WHO TURNED THE LIGHTS OUT?

Performance Standard 12 A/11B/13A/13B.E

Students will apply the processes of technological design to explore the patterns of change and stability at the macroscopic levels accordingly:

- *Knowledge*: Compare the stages of simple life cycles and impact on energy input on butterfly life cycle,
- *Application*: Apply the appropriate scientific habits of mind and applicable scientific technologies when investigating life cycle variations.
- *Communication*: Present the investigations' conclusions and correlations to the accepted practices of science.

Procedures

1. ***In order to know and apply the concepts that explain how living things function, adapt and change (12A), the concepts, principles and processes of technological design (11B) and apply the accepted practices of science (13A) and apply scientific technological (13B),*** students should experience sufficient learning experiences to develop the following:
   - Research sources of scientific information related to the life cycle of selected butterfly species.
   - Brainstorm design dilemma associated in terms of testing the variation of light on the metamorphosis of butterfly species.
   - Suggest appropriate materials, equipment and data-collection strategies, procedural sequence, success criteria and design options to safely test the posed dilemma.
   - Sketch design plan and select appropriate graphic display of data according to success criteria variables.
   - Complete assembly of testing apparatus, following classroom rules for preparation, procedures and clean-up.
   - Collect and display data from investigation accurately and honestly.
   - Use scientific technologies to collect, store, retrieve, and communicate data, and incorporate appropriate safety precautions.
   - Recognize the necessity of controlled variables and compare carefully recorded observations and summaries.
   - Identify faulty procedural steps which could cause different results, errors, or distort how variables interact.
   - Communicate an evaluation report to explain the observations and explanations of impact of light on butterfly metamorphosis for peer review.
   - Generate future design modifications and alternative applications for design and investigation.
   - Consider the over-arching accepted practices of science from this investigation.

   Note to teacher: This activity relates to knowledge associated with standard 12A, while addressing the performance descriptions for stage E within standard 11B, 13A, and 13B.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Students need to be familiar with the stages of the life cycle of the butterfly by having observed its growth form egg to caterpillar and the formation of its chrysalis. Provide students with Experimental Design Work Page to record their experimental and technological designs. Students need to design the logistics and mechanical parameters for maintaining full light and darkened conditions. Before forming their chrysalises, the caterpillars must be divided equally into two groups. One group will become the group that have their chrysalises exposed to normal lighting conditions and the other group will be covered to keep out as much light as possible. Ensure that one group of caterpillars is kept in darkness while they are pupating (in their chrysalis stage), while the other is exposed to normal light conditions. Provide students with the Experiment Data Sheet and Life Cycle Sketch Page. Continue with accurate data collection and sketches until butterflies are released.
4. After completion of data collection and release of butterflies, have students prepare graphs (using available graphing software, if possible) and a report on the results of the experiment from the focus of the accepted practices of science. Students should complete the Accepted Practices in Science Work Sheet. (This work sheet may be modified for use in other investigations.)
5. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:
   - *Knowledge:* The experimental design and observations are complete and correct.
   - *Application:* Data collection and observations are complete and correct.
   - *Communication:* The inferences and correlation to the accepted practices were complete and correct.

ACCEPTED PRACTICES IN SCIENCE WORK PAGE

Name_____DATE_____

1. When you conducted the experiment "Who Turned The Lights Out?" what were the safety concerns for the experimenter and the animals that you were using? List those concerns below.

Safety Concern	Human Experimenter	Animal

2. What did you or your group do to prevent accidents while you were performing the activities and experiments in this unit? My group and I did the following to prevent accidents to us and the animals and plants that we were using: (List at least three things)

3. When you did the experiment on the effect of light on butterfly chrysalises, what experimental variables had to be controlled to make sure that the results were valid?
The controlled variables were this:

4. Why did you have to make sure that the two groups of chrysalises had to have all the variables, except the one experiment one (light), kept the same?

5. What do you think might happen if a different group tried to recreate the results that your group received in the butterfly experiment, but they changed the experiment's procedures?

6. Why is it important when doing experiments that a group or individual accurately label and maintain their experimental observations and data?

7. What if when your group collected data on the butterfly chrysalises, they mistakenly recorded the data from the chrysalises kept in the dark with those of the chrysalises that were being kept in the light? What affect would it have on the findings and conclusions that a group who was interpreting the wrong data would have compared to what your group with the correct data would have?

Examples of Student Work not available

Time Requirements

- Monarch or Painted Ladies butterflies require 10 to 14 days to complete pupation and emerge from chrysalises. Preparatory and closure activities may require 1-2 class periods; record-keeping may require 15 minutes daily.

Resources

- 10 or more caterpillars (Monarch or Painted Ladies, etc.) Order according to biological supply house requirements with sufficient time for pupation and release to appropriate outdoor temperatures for release.
- Materials to admit and restrict light for butterfly cages (Try to maintain constant temperature for all specimen.)
- Experimental Design Work Page, Data Collection Sheet I and II and Life Cycle Sketch Page for experimental procedure; Accepted Practices of Science work sheet.

Who Turned the Lights Out?
Experimental Design Work Page

Name _____Date_____

Title: "Who Turned The Lights Out?"

Problem: What effect does light have on the length of time it takes for a butterfly to emerge from their chrysalis?

HYPOTHESIS:

EXPERIMENTAL VARIABLE:

CONTROLLED VARIABLE:

MATERIALS:

Two similar containers (cages) containing equal number of butterfly chrysalises.
Light restricting design materials: Dark paper, paper bag, or box to cover one container of chrysalises.
Data Collection Sheet.

PROCEDURE:

1. Before caterpillars have formed their chrysalises, divide them equally between two similar containers.
2. When caterpillars have formed their chrysalises, use your light design containers to restrict as much light as possible from shining on the chrysalises.
3. Check each of the containers daily to determine if and when the butterflies have emerged.
4. Record daily all data and observations on their data tables.
5. When all butterflies have emerged, use an appropriate graphing program or display to produce a graph that compares the data obtained from both groups studied.
6. Using your graphs and recorded data prepare and submit a written conclusion containing an explanation of the results of the experiment.

MEASURMENT AND COLLECTION OF DATA:

- Quantitative Results
- Qualitative Results

WHO TURNED THE LIGHTS OUT?
WORK PAGE 2-LIFE CYCLES

DAILY ANIMAL STUDY DATA COLLECTION SHEET I

NAME_____DATE_____

DAY#	QUANTITATIVE DATA	QUALITATIVE OBSERVATIONS
1.	Length_____mm	Stage of Life Cycle: Characteristics Observed:
2.	Length_____mm	Stage: Characteristics Observed:
3.	Length_____mm	Stage: Characteristics Observed:
4.	Length_____mm	Stage: Characteristics Observed:
5.	Length_____mm	Stage: Characteristics Observed:
6.	Length_____mm	Stage: Characteristics Observed:
7.	Length_____mm	Stage: Characteristics Observed:
8.	Length_____mm	Stage: Characteristics Observed:
9.	Length_____mm	Stage: Characteristics Observed:
10.	Length_____mm	Stage: Characteristics Observed:
11.	Length_____mm	Stage: Characteristics Observed:
12.	Length_____mm	Stage: Characteristics Observed:
13.	Length_____mm	Stage: Characteristics Observed:
14.	Length_____mm	Stage: Characteristics Observed:

WHO TURNED THE LIGHTS OUT?

EXPERIMENT DATA SHEET II

NAME_____DATE_____

DAY #	Light Group # Butterflies Emerged	Dark Group # Butterflies Emerged	Observations
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

DISPLAY OF DATA:

CONCLUSION:

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WORK PAGE 3

LIFE CYCLE BUTTERFLY SKETCH PAGE

NAME_____DATE_____

Use the space below to draw and label the stages of the animal that you have been studying.