1428 BIOLOGY

PROVIDER BASED ASSESSMENT

START GUIDE TO ETPS

Each learner will carry out several projects during the two-year teaching and learning of the Botswana Senior Secondary Education (BSSE) Biology syllabus. These projects will form the evidence to be included in the Portfolio of Evidence (PoE) which will be marked and moderated by the Education and Training Providers (ETPs) to meet the requirements of the Provider Based Assessment (PBA) component.

The Assessment Syllabus includes modules where PBA projects opportunities are available. The BSSE Biology teaching syllabus also details where PBA evidence should be produced. ETPs should provide opportunities for learners to undertake PBA projects where such are dictated by the Assessment Syllabus and BSSE Biology teaching syllabus.

Each PBA will be marked by the ETP staff. There will be internal moderation by the ETP and external moderation by the Botswana Examinations Council (BEC). For each learner, the BEC shall sample one task with a single mark out of **40** from the Portfolio of Evidence. The task will be determined by taking the mark awarded to the best piece of evidence in the portfolio.

Learners may only attempt each assessment task once. The task submitted for assessment must be a learner's own, unaided work. The teacher may, however, support the learners by reviewing and approving their plan before the learners are allowed to proceed with the experiments and/or models to finalize and hand in their work for final assessment. Thus, the role of the teacher should be to support learning. The advice should be kept at a basic level so that the learner leads the discussion and makes suggestions for any amendments. The teacher must not give detailed advice to individual learners or groups of learners on how their work can be improved to meet the assessment criteria. The teacher should **not** correct or edit the learner's draft reports. Similarly, a learner may not amend an assessment report once it has been submitted for marking by the ETP.

AUTHENTICATION

Learners must work on their own assessments individually. Learners are not expected to share or use the same information between them. Each ETP will need to ensure that the work submitted for assessment is that of the learner involved. Any work that is proven not to be the learner's own shall be considered **plagiarized** and shall not be given a score. No replacements shall be allowed for any work that has been proven to be plagiarized.

DETAILS OF SUPERVISION

Learners are expected to carry out most of their assessed tasks under direct supervision. Any work completed by learners outside the ETP will need to be authenticated by ETP staff. Where learners have taken rough work away and typed up their notes, the original notes should be collected with the work and included as part of the PoE.

If a learner is absent during an assessment, then the learner can complete the assessment later provided the ETP is satisfied that the assessment is secure.

GUIDELINES FOR SUITABLE ASSESSMENTS

Assessments should be designed to coincide with the teaching and learning of the topics within the BSSE Biology teaching syllabus. Good assessments will allow learners to access all the assessment criteria whilst be sufficiently 'open' that the learners do not know answers in advance.

INFORMATION TO BE GIVEN TO LEARNERS

Learners should be given an outline template for their assessment. The template should include the following headings:

1 Title Page

2 Theoretical Background

- Theoretical Biology
- Research questions
- Hypothesis

3 Methodology

- Variables (Independent / Dependent / Control)
- Instruments and materials
- Procedure
- Precaution

4 Data Presentation and Analysis

- Results
- Graph
- Interpretation of graph and/or results

5 Discussion

6 Conclusion

7 References

ADVICE ON MARKING

ETP staff should mark the assessments clearly in red ink using their professional judgement. The work should be annotated with a tick (✓) indicating where a mark is awarded and a cross (x) where a mark is not awarded. Comments should be added to justify when a mark is awarded or not awarded in close professional judgements decisions.

Half marks (or other fractions of marks) must not be used. ETP staff should read the work as a whole and award marks where evidence is observed. It is useful if the marking table is attached to each assessment. This will assist ETP staff in marking the work and aid both the internal and external moderation processes.

INTERNAL MODERATION OF MARKING

All learners at the ETP must be assessed to the same, common standard.

Internal moderation should normally include a standardization meeting between all the ETP staff marking the assessments before the marking of the assessments begin. At this meeting, the application of the marking criteria should be discussed in detail and agreed between the ETP staff marking the work. Examples should be provided. Feedback from BEC on the previous year's moderation should also be considered.

During the marking there should be regular checking of the marking across different ETP staff. Where differences are identified, the marking already completed should be amended so that all learners are marked to the same standard.

HEALTH AND SAFETY

Learners may be required to perform experiments or design models that may require them to adhere to the general safety guidelines for a science laboratory. It is the responsibility of the ETP to ensure that:

- the experiments and/or models planned by the learners are safe to be performed within the laboratory environment.
- the health and safety of the learners is paramount, and it is always maintained when the learners are engaged in experiments and/or designing models as part of this course.
- the necessary facilities and equipment are available and safe for each activity in which the learners are engaged in. Only materials required for the work should be kept at the work area.
- all laboratory safety equipment, like eyewash stations, emergency showers, fire extinguishers, and exits are always unobstructed and accessible.
- learners are supervised when carrying out their experiments and/or designing models.

MARKED EXAMPLE TASKS

CANDIDATE A

Effects of Varying Light Intensity on the Rate of Photosynthesis ✓

Clear relevant title, but aims and/objectives not stated

Theoretical background

Photosynthesis is the process by which plants, algae, and some bacteria convert light energy into chemical energy stored in glucose. Light intensity is one of the key factors influencing the rate of photosynthesis. This relationship can be understood by examining how changes in light intensity affect the light-dependent and light-independent reactions of photosynthesis. ✓

Photosynthesis Process Overview

Clear details and correct Biological concepts. Relevant theory not linked to any aim. One source has been used.

Photosynthesis occurs in two stages:

1. Light-dependent reactions: These occur in the thylakoid membranes of chloroplasts, where light energy is absorbed by chlorophyll and used to generate ATP and NADPH, (Stryer, 1995)

2. Light-independent reactions (Calvin Cycle): These occur in the stroma of the chloroplast, where ATP and NADPH drive the fixation of carbon dioxide into glucose. ✓

During photosynthesis, Oxygen gas is liberated as a by-product. The rate of photosynthesis is directly proportional to the amount of oxygen gas released. ✓

Hypothesis

Hypothesis clear and not ambiguous

Rate of photosynthesis increases with increase in light intensity. ✓

Research questions

1. How does varying light intensity affect the rate of photosynthesis? ✓

Methodology

Independent variable

Differing light intensity is provided through a light source at varying distances from the plant in a dark room. ✓

Dependent variable

Good detail on variables and how they are measured/controlled

Oxygen produced is captured through water displacement method and measured against various light intensities.

Other Influencing Factors that need to be kept constant:

While light intensity is critical, its effect on photosynthesis interacts with:

Carbon dioxide concentration: An equal amount of baking soda is added to each set-up to ensure constant carbon dioxide concentration.

Temperature: Thermometers are used in each setup to monitor temperature. Minimum proximity of set up to light source where heat from the light source begins to affect the setup must be observed to prevent this effect.

Chlorophyll concentration: Using the same plant at different intensities maintains the same chlorophyll concentration. ✓

Materials

aquatic plant (e.g., Elodea or Cabomba)

beaker (500 mL) ✓

water (preferably dechlorinated or pond water)

sodium bicarbonate (baking soda)

light source (lamp with an adjustable intensity or variable distance)

ruler or light meter (for measuring distance or intensity) ✓

stopwatch

funnel

measuring cylinder

thermometer

Apparatus available, relevant, justification for some instruments provided

Method

1. Setup:

Fill a beaker with water and add a small amount of sodium bicarbonate to provide a source of carbon dioxide for photosynthesis.

Put on gloves to prevent irritation due to contact with Elodea. ✓ Ensure careful handling of glassware to avoid injury. Using a scalpel or knife carefully to avoid injury carefully cut the fresh specimen of Elodea. Place the cut piece of Elodea in the beaker, ensuring the cut end faces upward. Cover the plant with an inverted funnel and place a measuring cylinder filled with water, inverted over the funnel's neck to collect oxygen bubbles. ✓

2. Control Variables:

- Maintain constant temperature by using a thermometer to monitor water temperature. Avoid overheating from the lamp.
- Ensure a consistent CO_2 concentration by dissolving the same amount of sodium bicarbonate in all trials. ✓

3. Vary Light Intensity:

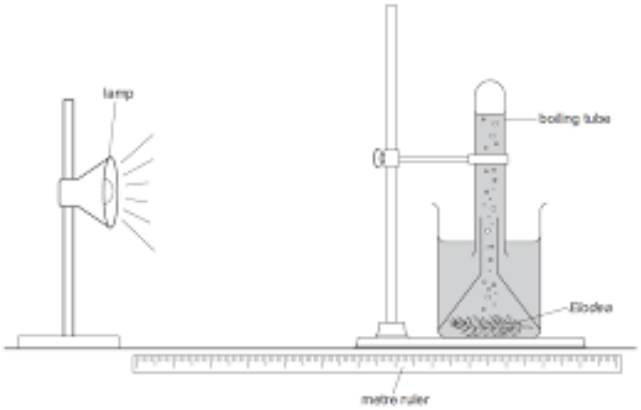
Place the lamp at a fixed starting distance (50 cm) from the plant. Turn on the lamp.

Measure the volume oxygen gas bubbles collected in the test tube after 10 minutes. ✓

Repeat the procedure at different distances of light source from the plant (100 cm, 150 cm, 200 cm).

4. Repetition:

Repeat each trial 3 times to ensure reliable results and calculate the average rate of oxygen production for each light intensity.



✓

Procedure logical and relevant. Variables correctly handled. Correctly labelled diagram, measures to avoid danger clear.

Results

Distance of light source/cm	Volume of oxygen collected/ml			average volume of oxygen /ml
	Trial 1	Trial 2	Trial 3	
0	1.80	1.70	1.75	1.75
20	0.90	0.80	0.85	0.85
40	0.50	0.40	0.45	0.45
60	0.30	0.20	0.25	0.25
80	0.20	0.10	0.15	0.15
100	0.25	0.15	0.20	0.20

Values provided, units enclosed, series of how results were obtained, stated range of independent variable shown (0 cm to 100 cm), and results consistent with trend

✓

✓

✓

✓

✓

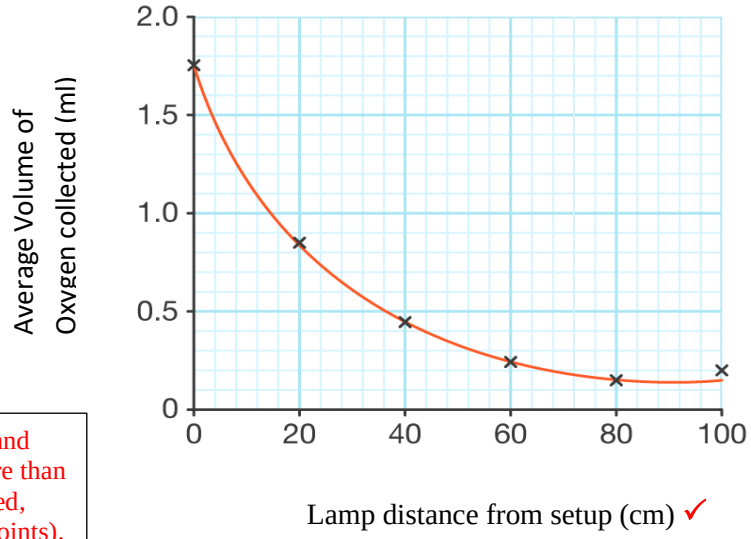
Average volume of oxygen produced at varied lamp distance from set up

✓

✓

✓

✓



Axis correctly labelled and graph drawn covers more than half of the space provided, correct notation (x for points). Points joined correctly

Results analysis

General trend described and data points stated.

As the distance increased from the setup, the volume of Oxygen gas collected decreased ✓between 50 and 100 cm, the average volume of Oxygen collected increased and between 100 cm and 200 cm, the average volume of Oxygen collected decreased. ✓

Discussions

Limitations provided, results relevant to theory, only one improvement provided

The average volume of oxygen collected decreases as distance between the lamp and the setup ✓ increases. Light intensity is inversely proportional to this distance therefore the graph suggests that, as light intensity decreases due to increase in distance, the amount of oxygen produced from photosynthesis also decreases significantly, (Beckett and Callagher, 2001). Inversely, the increase in light intensity causes an increase in the rate of photosynthesis. This is because light is needed as a source of energy in the process of oxygen, thus increasing the intensity of light would speed up the process, reaching a maximum at the saturation point. Beyond this point, further increase in light intensity would show no significant effect✓, and extremely high intensity may reduce the rate due to photo-inhibition ✓ or effect of excessive heat on enzyme activity. A heat filter could be used to reduce the effect of excessive heat on the rate of photosynthesis to improve the investigation. ✓

Attempt made by linking it to the hypothesis. Conclusion stated and linked to real life situation.

Conclusion

This experiment demonstrates how varying light intensity affects photosynthesis. It highlights the importance of light as a limiting factor and identifies the saturation point where other factors, such as CO_2 or temperature, become limiting. ✓ Providing enough light intensity in a greenhouse can increase the rate of photosynthesis, enhancing faster crop growth and higher yields for farmers. ✓ This will boost food security.

2 references included and evidence of citation of references made.

References: ✓ ✓

Stryer, L., 1995. *Biochemistry*. 4th ed. Stanford: Stanford University, pp. 61–62.

Beckett, B.S. and Callegher, D., 2001. *Biology for Higher Tier*. 3rd ed. Oxford: Oxford University Press, pp. 33–35.

Candidate A – Marking Summary

Marking criteria	Max Mark	score	Comment
1.0 Title, aims and objectives:	2	*1*	Clear title, but aim and/or objective not stated
2.0 Theoretical Background including a hypothesis and research question	5	*4*	The principles/theory are not linked to aims and objectives since they were not stated in 1.0, hypothesis and research questions stated and relevant.
3.0 Methodology	12	*11*	Excellent methodology with all aspects covered. Procedure is logical, all materials and variables described fully.
4.0 Data presentation and Analysis	12	*12*	Data presented well, correct notation (x for points)
5.0 Discussion	5	*3*	Good discussion but there is need to have more improvements and how to deal with anomalous result.
6.0 Conclusion	2	*2*	Excellent conclusion linked to real life situation.
7.0 References	2	*2*	Two references were provided, page numbers also stated.
TOTAL	40	*36*	***Excellent***

CANDIDATE B

How varying Light Intensity affects the Rate of Photosynthesis ✓

Clear relevant title and aims stated clearly.

Aims

To investigate the relationship between light intensity and the rate of photosynthesis to better understand how varying light conditions influence photosynthetic activity. ✓

Theoretical background

Photosynthesis is a fundamental process in which plants convert light energy into chemical energy, producing oxygen and glucose. Light intensity is a critical factor influencing the rate of photosynthesis. This relationship can be understood by examining how changes in light intensity affect the light-dependent and light-independent reactions of photosynthesis. ✓

Clear details and correct Biological concepts. Relevant theory linked to aim. No sources cited.

Hypothesis

Rate of photosynthesis is affected by an increase in light intensity. ×

Hypothesis incomplete as photosynthesis rate has not been qualified, research question is not adequate

Research questions

How does varying light intensity affect the rate of photosynthesis? ×

Methodology

Independent variable

Differing light intensity is provided through a light source at varying distances from the plant in a dark room. ✓

Good detail on variables and how they are measured/controlled

Dependent variable

Oxygen produced is captured through water displacement method and measured against various light intensities.

Other Influencing Factors that need to be kept constant:

Carbon dioxide concentration: An equal amount of baking soda is added to each set-up to ensure constant carbon dioxide concentration.

Temperature: Thermometers are used in each setup to monitor temperature. Minimum proximity of set up to light source where heat from the light source begins to affect the setup, must be observed to prevent this effect.

Chlorophyll concentration: Using the same plant at different intensities maintains the same chlorophyll concentration. ✓

Materials

aquatic plant (e.g., Cabomba)

beaker (500 mL) ✓

water (preferably dechlorinated or pond water)

sodium bicarbonate (baking soda)

light source (lamp with an adjustable intensity or variable distance)

ruler

stopwatch

funnel

measuring cylinder

thermometer

Apparatus available, relevant, justification for instrument provided in the method

Method

1. Setup:

Fill a beaker with water and add a small amount of sodium bicarbonate to provide a source of carbon dioxide for photosynthesis.

Ensure careful handling of glassware to avoid injury. Using a scalpel or knife carefully to avoid injury carefully cut the fresh specimen of Elodea. Place the cut piece of Elodea in the beaker, ensuring the cut end faces upward. Cover the plant with an inverted funnel and place a measuring cylinder filled with water, inverted over the funnel's neck to collect oxygen bubbles. ✓

2. Control Variables:

- Maintain constant temperature by using a thermometer to monitor water temperature. Avoid overheating from the lamp.

- Ensure a consistent CO_2 concentration by dissolving the same amount of sodium bicarbonate in all trials. ✓

3. Vary Light Intensity:

Place the lamp at a fixed starting distance (50 cm) from the plant. Turn on the lamp.

Measure the volume oxygen gas bubbles collected in the test tube after 10 minutes. ✓

Repeat the procedure at different distances of light source from the plant (100 cm, 150 cm, 200 cm).

Procedure logical and relevant.
Variables correctly handled.
Set up diagram not drawn; repetition implied. Awareness of danger only implied, measures to avoid danger not clear, size of the ruler not specified.

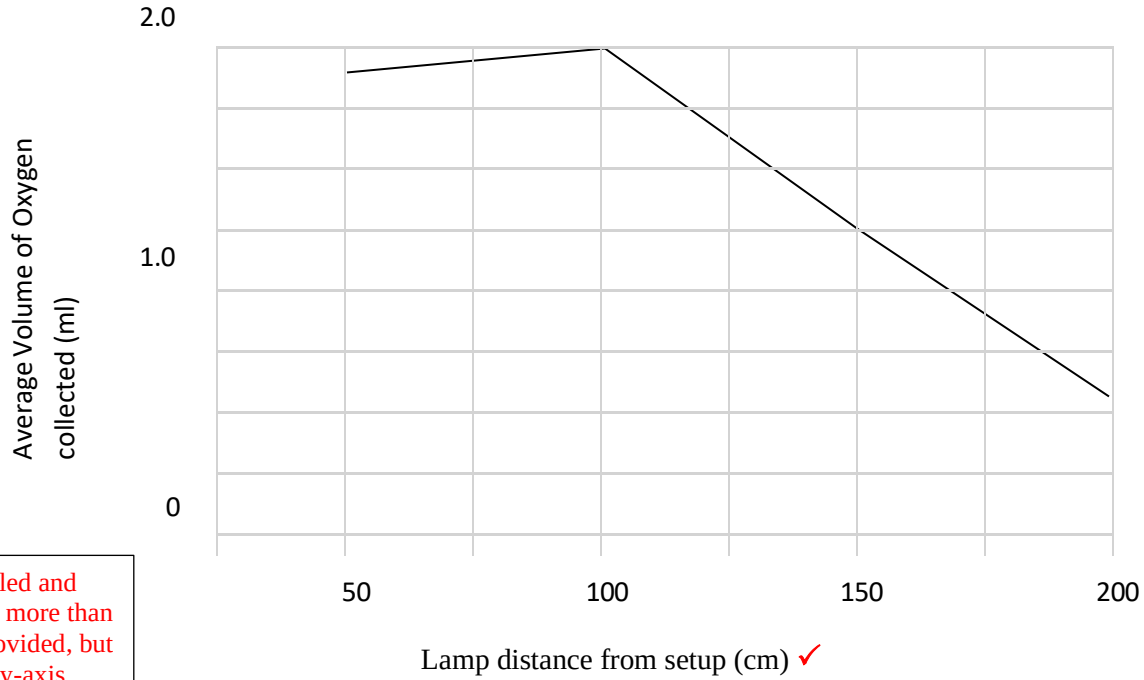
Results

Distance of light source(cm)	Volume of oxygen collected(l)			average volume of oxygen (ml)
	Trial 1	Trial 2	Trial 3	
50	2.0	1.9	1.8	1.9
100	1.7	2.0	2.1	2.0
150	1.3	1.2	1.4	1.3
200	0.8	0.5	0.7	0.6

Values provided, units enclosed, series of how results were obtained stated and independent variable ranged, results inconsistent with trend as litres are used for volume of Oxygen collected. Units also wrongly expressed rather than using slash, but brackets used.

✓
✓
✓
✓

Average volume of oxygen produced at varied lamp distance from set up



✓

Axis correctly labelled and graph drawn covers more than half of the space provided, but x-axis is not linear, y-axis values are not aligned with the gridlines, x for plots are not shown. Points not joined correctly

Results analysis

General trend described but no data points

As the distance increased from the setup, the volume of Oxygen gas collected decreased**.** ✓

Discussions

Limitations provided, results relevant to theory, only no set up improvement provided. Identifying and dealing with anomalous results described.

The average volume of oxygen collected decreases as distance between the lamp and the setup ✓ increases. Light intensity is inversely proportional to this distance therefore the graph suggests that, as light intensity decreases due to increase in distance, the amount of oxygen produced from photosynthesis also decreases significantly, (Beckett and Callagher, 2001). Inversely, the increase in light intensity causes an increase in the rate of photosynthesis. This is because light is needed as a source of energy in the process of oxygen, thus increasing the intensity of light would speed up the process, reaching a maximum at the saturation point. Beyond this point, further increase in light intensity would show no significant effect✓, and extremely high intensity may reduce the rate due to photo-inhibition ✓ or effect of excessive heat on enzyme activity. Anomalous results were obtained due to photo-inhibition at a distance of 50 cm, the value though plotted was ignored as more values expressed the expected trend.

Attempt made by linking it to the hypothesis. Conclusion linked to real life situation.

Conclusion

This experiment demonstrates how varying light intensity affects photosynthesis. It highlights the importance of light as a limiting factor and identifies the saturation point where other factors, such as CO_2 or temperature, become limiting. ✓ Providing enough light intensity in a greenhouse can increase the rate of photosynthesis enhancing faster crop growth and higher yields for farmers. ✓ This will boost food security.

2 references included and evidence of citation of references made but no page numbers

References: ✓

Stryer, L., 1995. *Biochemistry*. 4th ed. Stanford: Stanford University.

Beckett, B.S. and Callegher, D., 2001. *Biology for Higher Tier*. 3rd ed. Oxford: Oxford University Press.

Candidate B – Marking Summary

Marking criteria	Max Mark	score	Comment
1.0 Title, aims and objectives:	2	*2*	Clear title and aim stated correctly.
2.0 Theoretical Background including a hypothesis and research question	5	*2*	The principles/theory were linked to the aim, hypothesis is ambiguous, and research question is incomplete. No source cited.
3.0 Methodology	12	*8*	Variables correctly controlled. Method lacks labelled set up diagram, measures of safety not accounted for.
4.0 Data presentation and Analysis	12	*7*	Data presented well, but there is need to make adjustments more especially in the graph
5.0 Discussion	5	*3*	Good discussion but there is need to have improvements. Anomalous result is dealt with.
6.0 Conclusion	2	*2*	Excellent conclusion but not linked to real life situation.
7.0 References	2	*1*	2 references provided, but page numbers are not stated.
TOTAL	40	*25*	***Fair***