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 the picture packet used during the module.

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.

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 not showing) at the edge of the shadow. This will result in the rulers making a “L.”
3. Read the length of the shadow off the ruler with the numbers showing. (7 cm)

Width

1. Place two rulers (numbers not showing) 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) This will result in the rulers making a “H.”
Day 1: Conclusion Assessment/Technique/Observations/Variables

Note: We highly recommend that you complete the conclusion assessment prior to Day 1 of the module.

Schedule: You are responsible for BOLD sections

Introduction (SciTrek Lead) – 2 minutes  
Conclusion Assessment (SciTrek Lead) – 10 minutes  
Module Introduction (SciTrek Lead) – 3 minutes  
Technique (SciTrek Lead) – 5 minutes  
Observation Discussion (SciTrek Lead) – 4 minutes  
Observations (SciTrek Volunteers) – 20 minutes  
Variable Discussion (SciTrek Lead) – 5 minutes  
Variables (SciTrek Volunteers) – 9 minutes  
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. If the classroom has a document camera, ask the teacher to use it 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).
2. Write the three group colors on the board (orange, blue, and green) and the name(s) of the volunteer(s) that will be working with each group.
3. Make sure that volunteers are setting up for the initial observation. Details of how to do this are on a picture in the volunteer boxes.

Notebook Pages and Notepad Pages: (Note: Notebook pages are rectangular and filled out in black and notepad pages are squarer and filled out in blue.)

![Diagram of Protractors and Measurement Angles]

- 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 block and place the baseline parallel to the bottom of the block.
  2. Move the swing arm to point to the center of the flashlight.
  3. The angle is the value on the outer scale on the other side of the swing arm.
  4. Identify the angle of the flashlight in relation to the box.

  - A. 140°
  - B. 90°
  - C. 52°
  - D. 130°
OBSERVATIONS

Experimental Set-Up:
- Block height = 5 cm
- Block width = 7 cm
- Block length = 3 cm
- Light angle = 60°
- Flashlight pointed at block

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

<table>
<thead>
<tr>
<th>Light Color</th>
<th>Blue Light</th>
<th>White Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shadow Color</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Shadow Length</td>
<td>1.5 cm</td>
<td>1.5 cm</td>
</tr>
<tr>
<td>Shadow Width</td>
<td>10 cm</td>
<td>10 cm</td>
</tr>
</tbody>
</table>

Describe what happened during the experiment:
- Changing the light color does not change the shadow length or width, but the white light shadow is easier to see than the blue light shadow.
Introduction: (2 minutes – Full Class – SciTrek Lead)

- Introduce the module/SciTrek volunteers.

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

- Pass out assessments.
- Page 1: Read each statement and have students circle if 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.
  - Circle: time
  - Underline: shoe type, trail type, number of stops
  - Box: distance traveled, sock cleanliness
- Page 2: Have them 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 data 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 notebook.
  - 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?) and have students copy it onto the front cover of their notebook.
Technique: (5 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 A as a class. (page 2, student notebook)
- Have students fill out questions B-D 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: (20 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure that groups are moving along and only spending ~8 minutes on the experimental set-up, ~5 minutes on the colored light, and ~5 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 why/how this variable might affect the shadow length and width.

Variables: (9 minutes – Groups – SciTrek Volunteers)

- NOTE: IF YOU ARE RUNNING SHORT ON TIME DO THIS AS A FULL CLASS.
- 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.
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. If the classroom has a document camera, ask the teacher to use it for the question (page 6, student notebook), materials page (lead box), and experimental set-up (page 7, student notebook).
2. Have 2 example blocks of different heights to show students during the introduction.
3. Have volunteers set out notebooks so that students within the same subgroup can work together.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.

Notebook Pages and Materials Page:
**PROCEDURE**

Procedure Note:
Make sure to include all values of your changing variable(s) in the procedure. (Example, for a group that decided to change block height, one step would be: place block that is 2 cm tall and A) 2 cm, B) 4 cm, C) 6 cm, and D) 8 cm tall on the white plastic.)

1. Get a wood block that is 7 cm high, 3 cm long, and A) 1 cm, B) 2 cm, C) 3 cm, D) 4 cm wide.
2. Place block on white plastic.
3. Set up light with height 25 cm, distance and angle A) 25 cm, B) 60 cm, 30°, C) 10 cm, 90°, D) 45 cm, 20°.
4. Turn on white light.
5. Measure the length of the shadow.

*Note: Procedure does not match the lead experiment*
**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 last SciTrek visit.
- 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 of 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)
    - First: underline controls and circle changing variables.
    - Second: select values for the controls and changing variables.
      - Write trial letters next to changing variables values.
  - Fill out the experimental set-up for the example experiment (only trials A and B for the changing variable). (page 7, student notebook)
    - There will be one additional blank for controls. Lead students to come up with surface/white plastic.
  - Read the example procedure step for the changing variable. (page 8, student notebook)

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

- Walk around and help subgroups that are struggling.
- MAKE SURE VOLUNTEERS ARE NOT GIVING ADVICE ON HOW MANY CHANGING VARIABLES TO USE.
- Make sure subgroups are only picking changing variable(s) that are allowed.
  - Students may only change one block dimension: block height, block length, OR block width.
- Try to encourage subgroups to pick different changing variables.
- Make sure for the second part of the question (what you are measuring/observing) that students are specific (example: they should write, “the shadow length or width” and not just “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 fill 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 that 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 not too long but include all values of the changing variable, controls, and what data will be collected.

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

- Tell students what they will do next time.

**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. If the classroom has a document camera, ask the teacher to use it for 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).
2. Make sure that volunteers are putting ring stands together and setting materials out on the floor for students to use.
3. Have example block available to show students during the introduction.
4. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.
Picture Packet Page and Notebook Pages:

### RESULTS

<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>Block length</td>
<td>5 cm</td>
<td>10 cm</td>
<td>3 cm</td>
<td>7 cm</td>
</tr>
<tr>
<td>Block width</td>
<td>7 cm</td>
<td>1 cm</td>
<td>1 cm</td>
<td>1 cm</td>
</tr>
<tr>
<td>Light intensity</td>
<td>10 cm</td>
<td>20 cm</td>
<td>45 cm</td>
<td>25 cm</td>
</tr>
<tr>
<td>Light angle</td>
<td>25°</td>
<td>25°</td>
<td>25°</td>
<td>25°</td>
</tr>
<tr>
<td>Surface</td>
<td>White</td>
<td>White</td>
<td>White</td>
<td>White</td>
</tr>
</tbody>
</table>

### Predictions

- A shadow will be cast.
- The angle of the light will affect the length of the shadow.
- The distance from the light source will affect the length of the shadow.
- The size of the block will affect the length of the shadow.

### Graph

- **Shadow Length (cm)**
  - **Light Source (cm)**
    - **Block Height**: 5 cm, 3 cm
    - **Light Distance**: 10 cm, 15 cm

### SCIENTIFIC PRACTICES

#### Conclusions

1. **Directions:** Fill in the missing definition.
   - **Conclusion**: A claim supported by data
     - **Claim**: A statement that can be tested. The explanation of the data, the first part of a conclusion.
     - **Example**: Donuts have more fat than toast.
     - **Data**: Evidence collected from experiments (measuring or observations), the second part of a conclusion.
     - **Example**: A serving of donuts has 8 grams of fat while a serving of toast has 2 grams of fat.

2. **Directions:** Circle if the statement is a CLAIM, DATA, or OPINION.
   - a. out of 10 people only 4 can ride a unicycle
     - **Claim**
   - b. puppies are cute
     - **Descriptive Number**
   - c. people who get 7 hours of sleep experience drowsiness
     - **Claim**
   - d. ants were in the group, starburst, and frosted flakes
     - **Claim**
   - e. the fastest animal in the world is the cheetah
     - **Claim**
   - f. when 2 mL of vinegar was mixed with 3 g of baking soda, gas was produced
     - **Claim**
   - g. the more sugar the flower the more bees on the flower
     - **Claim**
Introduction: (8 minutes – Full Class – SciTrek Lead)

- If needed have volunteers set out notebooks.
- Make sure that volunteers are setting up for the experiments.
- Review the class question.
- Use the steps 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.
  - 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 that control values are written in trial A 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 with their experiment and make sure they will finish their experiment on time.
  - Make sure that students have their block orientation correct.
  - Make sure that students are measuring either the length and 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 that students are graphing their data from smallest shadow length/width to largest shadow length/width.
- Make sure students have their changing variable values not the trial letters on the x-axis.
- Make sure students are writing 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, 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 (observation/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 opinion.

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 3 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 measurement. It is called a descriptive number because it describes 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, 1 liter of gas was produced
  - **Data**
  
  - 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 extra 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 time.
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. If the classroom has a document camera, ask the teacher to use it for the conclusion activity (pages 12-15, student notebook).
2. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers pass out student notebooks to them. They will move to their subgroup seats after the conclusion activity.

Notebook Pages and Materials Page:
### Scientific Practices

#### Conclusions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block Height</td>
<td>6 cm</td>
<td>9 cm</td>
</tr>
<tr>
<td>Block Width</td>
<td>2 cm</td>
<td>2 cm</td>
</tr>
<tr>
<td>Light Distance</td>
<td>30 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td>Light Height</td>
<td>52 cm</td>
<td>52 cm</td>
</tr>
<tr>
<td>Light Angle</td>
<td>90°</td>
<td>90°</td>
</tr>
</tbody>
</table>

**Data**

- **Trial A**
  - Shadow: 15 cm
- **Trial B**
  - Shadow: 15 cm

3.

a. **Correct**
   - The taller the light, the longer the shadow.

b. **Incorrect**
   - When the block height was 6 cm, the shadow length was 15 cm when the block height was 9 cm, the shadow length was 15 cm.

c. **Correct**
   - When the block height was 6 cm, the shadow length increased.

d. **Incorrect**
   - When the block height was 6 cm, the shadow length increased.

e. **Correct**
   - The longer the distance from the light source, the longer the shadow.

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**

---

### 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**

**If NO:**

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

**If YES:**

**CONCLUSION**

- We can conclude: **[Blank]**

*Because:* [Blank]

---

**Making a Conclusion from Your Data**

**How many changing variables did you have in your experiment?** 1

*Can you make a conclusion from your data?* **Yes**

**If NO:**

- **Why:**

**If YES:**

**CONCLUSION**

- We can conclude: **[Blank]**

*Because:* [Blank]
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 2 (optional): 
Changing variable 3 (optional): 
What will you measure? (circle one) 
  Shadow Length 
  Shadow Width 

QUESTION

Question our group will investigate:

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

SciTrek Member Approval

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MATERIALS PAGE

You will only have access to the following materials.

1) Go through the bulleted words and circle if it is a changing variable and underline if it is a control. Ex. Control: Block Width, Ex. Changing variable: block length.

2) For variables that are controls select 1 value.

3) For variables that are changing variables, select 4 values and write the trial letter (A, B, C, D) next to each value. Ex: 10 cm A

General Materials:

Flashlight

Ring Stand with Clamp

White Plastic

Protractor

Measuring Tape

Ruler

Look at the picture below that defines the block dimensions. Two of your block's dimensions (which are controls) must be 2 cm and 5 cm. The third dimension can be a changing variable (shown below) and you may select the value(s). You may only circle ONE of these.

The block's length will be

- 2 cm
- 5 cm (original)
- 6 cm
- 7 cm
- 8 cm

The block's width will be

- 1 cm
- 2 cm
- 3 cm

The block's height will be

- 1 cm
- 2 cm

---

EXPERIMENTAL SET-UP

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

Changing Variable(s):

- block length: 3 cm, 10 cm, 8 cm, 4 cm
- light angle: 30°, 45°, 60°, 75°

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 distance: 50 cm

block height: 7 cm

block width: 3 cm

block angle: 60°

SciTrek Member Approval
**Introduction:** (2 minutes – Full Class – SciTrek Lead)

- If needed have volunteers pass out notebooks.
- Review class question and what they did last SciTrek visit.

**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 grams and 1 mL of coke weighs 1.1 grams.”
- Discuss that only the claim can be changed when the data and the claim do not match.
- Have students identify and circle the changing variables, underline the controls, 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 circling changing variables (every claim statement will have a changing variable), underlining controls, 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 5 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 circle the changing variable(s), underline the controls, 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.
  - If a group can make a conclusion make sure they are making a claim and using data to support it.
Question: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure that subgroups are only picking one changing variable.
- Try to encourage subgroups to pick different changing variables.
- Make sure for the second part of the question (what you are measuring/observing) that students are specific (example: they should write “the shadow length or width” and not just “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 that within one group 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 not too long but include all values of the changing variable, controls, and what data will be collected.
- If subgroups do not finish their procedure they will have time to work on it the next SciTrek visit.

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

- Tell students what they will do next time.

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. If the classroom has a document camera, ask the teacher to use it for the conclusion example (page 20, student notebook) and the block measurement pictures (page 1, picture packet).
2. Make sure that volunteers are putting ring stands together and setting materials out on the floor for students to use.
3. Have example block available to show students during the introduction.
4. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers pass out student notebooks to them. They will move to their subgroup seats after the introduction.

Notebook Pages:
Introduction: (20 minutes – Full Class – SciTrek Lead)

- If needed have volunteers pass out notebooks.
- Make sure that volunteers are setting up for the experiments.
- Have students identify and circle the changing variable, underline the controls, and box information about data collection on the data table. (page 20, student notebook)
- 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 it is made from because the blocks made out of wood, foam, metal, and cardboard all had a shadow lengths 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 not too long but 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 that control values are written in trial E 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 with their experiment and make sure they will finish their experiment on time.
  - Make sure that students have their block orientation correct.
  - Make sure that students are measuring either the length and 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 that students are graphing their data from smallest shadow length/width to largest shadow length/width.
- Make sure students have their changing variable values, not trial letters on the x-axis.
- Make sure that students are writing 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 that subgroups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and using data to back it up.
  - If subgroups use an observation as data, make sure their data statement includes “we observed.”
  - Do not reference trial letters in the conclusion.
- If subgroups do not finish their conclusions, they can work on them during the next SciTrek visit.
- Volunteers struggle with conclusions, so try to check at least one conclusion from each group.

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

- Tell students what they will do next time.

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. Ask the classroom teacher for a place to leave the student posters.
2. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.
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 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 poster is in your group box.
Introduction: (2 minutes – Full Class – SciTrek Lead)

- If needed have volunteers set out notebooks.
- Review the class question.
- Tell the students that they will be finishing their conclusion, filling out the sentence frame “I acted like a scientist when____,” and making a poster today.

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

- Walk around and help subgroups that are struggling.
- Make sure that subgroups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and using data to back it up.
  - If subgroups use an observation as data, make sure their data statement includes “we observed.”
  - Do not reference trial letters in the conclusion.
- Volunteers struggle with conclusions, therefore try to check at least one conclusion from each group.
- Have 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 poster. When gluing, make sure that the volunteers are gluing the poster in the exact order that is shown on the diagram and that the poster has a landscape orientation.
- Make sure that 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)
- Volunteers often forget to highlight student notebooks, 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. If the classroom has a document camera, ask the teacher to use it for the notes on presentations (page 4 and 5, picture packet). If there is no document camera write the class question on the board.
2. Organize posters so that experiments featuring the same changing variable will be presented back to back.
3. Have volunteers pass out notebooks.

**Notebook Pages:**

![Notes on Presentations](image)
Introduction: (2 minutes – Full Class – SciTrek Lead)

- If needed have volunteers pass out notebooks.
- Tell students that they will have 5 minutes to practice their posters.
- DO NOT GIVE STUDENTS MORE THAN 5 MINUTES OR YOU WILL RUN OUT OF TIME FOR POSTERS.

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

- Organize posters so that experiments featuring the same changing variable are presented back to back.
- 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 group 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 group’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.
  - When a group reads their question, record the changing variable and what data they will be collecting.
    - Stop the presentation after the question and have the class identify the changing variable and what data they will be collecting.
  - When a group reads their graph, record the values of the changing variable and their measurements.
- After each presentation ask students:
  - What questions do you have for this group?
  - Can someone summarize what we learned from this group?
- 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 group’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 SciTrek 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 classroom has a document camera, ask the teacher to use it for the tie to standards activity (pages 26-28, student notebook) and tie to standards pictures (pages 6-11, picture packet).
2. Pass out the conclusion assessments and notebooks.
3. Remind the teacher to give you their lab coat at the end of the day.

**Notebook Pages:**

![Notebook Pages Image]
Conclusion Assessment: (10 minutes – Full Class – SciTrek Lead)

- Pass out assessments.
- Page 1: Read each statement and have students circle if 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 data table. Then have them 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 data 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 for question 5 in the following order (sunrise, noon, sunset, midmorning, afternoon).
- Draw in the shadow for sunrise.
- Have students try to fill in the other shadows and share 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 summer.
- Ask students what the shadow length should be at midnight and 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 if this is a correct prediction? (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 summer. (14 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 winter.
• 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 winter. (10 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)