Student Handout Engagement Phase

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Solar Panels**–**$2 Summaries**

Read the article “Solar Panels.” As you read, highlight and look up any words you do not know. Circle the main ideas.

Next, write a “$2 Summary” of the article. Each word you write will cost you ten cents. You must write a summary that costs exactly $2.

In your small group, share share your summaries then either choose the best summary or work together to create a group summary that you will share with the whole class.

Student Handout Explore Phase

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Photosynthesis Leaf Disk Flotation Lab Planning Form**

*Over the next few days, you will design, set up, and carry out an investigation to figure out what impacts changing variables can have on the rate of photosynthesis. Use this lab planning form to design your investigation.*

1. Using academic sources, research the following.
2. Describe the organisms you are studying.
	* 1. Spinach (*Spinacia oleracea*)
3. What process do these organisms use to obtain food?
4. How are these organisms important to a working food web?
5. What impact do added reactants have on this process?
6. What impact do changes in light energy have on this process?
7. Cite, in MLA format, the references you used for question one.
8. What is the research question your group plans to investigate?
9. What observations or information led you to your research question?
10. What is your independent variable?
11. What specific changes will you make to the reactants or to the light energy?
12. What is your dependent variable?
13. What will you hold constant across all groups to ensure a controlled experiment?
14. What is your hypothesis?
15. What are your predictions?
16. If my hypothesis is supported, then I predict. . .
17. If my hypothesis is not supported, then I predict. . .
18. What will be the evidence that supports my hypothesis?

*Refer to the Leaf Disk Flotation Methods handout to help you answer the following:*

1. What are your experimental procedures?
2. What is your control group?
3. How will you treat your experimental group(s)?
4. What tools will you use to collect your data?
5. How often and for how long will you collect your data?

Adapted from French, Donald P. *Investigating Biology: A Laboratory Resource Manual*. Harcourt, 2021.

Student Handout Explore Phase

**Leaf Disk Flotation Methods**

**Investigation Materials:**

Each group will need:

* Three or four clear plastic punch cups
* Spinach leaves
* Drinking straws
* Water
* Desk lamp
* Food coloring, colored transparency paper, or colored light bulbs
* One 20 mL syringe
* Dish soap
* Small paint brush
* Stopwatch or timer
* Lamp

**Investigation Procedure:**

1. Use the drinking straw (or a hole punch) to cut 30–40 disks from the spinach leaves.
2. Fill each cup about two-thirds full of water and a drop of dish soap. Mix the soap in well.
3. Place 10 leaf disks in the syringe with about 20 mL of solution drawn from the cup. Push the plunger to remove any air. Covering the end of the syringe with a finger, pull back on the plunger as far as possible, then let go (while keeping your finger over the end of the syringe). You should see air bubbles come out of the leaf disks. Push the released air out. Repeat the process until the leaf disks no longer float.
4. Holding the syringe, plunger down, over your cup, remove the plunger to allow the water and leaves to fall into the cup. You may need to use the paint brush to remove any remaining leaves.
5. Repeat steps 2 and 3 for each water sample.
6. Place the cups under the lamp. In 10-second intervals, record the number of leaves floating to the top.

Each lab group may choose a variable to manipulate. These may include color of light (can be changed using food coloring in the water, colored plastic sheets over the cups, or the color of the light bulb), intensity of light (can be changed with varying light bulbs or by placing screens over the cups), or another variable the teacher approves. This investigation is focused on light; however, instructors may expand this to include varying amounts of carbon dioxide present in the water, temperature of the water, etc.

As you carry out the investigation, they record your observations on the Photosynthesis and Leaf Disk Flotation Data Sheet. In 10 second intervals, students count and record the number of leaf disks floating in each cup. Lab groups should assign roles for data collection including time keeper, leaf counter, and recorder.

Student Handout Explore Phase

Photosynthesis and Leaf Disk Flotation Data Sheet

|  | Number of Leaves Floating:Control | Number of Leaves Floating:Experimental Group 1 | Number of Leaves Floating:Experimental Group 2 | Number of Leaves Floating:Experimental Group 3 |
| --- | --- | --- | --- | --- |
| 10 seconds |  |  |  |  |
| 20 seconds |  |  |  |  |
| 30 seconds |  |  |  |  |
| 40 seconds |  |  |  |  |
| 50 seconds |  |  |  |  |
| 60 seconds |  |  |  |  |
| 70 seconds |  |  |  |  |
| 80 seconds |  |  |  |  |
| 90 seconds |  |  |  |  |
| 100 seconds |  |  |  |  |
| 110 seconds |  |  |  |  |
| 120 seconds |  |  |  |  |

Student Handout Explain Phase

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Leaf Disk Floatation Investigation Manuscript**

In your manuscript, you will share the findings from your microcosm experiment to answer your microcosm investigation research question. Your manuscript is expected to be three or four pages in length, typed, double spaced in twelve-point font.

**Manuscript title:** This is specific to your Group

**Group Members:** List names in alphabetical order

**Introduction:** Write 2-3 paragraphs of background information about the investigation. Briefly explain the natural phenomena addressed, give relevant biological information about the species studied and the relationships among them. Some questions that should be answered in the background section are:

* Describe the organisms you are studying.
* What process do these organisms use to obtain food?
* How are these organisms important to a working food web?
* What impact do added reactants have on this process?
* What impact do changes in light energy have on this process?

Cite sources where the background information was found with correct in-text citations. Be sure to include a reference list. After the background, introduce your study question and hypothesis.

**Methods**: Describe in detail how you carried out your investigation. Be sure to identify your independent variable, dependent variable, constants, control group, and experimental group.

**Results:** Report the data you collected in your investigation; describe trends and comparisons. Include table(s) and appropriate graph(s) of your data. Be sure to NOT interpret any of your findings in this section (do not explain any trends or state whether your hypothesis is supported).

**Discussion:** Write a thorough explanation of your findings, using the CRE format--Claim (Is your hypothesis supported?), Evidence (that backs up your claim), Reasoning (that explains why the evidence supports your claim).

**References:** Include a list of the peer-reviewed references you cited in MLA format.

\*\*Look back at your lab planning form to help you write your introduction and methods.

| **Category**  | **NGSS Component Addressed**  | **Unacceptable**  **(0)**  | **Marginal (1)**  | **Adequate**  **(2)**  | **Good (3)**  | **Excellent**  **(4)**  | **Comments**  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Title**   **(5%)**  |   | Missing  |   | Uninformative  |   | Descriptive & engaging title  |   |
| **Introduction (15%)**  | HS-LS2.C  | Objectives are unclear; no rationale is given for the research. Hypothesis is missing, poorly written, or untestable.  |   | Objectives are somewhat clear and complete. Background and rationale are presented but the link to the study question is not entirely clear. Hypothesis is adequately written and testable but the link to the objectives lacks clarity.  |   | The question and objectives are clearly stated. Concise background information is provided. Hypothesis is well-written, testable, and addresses the question.  |   |
| **Methods (20%)**  | SEP: Planning and carrying out an investigation.  | Methods are poorly described or do not match hypotheses.  |   | Most of the steps are described adequately, but the link to the hypothesis is unclear.  |   | All steps are described fully and are clearly related to the hypothesis. There are clear experimental and control groups.  |   |
|  **Results (20%)**  | SEP: Planning and carrying out an investigation.   | Results are poorly presented. Graphs / tables are missing or cannot be interpreted. No relevant data collected or analysis.  |   | Sufficient data is collected. Results are presented and explained clearly. Graphs or tables may lack some clarity. Interpretation is present when it should not be.  |   | Sufficient data is collected. Clear and concise presentation of results. Graphs / tables are appropriate, clearly labeled, descriptively captioned, and referenced in the narrative. Results are described with trends indicated clearly but not interpreted. Analysis is well conducted and appropriate.  |   |
| **Discussion (25%)**  | HS-LS2-6 HS-LS2.C SEP: Engaging in Argument from Evidence CCC: Stability & Change  | Interpretation is absent or inappropriate with respect to the original hypothesis. Science is inaccurate.  |   | Interpretation addresses the original hypothesis adequately. Consideration of alternative potential interpretations is weak or missing. Implications of future research are discussed minimally. Science is accurate.  |   | Interpretation is well-reasoned, entirely consistent with the original hypothesis and well supported by data. Alternative potential interpretations are addressed. Implications and future research discussed well.  |   |
| **References (5%)**  |   | References are inadequate; there is minimal attempt to paraphrase and cite materials properly.  |   | References are used adequately. All work is properly paraphrased and cited.  |   | Authors provide a comprehensive list of properly cited current literature. All citations are included with no additional references. All work is properly paraphrased and cited.  |   |
| **Communication and Style (10%)**  |   | Demonstrates poor communication skills.  |   | Demonstrates adequate communication skills.  |   | Demonstrates excellent communication skills. Clear, concise, and well-organized. Writing is grammatically correct and flows well.  |   |
| \*\*Level 1 indicates achievement of some characteristics of levels 0 and 2. Level 3 achievement indicates some characteristics of levels 2 and 4.  |   |

Adapted from French, Donald P. *Investigating Biology: A Laboratory Resource Manual*. Harcourt, 2021.

Student Handout Elaborate Phase

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Harnessing Solar Energy–Improving Efficiency**

| Using the internet, research factors that impact the efficiency of solar panels; list them below with a brief description of each. | What is a possible solution to this problem? GET CREATIVE and BE DESCRIPTIVE! | Can this solution be applied to increasing efficiency in soybean leaves? Describe how it can be. |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |

Choose one of your solutions to present to the class. You will create a 30 second promotional talk or video to present your ideas to the class. Be sure to include visual aids!

Your work will be scored using this rubric:

**Oral Presentation Rubric**

|  | 4—Excellent  | 3—Good  | 2—Fair  | 1—Needs Improvement |
| --- | --- | --- | --- | --- |
| Delivery  | • Holds attention of entire audience• Speaks with fluctuation in volume and inflection to maintain audience interest and emphasize key points | • Consistent use of direct eye contact with audience• Speaks with satisfactory variation of volume and inflection | • Displays minimal eye contact with audience, • Speaks in uneven volume with little or no inflection | • Holds no eye contact with audience • Speaks in low volume and/ or monotonous tone, which causes audience to disengage |
| Content/ Organization | • Demonstrates full knowledge by answering all class questions with explanations and elaboration • Provides clear purpose and subject | • Is at ease with expected answers to all questions, without elaboration • Has somewhat clear purpose and subject | • Is uncomfortable with information and is able to answer only rudimentary questions • Attempts to define purpose and subject | • Does not have grasp of information and cannot answer questions about subject • Does not clearly define subject and purpose |
| Visual aids–creativity and relevance | The visual aid was creative in showing the necessary information. | The visual aid was mostly creative in showing the necessary information. | The visual aid was somewhat creative in showing the necessary information. | The visual aid was not or barely creative in showing the necessary information or it did not relate to the work. |
| Visual aids–neatness | The visual aid was neat and organized and followed a logical flow. | The visual aid was mostly neat and organized and followed a logical flow. | The visual aid was sometimes neat and organized and followed a logical flow. | The visual aid was not or barely neat and organized and followed a logical flow. |
| Comments |  |