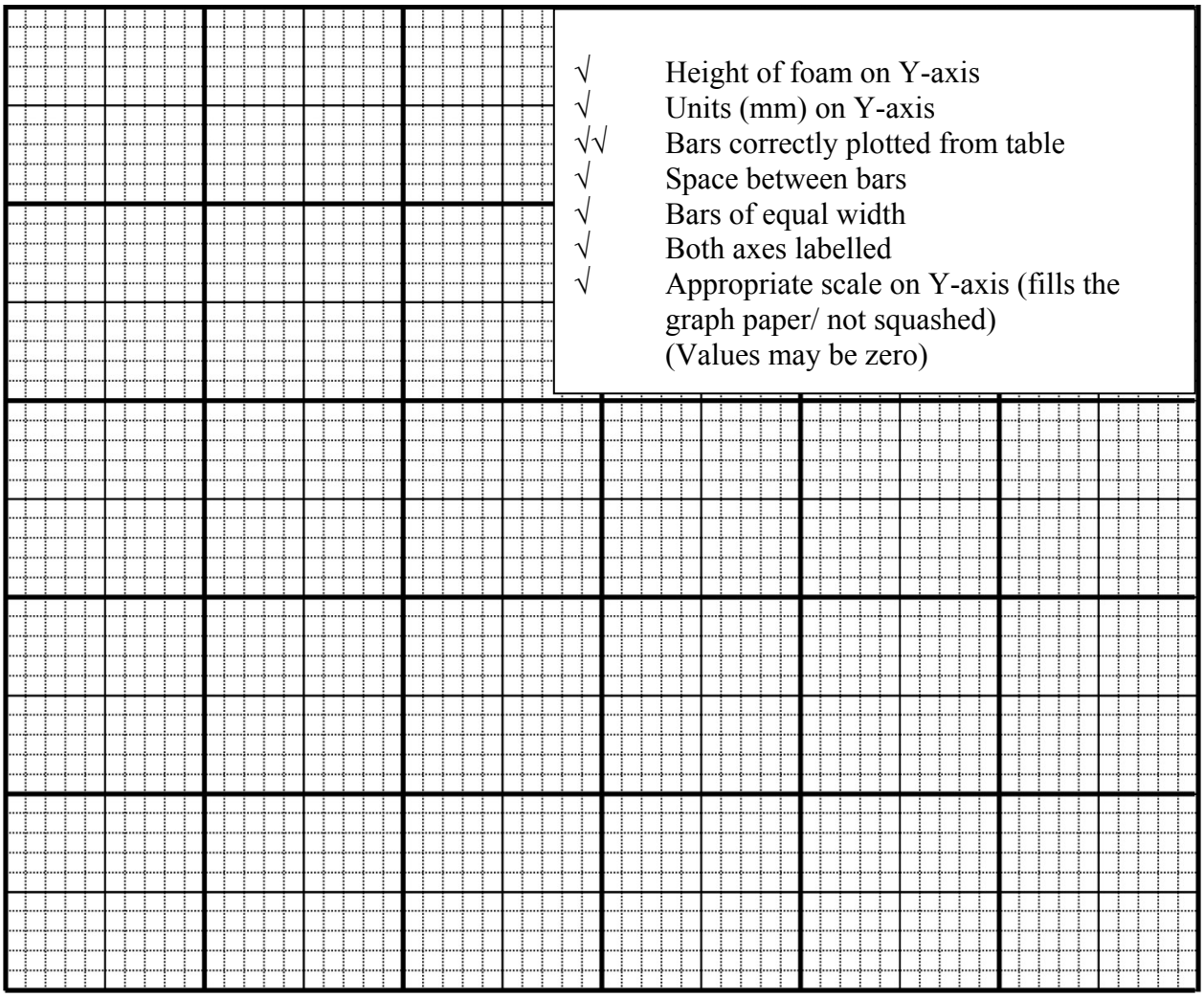
13. Complete the following table of results.

Test tube	Amount of foam produced (mm)
A	Two values recorded in the table. √ No units used in the body of the table. √ (Values may be zero)
B	

(2)

Table Heading: Table to show the height/ amount (√) of foam being produced in tubes A and B (√) (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: Bar graph to show height/ amount (√) of foam being produced in Tubes A and B (√) (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.

No √

- It is an element (carbon)/ It is not a protein. √
- It is produced at high temperatures which would denature the enzyme. √ (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?

No √

- Enzymes would need to be properly extracted and purified. √
- Their exact chemical composition would need to be determined. √ (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?

Heat the liver and yeast to very high temperatures (boil them). √

The enzyme must be denatured. √ (You must denature the enzyme) √

(2)

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

- Use the syringe to measure exactly 20 ml of peroxide into each tube. √
- Use a ruler to measure exactly 1cm^3 of liver. √
- Match the amount of yeast to the liver exactly. √
- Use forceps to place the liver into the test tube (no contact with fingers). √

ANY THREE RELEVANT ANSWERS REGARDING ACCURACY OF WORK DURING THE EXPERIMENT

(3)

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

- Use mass rather than volume to measure yeast and liver. √√
- Use a better method to determine the amount of oxygen gas liberated by the reaction. √√
- Use a water bath to keep the test tubes at the optimum temperature for the catalase enzyme. √√

ANY THREE RELEVANT ANSWERS REGARDING IMPROVEMENTS TO THE EXPERIMENTAL DESIGN

(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:

The enzyme (catalase) which is present in both yeast and liver can be extracted and retain all of its original properties.

√√ wording

√ statement (3)

20.2 Aim:

To investigate whether the enzyme (catalase) present in yeast and liver can be extracted and still retain all of its original properties. √√

(2)

20.3 The Independent Variable:

The enzyme (catalase) present in yeast and liver. √√

(2)

20.4 The Dependent Variable:

The breakdown of hydrogen peroxide into water and oxygen. √√

(rate of reaction) √√

(2)

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

Controlled/ Fixed variable	How it would be controlled
Amount of substrate (hydrogen peroxide) √	Measure exactly the same amount into each tube (using a syringe). √
Amount of yeast/ liver used √	Measure the mass carefully (using a mass meter). √
Amount of water used for extraction √	Measure volume carefully (using a measuring cylinder). √
Amount of extract used √	Use same volume of extract each time (using a syringe). √

ANY THREE CONTROLLED/ FIXED VARIABLES AND HOW THEY WOULD BE CONTROLLED. TABLE FORMAT NOT REQUIRED BY CANDIDATES

(6)

20.6 How to make a control:

Heat (boil) half of the extract made from liver and yeast in order to denature the enzyme and make the control. √√

(2)

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

A suitable method along the following lines:

- Use pestle and mortar to grind up identical amounts of liver and yeast using a fixed volume of water for each sample (use the clean sand for grinding).
- Clean pestle and mortar for second grinding.
- Filter the extract using the filter funnel and the filter paper.
- Test the filtrate on the hydrogen peroxide.
- Test the boiled control on the hydrogen peroxide.

USE THE RUBRIC BELOW TO ASSESS THE METHOD

Use the rubric below to allocate a mark out of 10 for the method given.

	0	**1**	**2**	**3**
Method laid out as a series of steps that are easy to follow (may be bulleted or numbered)	Method not given as a series of numbered/ bulleted steps	Method given as a series of numbered/ bulleted steps but NOT easy to follow	Method given as a series of numbered/ bulleted steps that are easy to follow	
Instructions given are logical and easy to follow	Instructions given are confusing and difficult to follow i.e. neither logical nor ordered	Instructions given follow a vague sequence but the order of the events is vague and unclear	Instructions given follow a logical sequence and some attempt is made to order the events properly	Instructions given follow a logical sequence and as an ordered series of events
ALL equipment given is used	No items given are used in the method	Few items given are used in the method	Most items given are used in the method	Every piece of equipment given is used in the method
Method relates to the aim	Method is not related to the aim	Method related to the aim in a vague manner	Method actually tests the aim given	
TOTALS				
GRAND TOTAL (MAX 10)				

(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.

- Enzymes could be extracted from plant and animal material which could be useful in industry.
- May be used to speed up industrial chemical processes where 'time is money'.
- Cheap source of biocatalysts which are readily available.

Use the rubric given below to allocate a mark out of 6.

	0	1	2
Quality of response	Response is poor and question appears to have been misunderstood	Response is weak with only a vague attempt being made at answering the question	Response is clear and concise and the question is properly understood
Reference to enzymes as biocatalysts	No reference made to the role of enzymes as catalysts of biochemical reactions	Poor reference made which is not explained	Reference made to enzymes as catalysts and their role is fully explained
Examples given	No examples given	Only catalase given as example	Examples given beyond catalase

(6)

Manipulative, procedural and measurement skills.

See attached grids for individual learners.

- Test tubes labelled A, B and C √
- Equal volumes of liquid (peroxide) in all test tubes √
- Equal amounts of liver and yeast √ (3)

Working independently
Performed under strict examination conditions/ no questions/ no asking for help/ No looking around √√ (2/1/10)

75 marks reduced to 50 marks

Total: 50 marks