Lead Information Packet

Module 1: Shadows
5th Grade

This document is not intended to give you all of the information you need to lead the module. It is only intended to be a reference during the module. You can find the complete instructions at http://www.chem.ucsb.edu/scitrek/module as well as the student notebook and picture packet used during the module.

Note: We highly recommend that teachers complete the initial Conclusion Assessment outside of SciTrek sessions.

Important Things to Remember During the Module

1. You are responsible for keeping track of time in the classroom and making sure that ALL activities run smoothly. There will be a time card in the lead box with suggested times to start/stop each activity.
2. You are responsible for keeping volunteers and students on track.
3. Walk around during times volunteers are working with students and help struggling groups/subgroups.

Types of Documents:

Student Notebook:
One given to every student and is filled out by the student. In these instructions, the examples are rectangular and filled out in black. The lead will use a student notebook to write in as an example for students. The notebook that the lead uses is referred to as the class notebook in these instructions.

Notepad:
One given to every group and is filled out by the volunteer. In these instructions, the examples are squarer and filled out in blue.

Picture Packet:
One per class that, if needed, the lead fills out. In these instructions, the examples are rectangular, labeled, and, if applicable, filled out in blue.

In these instructions, all other example documents are labeled.

How to Measure Lengths and Widths of Shadows
Length
1. Line up the 0 cm mark of a ruler with the front of the block (front of the white plastic).
2. Place another ruler (numbers side down) at the edge of the shadow. This will result in the rulers making an “L.”
3. Read the length of the shadow off the ruler with the numbers showing (7 cm in picture above).

Width
1. Place two rulers (numbers side down) perpendicular to the white plastic on either side of the shadow.
2. Measure between the two rulers with a third ruler which will give you the shadow width (8 cm in picture above). This will result in the rulers making an “H.”

Day 1: Technique/Observations/Variables

We **highly recommend** that teachers complete the initial Conclusion Assessment prior to Day 1 of the module. The suggested times in the lesson plan below are assuming that the Conclusion Assessment was given prior to SciTrek arriving.

*Schedule: You are responsible for **BOLD** sections*

<table>
<thead>
<tr>
<th>Times if teacher gave assessment prior to SciTrek:</th>
<th>Times if SciTrek must give assessment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction (SciTrek Lead) – 2 minutes</td>
<td>Introduction (SciTrek Lead) – 2 minutes</td>
</tr>
<tr>
<td>Module Introduction (SciTrek Lead) – 3 minutes</td>
<td>Conclusion Assessment (SciTrek Lead) – 10 minutes</td>
</tr>
<tr>
<td>Technique (SciTrek Lead) – 7 minutes</td>
<td>Module Introduction (SciTrek Lead) – 3 minutes</td>
</tr>
<tr>
<td>Observation Discussion (SciTrek Lead) – 4 minutes</td>
<td>Technique (SciTrek Lead) – 5 minutes</td>
</tr>
<tr>
<td>Observations (SciTrek Volunteers) – 25 minutes</td>
<td>Observation Discussion (SciTrek Lead) – 4 minutes</td>
</tr>
<tr>
<td>Variable Discussion (SciTrek Lead) – 5 minutes</td>
<td>Observations (SciTrek Volunteers) – 20 minutes</td>
</tr>
<tr>
<td>Variables (SciTrek Volunteers) – 12 minutes</td>
<td>Variable Discussion (SciTrek Lead) – 5 minutes</td>
</tr>
<tr>
<td>Wrap-Up (SciTrek Lead) – 2 minutes</td>
<td>Variables (SciTrek Volunteers) – 9 minutes</td>
</tr>
<tr>
<td></td>
<td>Wrap-Up (SciTrek Lead) – 2 minutes</td>
</tr>
</tbody>
</table>

*Preparation:*

1. Get the Conclusion Assessment and put them in the lead box.
2. Make sure volunteers are writing their name and group color on the whiteboard.
3. Make sure volunteers are passing out nametags.
4. Make sure volunteers are setting up for the initial observation.
5. Set up the document camera for the class question (front cover, student notebook), Technique Activity (page 2, student notebook), and the block measurement pictures (page 1 and 2, picture packet).
**Notebook Pages and Notepad Pages:**

**TECHNIQUE**

**Protractors**

Protractors are used to measure and draw angles.

- **How to measure an angle using a protractor:**
  1. Line up the angle with the center point of the protractor.
  2. Move the swing arm to point to the center of the protractor.
  3. The angle is the value on the outer clear scale, on the clear side of the swing arm.

**Angles:**

1. 160°
2. 90°
3. 50°
4. 126°

**OBSERVATIONS**

**Experimental Set-up:**

- Block Height: 5 cm
- Block Width: 7 cm
- Block Length: 3 cm

- Light Angle: 90°
- Flashlight pointed at block

On the chart below, color the box that indicates the light distance and light height.

Circle the appropriate box:

**Teacher:** Mr. Gordon

**Volume:** Sierra

**Color:** Blue
Introduction: (2 minutes – Full Class – SciTrek Lead)

- Allow volunteers to introduce themselves.
- Introduce the module.
**Conclusion Assessment:** *(10 minutes – Full Class – Given By Classroom Teacher Prior to SciTrek)*

- Pass out assessments.
- Page 1: Read each statement and have students circle if the statement is a claim, data, or opinion.
- Page 2: **As a class**, have students underline controls, circle changing variable(s), and box information about data collection on the results table. Then have students individually decide if the group could make a conclusion.
- Page 2: Read each statement and have students identify if the statement is a claim or data and then circle if statement is a correct claim, correct data, or incorrect based on the results table.
- Page 3: Repeat the process for page 3.
- Collect assessments.

**Module Introduction:** *(3 minutes – Full Class – SciTrek Lead)*

- Have volunteers pass out notebooks.
- Have students fill out the front cover of their notebooks.
  - They will not fill out their subgroup number or class question.
- Go over what a shadow is and what causes them.
- Introduce the class question, “What variables affect shadows?”
  - Write the class question on the front cover of the class notebook and have students copy it onto their notebooks.

**Technique:** *(7 minutes – Full Class – SciTrek Lead)*

- Have volunteers pass out protractors.
- Review the parts of a protractor and how to measure angles with a protractor.
- Fill out question 1 as a class (page 2, student notebook).
- Have students fill out questions 2-4 by themselves before reviewing.
- Have volunteers collect protractors.

**Observation Discussion:** *(4 minutes – Full Class – SciTrek Lead)*

- Review the definition of an observation (a description using your five senses).
- Tell students how to measure the length and width of a shadow (page 1, picture packet).
- Measure the length and width of the shadow (page 2, picture packet).
- Have students move to their groups.
  - If a student does not have a nametag, identify the group with the least number of students in it and write the student’s name on one of the extra nametags that are in the lead box using that color of marker.

**Observations:** *(25 minutes – Groups – SciTrek Volunteers)*

- Walk around and help groups that are struggling.
- Make sure groups are moving along and only spending ~10 minutes on the experimental set-up, ~7 minutes on the colored light, and ~7 minutes on the white light.
Variable Discussion: (5 minutes – Full Class – SciTrek Lead)

- Have groups share what they did/learned.
  - All lights at the same position will give approximately the same shadow length and width.
  - White light gives a crisper shadow than colored light.
- Review the definition of a variable (something in an experiment that can be changed).
- Explore one possible changing variable with the class and have students share how/why this variable might affect the shadow length and width.

Variables: (12 minutes – Groups – SciTrek Volunteers)

- If there are less than 5 minutes left, do this section as a class instead of in groups.
- Walk around and help groups that are struggling.
- Make sure volunteers are having their group come up with three possible variables as well as how/why these variables might affect shadows.
- Make sure students are generating at least one additional variable by themselves.

Wrap-Up: (2 minutes – Full Class – SciTrek Lead)

- Have each group share one variable with the class and how/why they think it will affect shadows.
- Tell students what they will do next session.

Day 2: Question/Materials Page/Experimental Set-Up/Procedure

Schedule: You are responsible for BOLD sections

- Introduction (SciTrek Lead) – 13 minutes
- Question (SciTrek Volunteers) – 10 minutes
- Materials Page (SciTrek Volunteers) – 7 minutes
- Experimental Set-Up (SciTrek Volunteers) – 8 minutes
- Procedure (SciTrek Volunteers) – 19 minutes
- Wrap-Up (SciTrek Lead) – 3 minutes

Preparation:

1. Make sure volunteers are setting out notebooks to allow students in the same subgroup to work together.
2. Set up the document camera for the question (page 6, student notebook), materials page (lead box), and experimental set-up (page 7, student notebook).
3. Have 2 example blocks of different heights to show students during the introduction.
Experimental Considerations:

1. You will only have access to the materials on the materials page.
2. You will only have access to one flashlight with white light and one flashlight with blue light.
3. All objects will be rectangular wooden blocks and you will only be able to change one dimension of the block.

Changing Variable(s) (Independent Variable(s))

You will get to perform two experiments. For your first experiment, decide which variable(s) (max three) that you would like to test. For each changing variable that you select, discuss with your group why you think that variable will affect the shadow.

Changing Variable 1: Light Distance
Discuss with your group how you think changing variable 1 will affect the shadow.

Changing Variable 2 (optional): Block Length
Discuss with your group how you think changing variable 2 will affect the shadow.

Changing Variable 3 (optional): Shadow Length
Discuss with your group how you think changing variable 3 will affect the shadow.

What will you measure? (circle one)
- Shadow Length
- Shadow Width

Question our group will investigate:
- If I change the __________, what will happen to the __________?

Quick Lab:

Shadow Length

If you have no circles you can select/mark any value that is not greyed out. If you have one circle you can only select/mark values within that circle. If you have two circles you can only select the value that is circled by both circles.

Experimental Set-Up:

Determine the values of your changing variable(s) (e.g., block height) from the materials page and write the values (e.g., 5 cm) for your four trials under each block.

Changing Variable(s):
- Light Distance
- Block Length
- Block Height

Controls (variables you will hold constant):
Determine the variables that you will hold constant and indicate the specific value you will use in all your trials.

Light Color: White
Light Height: 25 cm
Block Height: 7 cm
Block Width: 3 cm
Surface: White Plastic

SciTrek Member Approval: [Signature]
**Introduction:** (13 minutes – Full Class – SciTrek Lead)

- If needed, have volunteers set out notebooks so students are sitting next to members of their subgroup.
- Review the class question and what they learned /did last session.
- Review experimental considerations with the class (top of page 6, student notebook):
  - You will only have access to the materials on the materials page.
  - You will only have access to one flashlight with white light and the light must be focused and pointed directly at the center of the block.
  - All objects will be rectangular wooden blocks and you will only be able to change one dimension of the block.
    - Use example blocks to show how to change each dimension.
- Design an example experiment with the class.
  - For the changing variables, pick a variable about the light (light height or light distance) and a variable about the block (block height, block length, or block width) (page 6, student notebook).
  - For what you will measure you can pick either shadow length or width.
  - Show students how to write the question.
    - If we change the block height and light height, what will happen to the shadow length?
  - Fill out the materials page for the example experiment (lead box).
    - Read step 1 and have students tell you what to do for each bolded word (underline controls and circle the changing variables)
    - Go through the list of general materials and check them off.
    - Read steps 2 and 3. You should choose the control values, but let students choose the 4 changing variable values.
      - Make sure students understand how to select block dimensions and light distances/heights.
      - Remind students to pick changing variable values that are spread out.
      - Write trial letters next to changing variables values (Ex: Block Length 6 cm A)
Fill out the experimental set-up for the example experiment (only trials A and B for the changing variable) (page 7, student notebook).
- Draw an additional line under the controls list for another control and its value.
- If students choose to change 3 variables, there will be two additional blank for controls. Lead students to come up with surface/white plastic and block material/wood.

Read the example procedure step that includes the changing variable at the top of page 8 in the student notebook.

**Question:** (10 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Encourage subgroups to pick different changing variables.
- MAKE SURE VOLUNTEERS ARE NOT GIVING ADVICE ON HOW MANY CHANGING VARIABLES TO USE.
- Make sure students do not have more than one block dimension changing.
- Encourage subgroups to measure the dimension of the shadow (length or width) they think they know the least about.
- Make sure for the second part of the question (what you are measuring/observing) that students are specific (Ex: the shadow length or width instead of the shadow).

**Materials Page:** (7 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure subgroups are underlining their controls and circling their changing variable(s).
- Make sure subgroups are filling out the materials page correctly and completely.

**Experimental Set-Up:** (8 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure within one subgroup, all students have the same order for their changing variable(s) values.
- Make sure all control blanks are filled out.

**Procedure:** (19 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure procedures are concise, but still include all values of the controls, changing variable(s), and what data will be collected.

**Wrap-Up:** (3 minutes – Full Class – SciTrek Lead)

- Tell students what they will do next session.
Day 3: Results Table/Experiment/Graph/Conclusion Activity

Schedule: You are responsible for **BOLD** sections

- **Introduction (SciTrek Lead)** – 8 minutes
- Results Table (SciTrek Volunteers) – 3 minutes
- Experiment (SciTrek Volunteers) – 22 minutes
- Graph (SciTrek Volunteers) – 10 minutes
- **Conclusion Activity (SciTrek Lead)** – 15 minutes
- **Wrap-Up (SciTrek Lead)** – 2 minutes

Preparation:

1. Make sure volunteers are setting out notebooks.
2. Make sure volunteers are setting up for the experiment.
3. Set up the document camera to show the filled out results table (page 3, picture packet), graph (page 10, student notebook), Conclusion Activity (page 11, student notebook), and block measurement pictures (page 1, picture packet).
4. Have example block available to show students during the introduction.

**Picture Packet Page and Notebook Pages:**

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**Page 3, Picture Packet**

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Introduction: (8 minutes – Full Class – SciTrek Lead)

- Review the class question and what they learned/did last session.
- Show student how to fill out the results table (page 3, picture packet).
- Use the checklist on the top of page 10 (student notebook) to go over how to graph results.
  - A filled out results table is on page 3 of the picture packet, use this data for the graph.
  - Stress the importance of step 4 to ensure that students’ graphs are in increasing order.
  - Only graph the results for the first two smallest shadow lengths (5 cm and 23 cm).
- Using an example block, review how the block dimensions are defined.
- Have students raise their hand to identify whether they are measuring shadow length or width.
- Review how to measure shadow lengths and widths (page 1, picture packet).

Results Table: (3 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure students are underlining controls, circling changing variables, and boxing data collection.
- Make sure control values are written in the trial A box with an arrow through the rest of the trials’ and that changing variable(s) values are written in each trials’ box.

Experiment: (22 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
  - Make sure students have their block orientation correct.
  - Make sure students are measuring either the length or the width of the shadow correctly.
- Do not have students clean up their set-up until after they have made their graph. This allows them to check measurements, if necessary.
**Graph: (10 minutes – Subgroups – SciTrek Volunteers)**

- Walk around and help subgroups that are struggling.
- Make sure students are graphing their data from smallest shadow length/width to largest shadow length/width.
- Make sure students have their changing variable values (Ex: 5 cm), not the trial letters (Ex: trial A), on the x-axis.
- Make sure students are writing the numerical value of the shadow lengths/widths on top of each column.

**Conclusion Activity: (15 minutes – Full Class – SciTrek Lead)**

- **MAKE SURE TO START THE CONCLUSION ACTIVITY AT LEAST 10 MINUTES BEFORE THE END OF THE HOUR, EVEN IF STUDENTS ARE NOT DONE WITH THEIR GRAPHS.**
- Review the definition of a conclusion (claim supported by data) (page 11, student notebook).
- Review the definition of a claim (a statement that can be tested).
  - Have students give a few examples of claims.
- Review the forms of data (observations/measurements).
- Read each statement.
  - As a class, discuss if each statement is a claim, data, or opinion and then circle the correct statement type.
  - When applicable, underline controls (descriptive numbers), box data collection, and double underline opinions.
  - For claim statements, have students tell you what data would need to be collected to back up the claim.
  - For data statements, have students tell you the claim that it could be paired with to make a conclusion.
  - **Letter a:** out of 10 people only □ can ride a unicycle
    - **Data**
      - Possible Claim: more people do not know how to ride a unicycle than do know how to ride a unicycle
  - **Letter b:** puppies are cute
    - **Opinion**
  - **Letter c:** people who get 4 hours of sleep experience dizziness
    - **Claim**
      - 4 hours is not a data measurement. It is called a descriptive number because it describes a control in the experiment.
      - Possible Data: asking/counting the number of people that feel dizzy after getting 4 hours of sleep.
  - **Letter d:** ants were observed on syrup, starbursts, and frosted flakes
    - **Data**
      - Possible Claim: ants are attracted to sugar
  - **Letter e:** the fastest land animal in the world is the cheetah
    - **Claim**
      - Possible Data: time the animals running a specific distance
Letter f: when 2 mL of vinegar was mixed with 2 g of baking soda, $\frac{1}{3}$ L of gas was produced
  • Data
    o Possible Claim: vinegar and baking soda undergo a chemical reaction when mixed

Letter g: the more simple the flower the more bees on the flower
  • Opinion

If there is additional time you can continue on to the next page of the Conclusion Activity.

Wrap-Up: (2 minutes – Full Class – SciTrek Lead)

• Tell students what they will do next session.

Day 4: Conclusion Activity/Conclusion/Question/Materials Page/Experimental Set-Up/Procedure

Schedule: You are responsible for BOLD sections

Introduction (SciTrek Lead) – 2 minutes
Conclusion Activity (SciTrek Lead) – 30 minutes
Conclusion (SciTrek Volunteers) – 5 minutes
Question (SciTrek Volunteers) – 5 minutes
Materials Page (SciTrek Volunteers) – 5 minutes
Experimental Set-Up (SciTrek Volunteers) – 5 minutes
Procedure (SciTrek Volunteers) – 6 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. Make sure volunteers are setting out notebooks.
2. Set up the document camera for the Conclusion Activity (pages 12-15, student notebook).
SCIENTIFIC PRACTICES

Conclusions

3. Directions: Draw a line connecting claims with correct data. If there is no data that supports the claim, do not draw a line.

<table>
<thead>
<tr>
<th>Claim</th>
<th>Because</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. More people go to soccer matches than basketball games</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Sappy food causes heartburn</td>
<td>51% of people get heartburn when they use hot sauce and 40% of people get heartburn when they don't use hot sauce.</td>
<td></td>
</tr>
<tr>
<td>3. Cars increase air pollution</td>
<td>The air has been observed to be brown in areas with large numbers of cars.</td>
<td></td>
</tr>
<tr>
<td>4. Diet coke weighs less than regular coke</td>
<td>10 people went to the movies while 15 went shopping.</td>
<td></td>
</tr>
</tbody>
</table>

5. a. The longer the light the longer the shadow
   b. When the block height was 6 cm, the shadow length was 1.5 cm. When the block height was 3 cm, the shadow length was 0.75 cm.
   c. When the block height is smaller the shadow length is longer.
   d. The longer the light distance the longer the shadow length.

If no claim can be made from the data state why not. No claim can be made because there is more than 1 changing variable.

If no claim can be made from the results can you make a conclusion? Yes

Table A

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Color</td>
<td>White</td>
<td>White</td>
</tr>
<tr>
<td>Block Height</td>
<td>6 cm</td>
<td>10 cm</td>
</tr>
<tr>
<td>Light Distance</td>
<td>30 cm</td>
<td>50 cm</td>
</tr>
<tr>
<td>Light Length</td>
<td>25 cm</td>
<td>40 cm</td>
</tr>
<tr>
<td>Data</td>
<td>Trial A</td>
<td>Trial B</td>
</tr>
<tr>
<td>Final Observations/Measurements</td>
<td>5 cm</td>
<td>10 cm</td>
</tr>
</tbody>
</table>

Table B

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Color</td>
<td>Yellow</td>
<td>Yellow</td>
</tr>
<tr>
<td>Block Height</td>
<td>9 cm</td>
<td>13 cm</td>
</tr>
<tr>
<td>Light Distance</td>
<td>40 cm</td>
<td>60 cm</td>
</tr>
<tr>
<td>Light Length</td>
<td>30 cm</td>
<td>50 cm</td>
</tr>
<tr>
<td>Data</td>
<td>Trial A</td>
<td>Trial B</td>
</tr>
<tr>
<td>Final Observations/Measurements</td>
<td>6 cm</td>
<td>10 cm</td>
</tr>
</tbody>
</table>

Table C

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Color</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Block Height</td>
<td>7 cm</td>
<td>11 cm</td>
</tr>
<tr>
<td>Light Distance</td>
<td>50 cm</td>
<td>70 cm</td>
</tr>
<tr>
<td>Light Length</td>
<td>45 cm</td>
<td>60 cm</td>
</tr>
<tr>
<td>Data</td>
<td>Trial A</td>
<td>Trial B</td>
</tr>
<tr>
<td>Final Observations/Measurements</td>
<td>3 cm</td>
<td>5 cm</td>
</tr>
</tbody>
</table>

Graph D

Can this scientist make a claim/conclusion? Yes

Table D

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Color</td>
<td>Brown</td>
<td>Brown</td>
</tr>
<tr>
<td>Block Height</td>
<td>3 cm</td>
<td>5 cm</td>
</tr>
<tr>
<td>Light Distance</td>
<td>10 cm</td>
<td>20 cm</td>
</tr>
<tr>
<td>Light Length</td>
<td>60 cm</td>
<td>80 cm</td>
</tr>
<tr>
<td>Data</td>
<td>Trial A</td>
<td>Trial B</td>
</tr>
<tr>
<td>Final Observations/Measurements</td>
<td>2 cm</td>
<td>4 cm</td>
</tr>
</tbody>
</table>

Can this scientist make a claim/conclusion? No.
Making a Conclusion from Your Data

How many changing variables did you have in your experiment? 2

Can you make a conclusion from your data? □ YES □ NO

IF NO

Why: I cannot make a conclusion because my experiment had more than 1 changing variable.

IF YES

CONCLUSION

We can conclude

because

Spin Trek Member Approval [Signature]

Materials Page

Changing Variable(s) (Independent Variable(s))

For your second experiment, decide which variable(s) (max three) that you would like to test.

Changing Variable = block length

Changing Variable 1 (optional): 

Changing Variable 2 (optional): 

What will you measure? (circle one) [Shadow Length, Shadow Width]

QUESTION

Question our group will investigate:

If we change the block length, what will happen to the shadow length?

Get a materials page from your SciTrek volunteer and fill it out before moving onto the experimental set-up.

Materials Page

You will only have access to the following materials:

1) For each bolded word, underline if it is a constant and circle if it is a changing variable. Example: control: block length, example changing variable: block length

2) For variables that are constants, choose one value.

3) For variables that are changing variables, choose a values and write the initial letter (A,B,C,D,E,F,G,H) next to each value. Ex: if 2 cm A

General Materials:

- Flashlight
- Ring Stand with Clamp
- White Plastic
- Protractor
- Measuring Tape
- (5) Rulers

Look at the picture below that defines the block dimensions. Two of your block’s dimensions (which are constants) must be 7 cm and 3 cm. The third dimension can be a constant or changing variable and you may select the value(s). You may only circle ONE of these.

<table>
<thead>
<tr>
<th>Block Length</th>
<th>Block Width</th>
<th>Block Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 cm</td>
<td>5 cm (original)</td>
<td>5 cm (new)</td>
</tr>
<tr>
<td>3 cm</td>
<td>5 cm (new)</td>
<td>5 cm (new)</td>
</tr>
<tr>
<td>4 cm</td>
<td>5 cm (new)</td>
<td>5 cm (new)</td>
</tr>
<tr>
<td></td>
<td>5 cm (new)</td>
<td>5 cm (new)</td>
</tr>
<tr>
<td></td>
<td>5 cm (new)</td>
<td>5 cm (new)</td>
</tr>
</tbody>
</table>
**Introduction:** (2 minutes – Full Class – SciTrek Lead)

- Review class question and what they did/learned last session.
**Conclusion Activity: (30 minutes – Full Class – SciTrek Lead)**

- Read the directions on page 12, student notebook.
- Have students make matches between claims and data and then share out matches.
  - **Correct matches**
    - Spicy food causes heartburn, because 50% of people get heartburn when they use hot sauce and 10% of people get heartburn when they don’t use hot sauce.
    - Cars increase air pollution, because the air has been observed to be brown in areas with large numbers of cars.
- Discuss why the statement “Diet coke weighs less than regular coke” does not match with “1 mL of diet coke weighs 5 g and 1 mL of coke weighs 1.1 g.”
- Discuss why only the claim can be changed when the data and the claim do not match.
- Have students identify and underline the controls, circle the changing variable(s), and box information about data collection on the results table (page 13, student notebook).
- Read each statement.
  - As a class, discuss if each statement is a claim or data and write a C or D on the line.
  - Have students help you annotate the statement by underlining controls, circling changing variables (every claim statement will have a changing variable), and boxing data.
  - Have students look at the results table to see if the statement is a correct claim, correct data, or incorrect.
    - Statements are incorrect if they are not supported by the results table or if they have not been tested.
- Questions used for statements that are claims:
  - What type of statement is this and how do you know?
  - What would need to be the changing variable for this claim to be correct?
  - Is that variable a changing variable in the experiment?
    - If answer is yes
      - Is this claim consistent with the data?
      - Is the statement a correct claim, correct data, or incorrect?
    - If answer is no
      - Is the statement a correct claim, correct data, or incorrect?
- Questions used for statements that are data:
  - What type of statement is this and how do you know?
  - Is the data correct based on the results table?
  - Is this statement a correct claim, correct data, or incorrect?
- **Letter a:** the light height affects the length of the shadow
  - Claim/Incorrect (Variable Held Constant)
- **Letter b:** a larger light angle will result in a longer shadow
  - Claim/Correct Claim
- **Letter c:** when a block is 9 cm tall, different light angles give different shadow lengths
  - Claim/Correct Claim
    - The number in this claim is a descriptive number.
- **Letter d:** when the light angle was 60° the shadow length was 6 cm
  - Data/Incorrect
- Have students determine data that backs up claim b.
  - when the light angle was 30° the shadow length was 6 cm and when the light angle was 60° the shadow length was 10 cm
- Have students repeat the process for page 14.
- **Letter a:** the brighter the light the longer the shadow
  - Claim/Incorrect (No Data Gathered)
• **Letter b:** when the block height was 6 cm the shadow length was **6 cm** and when the block height was 10 cm the shadow length was **13 cm**
  
  **Data/Correct Data**

• **Letter c:** when the block height is smaller the shadow length is longer
  
  **Claim/Incorrect (Inconsistent with Data)**

• **Letter d:** the longer the light distance the longer the shadow length
  
  **Claim/Incorrect (More than One Changing Variable)**

• Go over the two questions on the bottom of page 14.
• On page 15, have students identify and underline the controls, circle the changing variable(s), and box information about data collection, and then determine if the group can make a conclusion.
• Tell students they will now determine if they can make a conclusion from their first experiment and then design another experiment.

**Conclusion:** (5 minutes – Subgroups – SciTrek Volunteers)

• If subgroups have not finished the graph DO NOT make them go back and finish it. Most likely these subgroups will not be able to make a conclusion; therefore, they will not use the data from their first experiment.
• Walk around and help subgroups that are struggling.
• Subgroups that can make a conclusion will need more help than those that cannot.
  
  **Claim/Incorrect (More than One Changing Variable)**

• Make sure for the second part of the question (what you are measuring/observing) that students are specific (Ex: the shadow length or width, instead of the shadow).

**Question:** (5 minutes – Subgroups – SciTrek Volunteers)

• Walk around and help subgroups that are struggling.
• Make sure subgroups are only picking one changing variable.
• Encourage subgroups to pick different changing variables.
• Encourage subgroups to measure the dimension of the shadow (length or width) they think they know the least about
• Make sure for the second part of the question (what you are measuring/observing) that students are specific (Ex: the shadow length or width, instead of the shadow).

**Materials Page:** (5 minutes – Subgroups – SciTrek Volunteers)

• Walk around and help subgroups that are struggling.
• Make sure subgroups are underlining their controls and circling their changing variable.
• Make sure subgroups fill out the materials page correctly and completely.

**Experimental Set-Up:** (5 minutes – Subgroups – SciTrek Volunteers)

• Walk around and help subgroups that are struggling.
• Make sure within one subgroup, all students have the same order for their changing variable values.
• Make sure all control blanks are filled out.
**Procedure:** (6 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure procedures are concise, but still include all values of the controls, changing variable, and what data will be collected.
- If subgroups do not finish their procedure, they will have time to work on it the next session.

**Wrap-Up:** (2 minutes – Full Class – SciTrek Lead)

- Tell students what they will do next session.

**Day 5: Procedure/Results Table/Experiment/Graph/Conclusion**

**Schedule:** You are responsible for **BOLD** sections

- Introduction (SciTrek Lead) – 10 minutes
- Procedure (SciTrek Volunteers) – 5 minutes
- Results Table (SciTrek Volunteers) – 5 minutes
- Experiment (SciTrek Volunteers) – 25 minutes
- Graph (SciTrek Volunteers) – 5 minutes
- Conclusion (SciTrek Volunteers) – 8 minutes
- Wrap-Up (SciTrek Lead) – 2 minutes

**Preparation:**

1. Make sure volunteers are setting out notebooks.
2. Make sure volunteers are setting up for the experiment.
3. Set up the document camera for the conclusion example (page 20, student notebook) and the block measurement pictures (page 1, picture packet).
4. Have example block available to show students during the introduction.
**SCIENTIFIC PRACTICES**

**Conclusions**

**Question:** If we change the block material, what will happen to the shadow length?

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Color</td>
<td>White</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Height</td>
<td>7 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Width</td>
<td>3 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Distance</td>
<td>35 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Angle</td>
<td>90°</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Material</td>
<td>Wood</td>
<td>Foam</td>
<td>Metal</td>
<td>Cardboard</td>
</tr>
<tr>
<td>Raw Measurement</td>
<td>12 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shadow Length</td>
<td>12 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Write a conclusion from the results above:

We can conclude that for a given block dimension, the shadow length will be the same regardless of the block material because the blocks made from wood, foam, metal, and cardboard all had a shadow length of 12 cm.

---

**RESULTS**

**Graph**

Check off the steps as you complete them.

- Write what you measured (e.g., shadow length) on the y-axis (vertical).
- Determine an appropriate scale which will allow you to graph all of your data points and write the numbers on the given axes.
- Write your changing variable(s) (e.g., trial) on the x-axis (horizontal).
- Changing variable(s) will only be effective if you have 2 or 3 changing variables.
- On your results table, label your measurements from 1 to 4, with being the trial with the smallest measurement and 4 being the trial with the largest measurement.
- Plot your data in increasing order.
- Make sure the changing variable values (e.g., 1 or 2) are under the first column.
- Graph your data for that trial and write the measurement above the bar.
- Repeat the process for the other trials.

---

**CONCLUSION**

We can conclude increasing the block length will slightly increase the shadow length when the light distance and light height are both 50 cm because when the block length was 3 cm, the shadow length was 7 cm and when the block length was 10 cm, the shadow length was 9 cm.

Can you test the first part (claim) of the conclusion? [ ] Yes [ ] No (If you checked this box, go back and rewrite your claim so that it can be tested.)

The second part of the conclusion is data because it contains a measurement. I acted like a scientist when I wrote a procedure for the experiment.
Introduction: (10 minutes – Full Class – SciTrek Lead)

- Review the class question and what they learned/did last session.
- Review the definition of a conclusion.
- On the data table (page 20, student notebook), have students identify and underline the controls, circle the changing variable, and box information about data collection.
- Have students identify the question the group was investigating.
- Have students make a conclusion from the data.
  - We can conclude that for a given block dimension, the shadow length will be the same regardless of the material the block is made from, because the blocks made out of wood, foam, metal, and cardboard all had a shadow length of 12 cm.
- Using an example block, review how the block dimensions are defined.
- Have students raise their hand to identify whether they are measuring shadow length or width.
- Review how to measure shadow lengths and widths (page 1, picture packet).

Procedure: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure procedures are concise, but still include all values of the changing variable, controls, and what data will be collected.

Results Table: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure students are underlining controls, circling changing variables, and boxing data collection.
- Make sure control values are written in the trial E box with an arrow through the rest of the trials and that changing variable values are written in each trials’ box.

Experiment: (25 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
  - Make sure students have their block orientation correct.
  - Make sure students are measuring either the length or the width of the shadow correctly.
- Do not have students clean up their set-up until after they have made their graph. This allows them to check measurements if necessary.

Graph: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure students are graphing their data from smallest shadow length/width to largest shadow length/width.
- Make sure students have their changing variable values (Ex: 5 cm), not the trial letters (Ex: trial A) on the x-axis.
- Make sure students are writing the numerical value of the shadow lengths/widths on top of each column.
**Conclusion:** (8 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure subgroups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and use at least two specific data points to support it.
  - If subgroups use observations as their data, make sure their data statement includes "we observed."
  - If subgroups use measurements as their data, make sure they are including numerical values in their data statement.
  - Do not reference trial letters in the conclusion.
- Volunteers struggle with conclusions, therefore, check at least one conclusion from each group.
- If subgroups do not finish their conclusions, they can work on them during the next session.

**Wrap-Up:** (2 minutes – Full Class – SciTrek Lead)

- Tell students what they will do next session.

**Day 6: Conclusion/Poster Making**

**Schedule:** You are responsible for BOLD sections

- Introduction (SciTrek Lead) – 2 minutes
- Conclusion (SciTrek Volunteers) – 18 minutes
- Poster Making (SciTrek Volunteers) – 35 minutes
- Wrap-Up (SciTrek Lead) – 5 minutes

**Preparation:**

1. Make sure volunteers are setting out notebooks.
2. Find a place to leave student posters.
CONCLUSION

We can conclude: Increasing the block length will slightly increase the shadow length, when the light distance and light height are both 50 cm.

What data do you have to support your claim? (Remember to include your measurements and/or observations.)

Because, when the block length was 3 cm the shadow length was 7 cm and when the block length was 10 cm the shadow length was 9 cm.

Can you test the first part (claim) of the conclusion? [ ] yes [ ] no

If you checked this box, go back and revise your claim so that it can be tested.

The second part of the conclusion is data because it contains a measurement.

I acted like a scientist when I wrote a procedure for the experiment.

A larger version of this poster is in your lead box.

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**#3 EXPERIMENTAL SET-UP**

Determine the value of your changing variable (x) over the entire range of your data. (x=10°, 20°, 30°, 40°, 50°)

**Change variable:**

<table>
<thead>
<tr>
<th>Block length</th>
<th>Light height</th>
<th>Light distance</th>
<th>Angle</th>
<th>Shadow length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 cm</td>
<td>50 cm</td>
<td>30 cm</td>
<td>10°</td>
<td>5 cm</td>
</tr>
<tr>
<td>5 cm</td>
<td>50 cm</td>
<td>30 cm</td>
<td>20°</td>
<td>7 cm</td>
</tr>
<tr>
<td>7 cm</td>
<td>50 cm</td>
<td>30 cm</td>
<td>30°</td>
<td>9 cm</td>
</tr>
<tr>
<td>9 cm</td>
<td>50 cm</td>
<td>30 cm</td>
<td>40°</td>
<td>11 cm</td>
</tr>
<tr>
<td>11 cm</td>
<td>50 cm</td>
<td>30 cm</td>
<td>50°</td>
<td>13 cm</td>
</tr>
</tbody>
</table>

---

**PROCEDURE**

Precondition:

- The objects and equipment must be clean and ready to use.
- The light source must be turned on and adjusted to the correct height and distance.

1. Set a block that is 3° high, 5 cm wide, and 10 cm, 25 cm, 35 cm, 45 cm, 55 cm, 65 cm, and angle 90°.
2. Place the objects on a white plastic.
3. Set the light with distance 50 cm, height 60 cm, and angle 90°.
4. Turn on light.
5. Measure shadow length and width.
6. Repeat steps 1-4 with different angles and distances.
**Introduction:** (2 minutes – Full Class – SciTrek Lead)

- Review the class question, what they learned/did last session, and what they will do today.

**Conclusion:** (18 minutes – Full Class – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure subgroups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and use at least two specific data points to support it.
  - If subgroups use observations as their data, make sure their data statement includes “we observed.”
  - If subgroups use measurements as their data, make sure they are including numerical values in their data statement.
  - Do not reference trial letters in the conclusion.
- Volunteers struggle with conclusions, therefore, check at least one conclusion from each group.
- Make sure students fill out the sentence frame on page 23, “I acted like a scientist when.”

**Poster Making:** (35 minutes – Subgroups – SciTrek Volunteers)

- Help volunteers glue poster pieces onto the posters. When gluing, make sure you or the volunteers (not the students) are gluing the poster in the exact order that is shown on the diagram and that the poster has a landscape orientation.
- Make sure the student in each subgroup who is presenting the results graph has a sentence frame sticker in their notebook and the volunteer has gone over how to present the four sentences with the student several times.
- Each student should have the part(s) that they are presenting highlighted and numbered in their notebook: 1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results graph, and 6) conclusion (see pictures above).
  - Remind the volunteers that if a student is presenting multiple parts, they should have multiple sections highlighted and numbered in their notebook.
- Volunteers often forget to highlight student notebooks, so make sure this is done before Day 7.
Wrap-Up: (5 minutes – Full Class – SciTrek Lead)

- Ask students the following questions:
  - How did you act like a scientist during this project?
  - What did you do that scientists do?

Day 7: Poster Presentations

Schedule: You are responsible for **BOLD** sections

**Introduction (SciTrek Lead) – 2 minutes**
**Practice Posters (SciTrek Volunteers) – 5 minutes**
**Poster Presentations (SciTrek Volunteers/SciTrek Lead) – 51 minutes**
**Wrap-Up (SciTrek Lead) – 2 minutes**

Preparation:

1. Make sure volunteers are setting out notebooks.
2. Set up the document camera to use for the Notes on Presentations (page 4 and 5, picture packet).
3. Organize posters so experiments featuring the same changing variable are presented back to back and posters are presented from easiest to understand to hardest to understand (suggested order: block height, block width, block length, light height, light distance, light angle).

Picture Packet Pages: (Student notebook pages 24 and 25 are identical to picture packet pages 4 and 5, but have space for only 8 subgroups.)
Introduction: (2 minutes – Full Class – SciTrek Lead)

- Tell students that they will have 5 minutes to practice their posters.

Practice Posters: (5 minutes – Subgroups – SciTrek Volunteers)

- **DO NOT GIVE STUDENTS MORE THAN 5 MINUTES TO PRACTICE OR YOU WILL RUN OUT OF TIME FOR PRESENTATIONS.**
- Make sure students are reading from their notebook and practicing the poster in the following order: 1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results graph, and 6) conclusion. They will NOT read the “I acted like a scientist when” or results table from their poster.

Poster Presentations: (51 minutes – Full Class – SciTrek Volunteers/SciTrek Lead)

- Tell students that if they ask a scientific question (a question that helps summarize what the subgroup did/learned) they will receive a SciTrek pencil after the presentations are done.
- Have students present their posters.
- While posters are being presented, record each subgroup’s changing variable values, what data they will be collecting, and their data on pages 5 and 6 of the picture packet, while students record the information on pages 24 and 25 of their notebooks.
  - After subgroups read their question, stop the presentation and have the class identify the changing variable and what shadow measurement the subgroup made. Then record it in the picture packet.
  - When subgroups read their results graph, record the values of the changing variable and their measurements.
- **After each presentation, ask students:**
  - What questions do you have for this subgroup?
  - Can someone summarize what we learned from this subgroup?
- Record what they learned under the summary on pages 5 and 6 of the picture packet; while students record the summary on pages 24 and 25 of their notebooks.
- Students will not record information about their own subgroup’s poster presentation.
- After all presentations are over, have students tell you the variable values that they would select to make the longest shadow.

Wrap-Up: (2 minutes – Full Class – SciTrek Lead)

- Tell the students that the volunteers that have been working with them are undergraduate and graduate students that volunteer their time so that they can do experiments. Have the students say thank you to the volunteers. This is the last day with their SciTrek volunteers, therefore, they should say goodbye to them.
- Have volunteers give students SciTrek pencils.
- Tell students to remove the paper part of their nametag from the plastic holder and that they can keep the paper nametag but need to give the plastic holder back to their volunteer.
Day 8: Conclusion Assessment/Tie to Standards

Schedule: You are responsible for **BOLD** sections

Conclusion Assessment (SciTrek Lead) – 10 minutes
Tie to Standards (SciTrek Lead) – 50 minutes

**Preparation:**

1. If the teacher is not leading the Tie to Standards Activity, do the following:
   a. Give the teacher an extra student notebook and have them fill it out with their students to follow along during the Tie to Standards Activity.
   b. Collect the teacher’s lab coat and put it in the lead box.
2. Pass out the Conclusion Assessments and notebooks.
3. Set up the document camera for the Tie to Standards Activity (pages 26-28, student notebook and pages 6-11, picture packet).
4. Put your lab coat in the lead box at the end of the day.

**Notebook Pages:**
**Conclusion Assessment:** (10 minutes – Full Class – SciTrek Lead)

- Pass out assessments.
- Page 1: Read each statement and have students circle if the statement is a claim, data, or opinion.
- Page 2: Have students underline controls, circle changing variable(s), and box information about data collection on the results table. Then have students decide if the group could make a conclusion.
- Page 2: Read each statement and have students identify if the statement is a claim or data and then circle if statement is a correct claim, correct data, or incorrect based on the results table.
- Page 3: Repeat the process for page 3.
- Collect assessments.

**Tie to Standards:** (50 minutes – Full Class – SciTrek Lead)

**Effects of Changing the Light (15 minutes)**

- For each of the parts in question 1, explain the change that will be made for each trial and then have students circle what they think will happen to the shadow length/width.
- Have one student share their answer and why they made that prediction.
- Show students the data (pages 6-9, picture packet).
- Box what happened to the shadow length/width.
  - It might be necessary to measure the shadow width in experiment 3 (light distance).
Connection to the Sun (10 minutes)

- Have students fill in questions 2, 3, and 4.
- Draw in the location of the suns and label them with students for question 5 in the following order (sunrise, noon, sunset, midmorning, afternoon).
- Draw in the shadow for sunrise with students and label it.
- Have students try to fill in the other shadows on their own and then share their drawing and their reasoning.
- Draw in other shadows.
- Have student fill in questions 6 and 7.

Seasonal Shadows (23 minutes)

- Have volunteers pass out red pens.
- Tell student that they are now going to draw, with the red pen, what they think happens to the shadow length over the course of 24 hours in the winter.
- Ask students, “What would the shadow length be at midnight?” Students should reply, “0” Then draw on the first few points with them.
- Tell students that if they thought the shadow length was 0 over the full 24 hours then they would just draw a straight line with their red pen.
  - Ask them, “Is this prediction correct?” Students should reply, “NO.”
- Have one student share their prediction.
- Graph the actual data in pencil with the students (page 10, picture packet).
• Determine the number of daylight hours in the winter (10 hours).
• Point out that the graph is symmetric.
• Tell student that they are now going to draw, with the red pen, what they think happens to the shadow length over the course of 24 hours in the summer.
• Have one student share their prediction.
• Graph the actual data in pencil with the students (page 11, picture packet).
• Determine the number of daylight hours in the summer. (14 hours)
• As a class fill in the conclusion about number of daylight hours.

**Sundials (2 minutes)**

• Tell students that since shadows are predictable, before there was electricity sundials were used to tell time.
• Have students determine the time of day for each sundial.

**Extra Practice Solutions:**

![Extra Practice Solutions](image-url)