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 scitrek.chem.ucsb.edu/module as well as the notebook and picture packet used during the module.

Note: We **highly recommend** teachers give 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 **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:

Notebook:
: One given to every student and is filled out by the student. The lead will use a notebook to write in as an example for students. The notebook 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 narrower and taller than the notebook pages.

Picture Packet:
: One per class that, if needed, the lead fills out. In these instructions, the examples are the same size as the notebook pages but are labeled.

In these instructions, all other example documents are labeled.

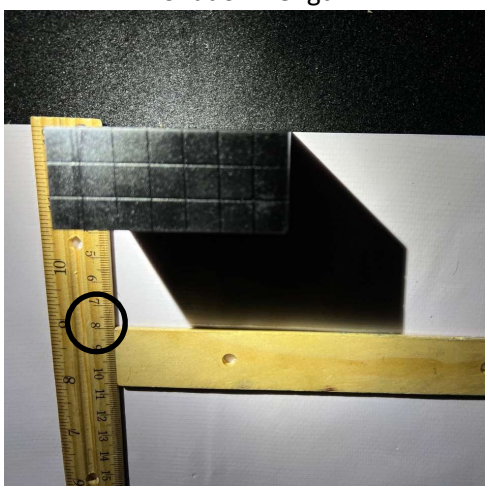
How to Measure Shadow Lengths (left image below)

1. Line up the 0 cm mark of a ruler with the front of the block (edge 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. The shadow length will be the measurement from the front of the block to the beginning of the upside-down ruler. This point is indicated with a circle in the image below (8 cm).

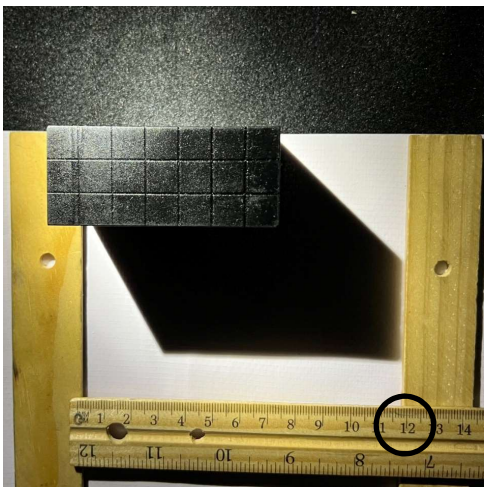
How to Measure Shadow Widths (right image below)

1. Place two rulers (numbers side down) perpendicular to the short side of white plastic on either side of the shadow.
2. Line the 0 cm mark of a third ruler with the inside edge of one of the upside-down rulers. This will result in the rulers making an “H.”
3. The shadow width will be the measurement between the two number-side-down rulers. This point is indicated with a circle in this image below (12 cm).

Shadow Length



Shadow Width



Day 1: Technique/Observations/Variables

We **highly recommend** teachers give the conclusion assessment prior to Day 1 of the module. The suggested times in the lesson plan below are assuming students completed the conclusion assessment prior to SciTrek's arrival.

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

Times if teacher gave assessment prior to SciTrek:
Introduction (SciTrek Lead) – 2 minutes
Module Introduction (SciTrek Lead) – 3 minutes
Technique (SciTrek Lead) – 7 minutes
Observation Discussion (SciTrek Lead) – 4 minutes
Observations (SciTrek Volunteers) – 25 minutes
Variable Discussion (SciTrek Lead) – 5 minutes
Variables (SciTrek Volunteers) – 12 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Times if SciTrek must give assessment:
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:

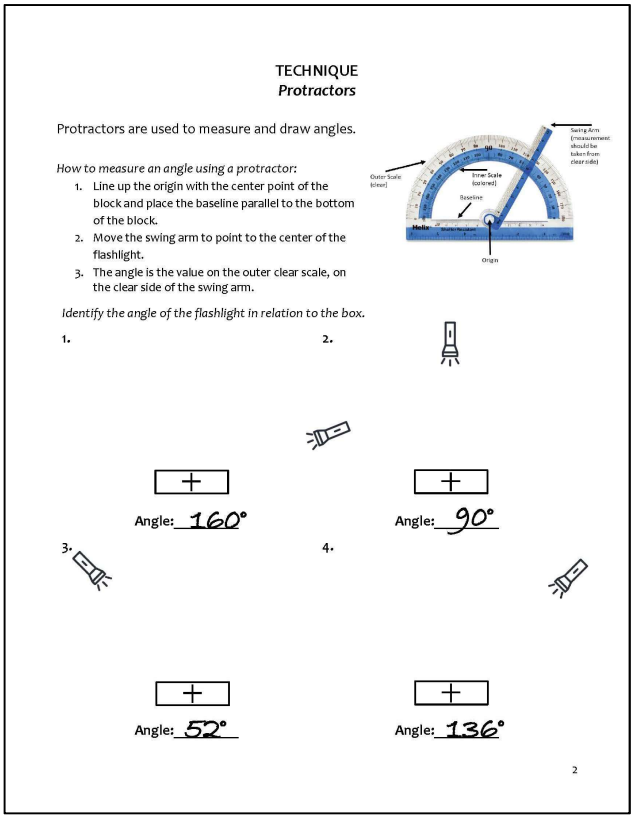
1. Get the conclusion assessment and put them in the lead box.
2. Make sure volunteers are writing their name and group color on the whiteboard.
3. Make sure volunteers are passing out nametags.
4. Make sure volunteers are setting up for the initial observation.
5. Set up the document camera for the class question (notebook, front cover), technique activity (notebook, page 2), and the block measurement pictures (picture packet, pages 1 and 2).

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)*

- Page 1 (top): Read the two questions aloud and have students fill them in.
- Page 1 (bottom): Read each statement and have students circle whether the statement is a claim, data, or opinion.
- Page 2 (top): **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 (bottom): 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.


TECHNIQUE
Protractors

Protractors are used to measure and draw angles.

How to measure an angle using a protractor:

1. Line up the origin 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 clear scale, on the clear side of the swing arm.

Identify the angle of the flashlight in relation to the box.

1. 2.

Angle: 160° Angle: 90°

3. 4.

Angle: 52° Angle: 136°

2

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

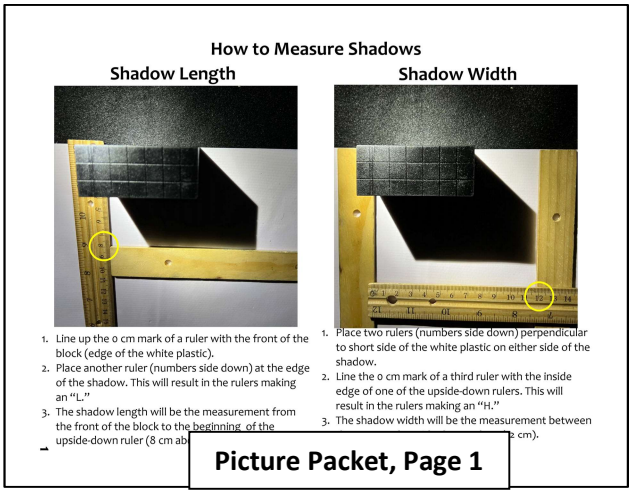
- Have volunteers pass out notebooks.
- Have students fill out the front cover of their notebooks.
  - They will not fill out their subgroup number or class question.
- Go over what a shadow is and what causes them.
- Introduce the class question, "What variables affect shadows?"
  - Write the class 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 (notebook, page 2).
- 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).
- Explain to students how they will measure the length and width of a shadow (picture packet, page 1).


How to Measure Shadows

Shadow Length

Shadow Width

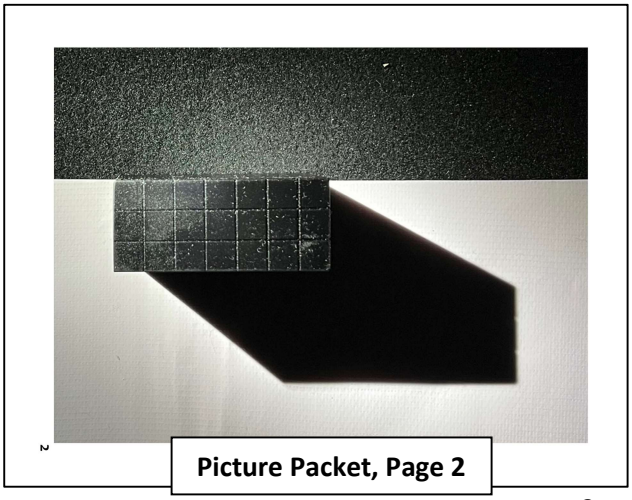
1. Line up the 0 cm mark of a ruler with the front of the block (edge of the white plastic).
2. Place another ruler (numbers side down) at the edge of the shadow. This will result in the rulers making an "L."
3. The shadow length will be the measurement from the front of the block to the beginning of the upside-down ruler (8 cm ab

1. Place two rulers (numbers side down) perpendicular to short side of the white plastic on either side of the shadow.
2. Line the 0 cm mark of a third ruler with the inside edge of one of the upside-down rulers. This will result in the rulers making an "H."
3. The shadow width will be the measurement between

cm).

1

Picture Packet, Page 1

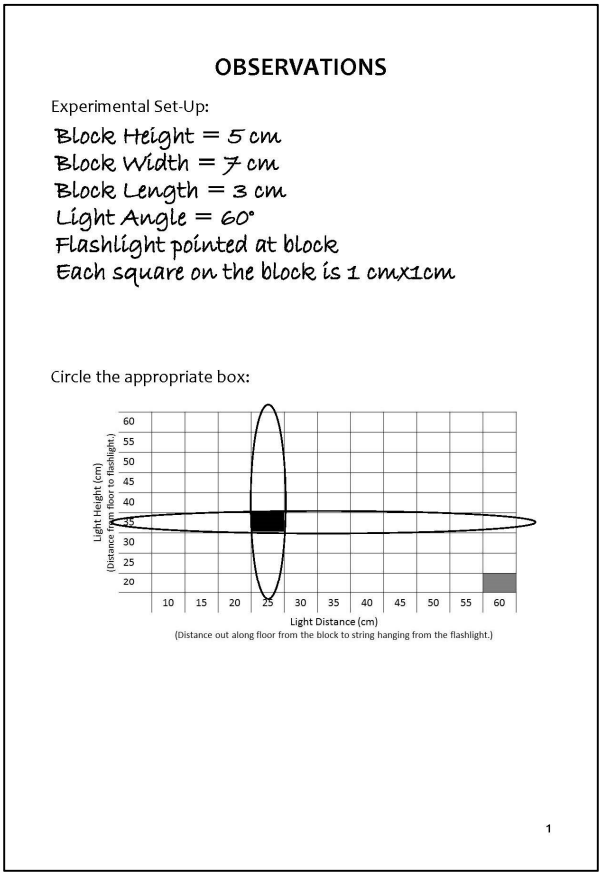

2

Picture Packet, Page 2

- Measure the length and width of the shadow (picture packet, page 2).
- Have students move to their groups.
    - If a student does not have a nametag, identify the group color with the least number of students in it and write the student's name on one of the extra nametags in the lead box using that color of marker.

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

- Walk around and help groups who 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.



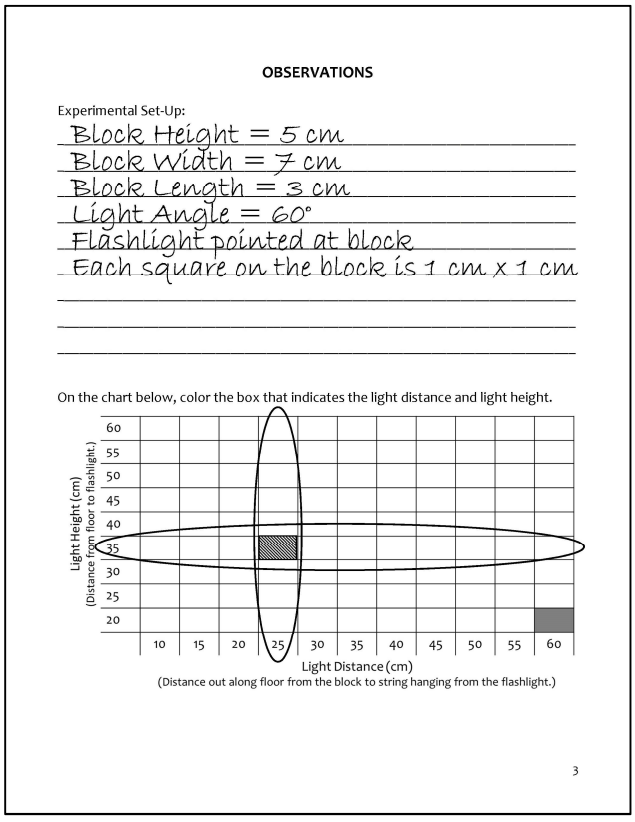
OBSERVATIONS

Experimental Set-Up:

Block Height = 5 cm
Block Width = 7 cm
Block Length = 3 cm
Light Angle = 60°
Flashlight pointed at block
Each square on the block is 1 cmx1cm

Circle the appropriate box:

1



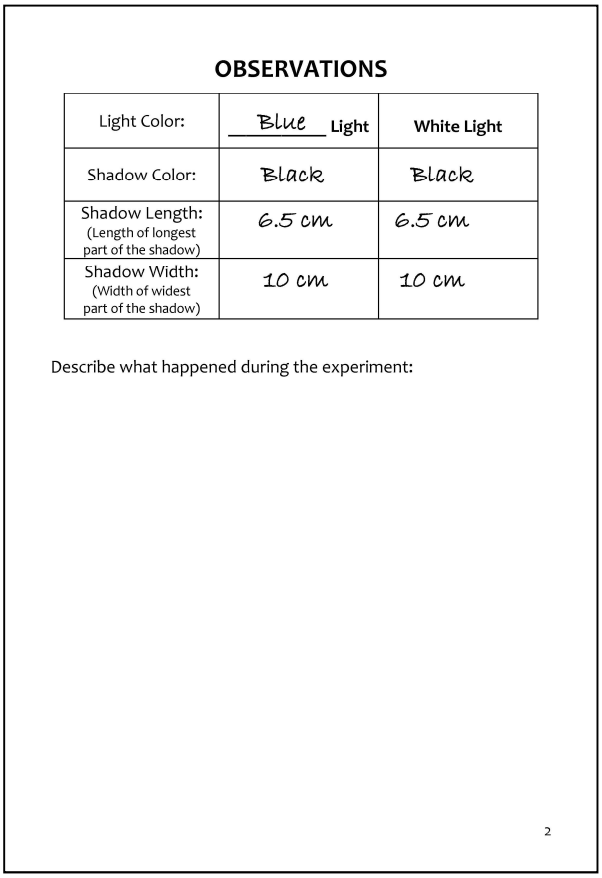
OBSERVATIONS

Experimental Set-Up:

Block Height = 5 cm
Block Width = 7 cm
Block Length = 3 cm
Light Angle = 60°
Flashlight pointed at block
Each square on the block is 1 cm x 1 cm

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

3

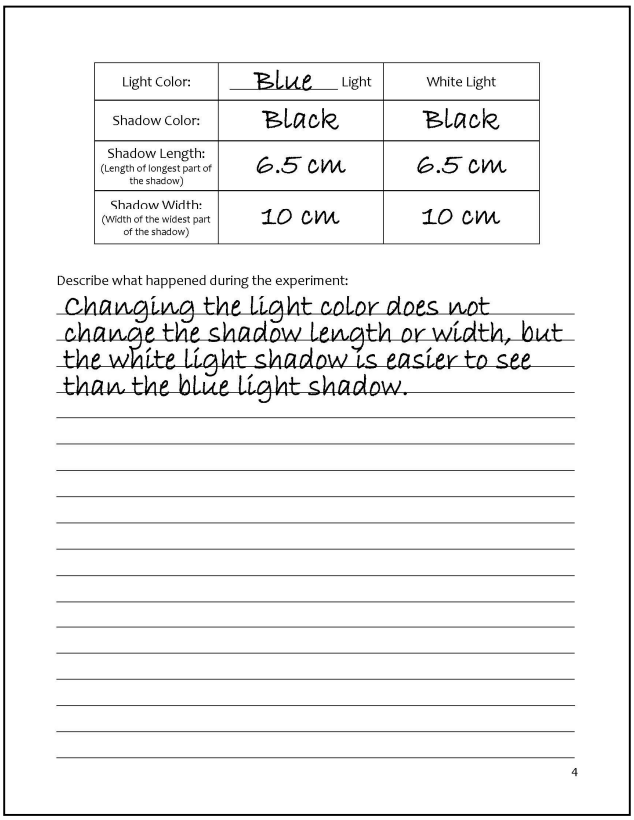


OBSERVATIONS

Light Color:	Blue Light	White Light
Shadow Color:	Black	Black
Shadow Length: (Length of longest part of the shadow)	6.5 cm	6.5 cm
Shadow Width: (Width of widest part of the shadow)	10 cm	10 cm

Describe what happened during the experiment:

2



Light Color:	Blue Light	White Light
Shadow Color:	Black	Black
Shadow Length: (Length of longest part of the shadow)	6.5 cm	6.5 cm
Shadow Width: (Width of the widest part of the shadow)	10 cm	10 cm

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.

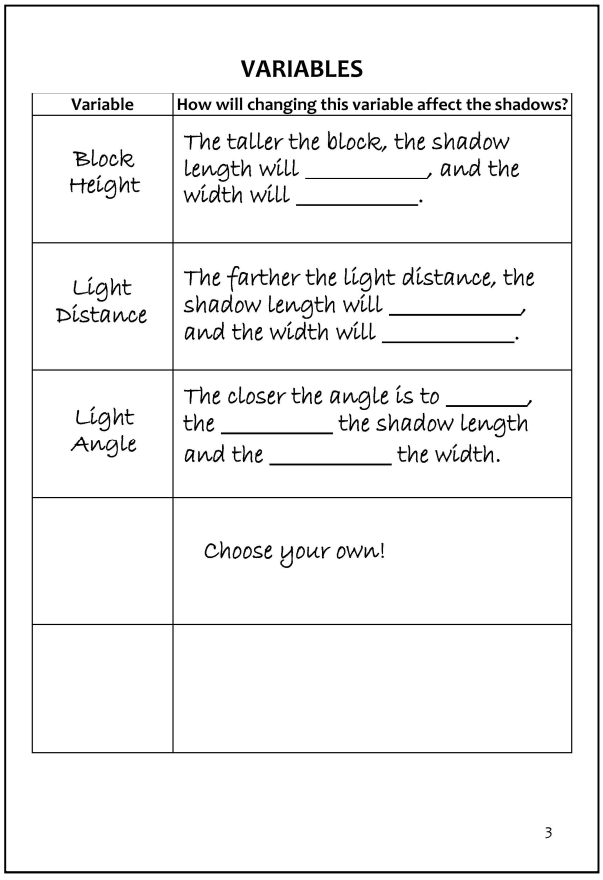
4

Variable Discussion: *(5 minutes – Full Class – SciTrek Lead)*

- Have groups share what they did and learned.
  - Groups should have learned all light colors at the same position will give approximately the same shadow length and width. However, 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 and why they believe this variable might affect the shadow length and width.

Variables: *(12 minutes – Groups – SciTrek Volunteers)*

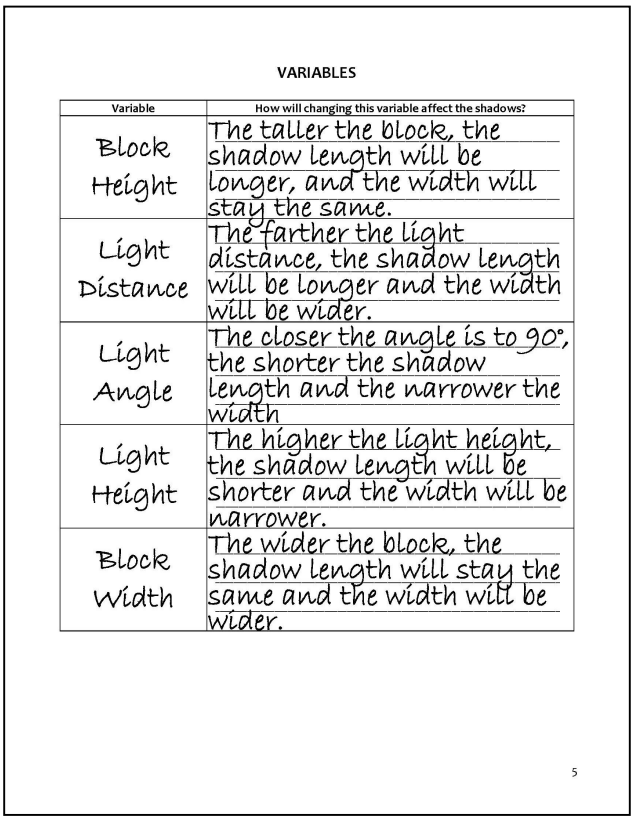
- **If there are less than 5 minutes in the session left, do this as a class instead of in groups.**
- Walk around and help groups who are struggling.
- Make sure volunteers are having their group come up with three possible variables, as well as how and why they believe these variables might affect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



VARIABLES

Variable	How will changing this variable affect the shadows?
Block Height	The taller the block, the shadow length will _____, and the width will _____.
Light Distance	The farther the light distance, the shadow length will _____, and the width will _____.
Light Angle	The closer the angle is to _____, the _____ the shadow length and the _____ the width.
	Choose your own!

3



VARIABLES

Variable	How will changing this variable affect the shadows?
Block Height	The taller the block, the shadow length will be longer, and the width will stay the same.
Light Distance	The farther the light distance, the shadow length will be longer and the width will be wider.
Light Angle	The closer the angle is to 90°, the shorter the shadow length and the narrower the width
Light Height	The higher the light height, the shadow length will be shorter and the width will be narrower.
Block Width	The wider the block, the shadow length will stay the same and the width will be wider.

5

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

- Have each group share one variable with the class, as well as how and why they think this variable will (or will not) affect shadows.
- Go over what students will do next session.

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

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

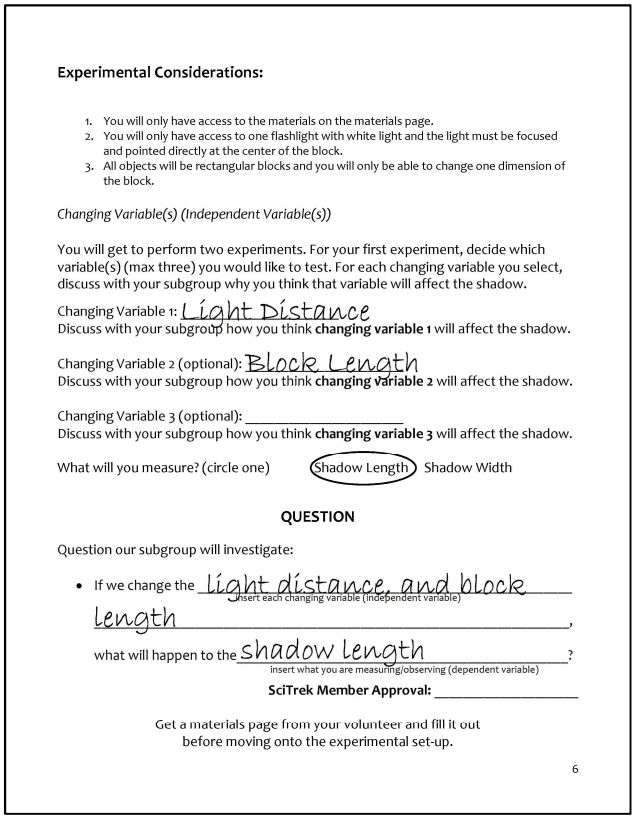
Introduction (SciTrek Lead) – 13 minutes
Question (SciTrek Volunteers) – 10 minutes
Materials Page (SciTrek Volunteers) – 7 minutes
Experimental Set-Up (SciTrek Volunteers) – 8 minutes
Procedure (SciTrek Volunteers) – 19 minutes
Wrap-Up (SciTrek Lead) – 3 minutes

Preparation:

1. Make sure volunteers are setting out notebooks in such a way that allows students within the same subgroup to work together.
2. Set up the document camera for the question (notebook, page 6), materials page (lead box), and experimental set-up (notebook, page 7).
3. Have two example blocks of different heights to show students during the Introduction.

Introduction: *(13 minutes – Full Class – SciTrek Lead)*

- Review the class question, as well as what students did and learned last session.
- Review experimental considerations with the class (notebook, page 6, top):
    - *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 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, 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 <u>light distance and block length</u>, what will happen to the <u>shadow length</u>?
    - 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 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 four 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: 6 cm A).



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 the light must be focused and pointed directly at the center of the block.
3. All objects will be rectangular 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) you would like to test. For each changing variable you select, discuss with your subgroup why you think that variable will affect the shadow.

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

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

Changing Variable 3 (optional): _____
Discuss with your subgroup how you think **changing variable 3** will affect the shadow.

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

QUESTION

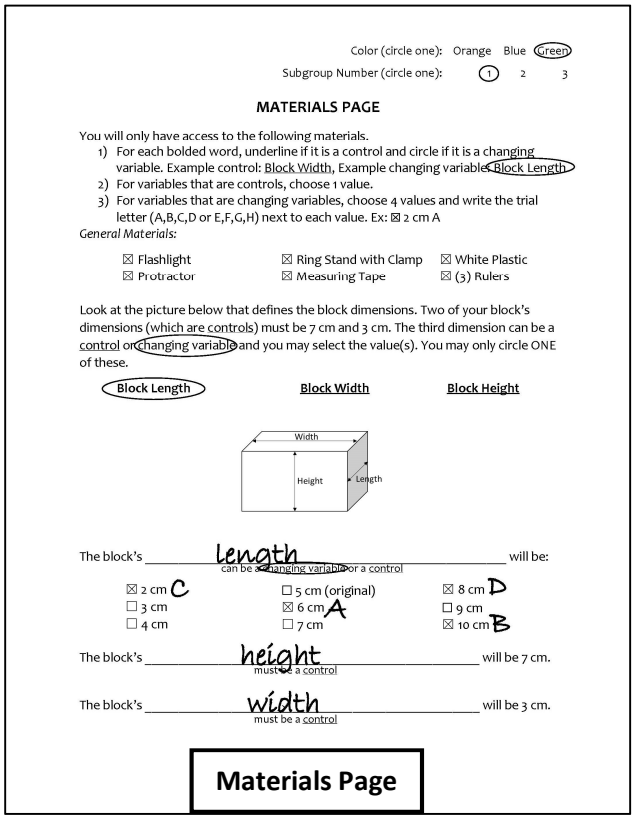
Question our subgroup will investigate:

- If we change the light distance, and block length (insert each changing variable (independent variable)),
what will happen to the shadow length (insert what you are measuring/observing (dependent variable))?

SciTrek Member Approval: _____

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

6



Color (circle one): Orange Blue (Green)
Subgroup Number (circle one): (1) 2 3

MATERIALS PAGE

You will only have access to the following materials.

1) For each bolded word, underline if it is a control and circle if it is a changing variable. Example control: Block Width, Example changing variable: Block Length
2) For variables that are controls, choose 1 value.
3) For variables that are changing variables, choose 4 values and write the trial letter (A,B,C,D or E,F,G,H) next to each value. Ex: ☒ 2 cm A

General Materials:

☒ Flashlight ☒ Ring Stand with Clamp ☒ White Plastic
☒ Protractor ☒ Measuring Tape ☒ (3) Rulers

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

(Block Length) Block Width Block Height

Width, Height, Length

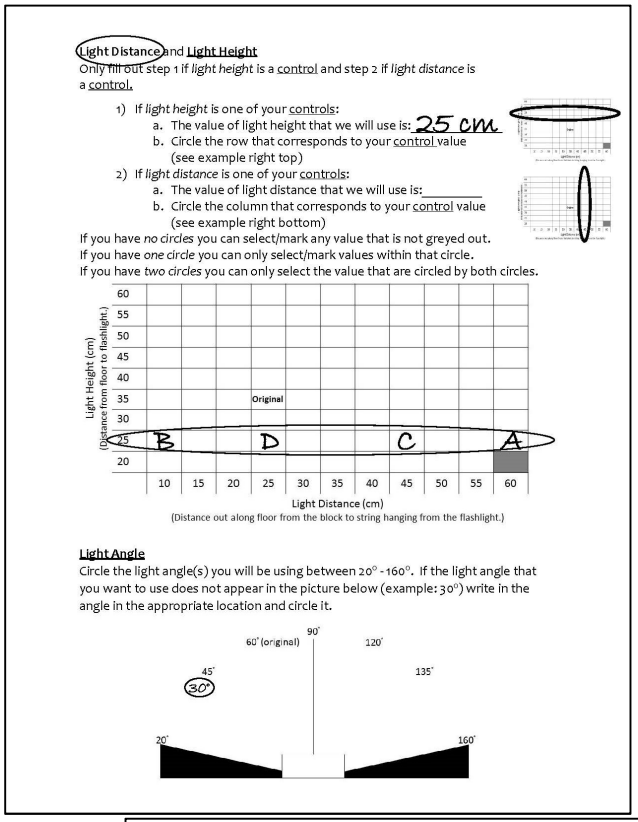
The block's length will be:
can be a changing variable or a control

☒ 2 cm C ☐ 5 cm (original) ☒ 8 cm D
☐ 3 cm ☒ 6 cm A ☐ 9 cm
☐ 4 cm ☐ 7 cm ☒ 10 cm B

The block's height will be 7 cm.
must be a control

The block's width will be 3 cm.
must be a control

Materials Page



(Light Distance) and Light Height
Only fill out step 1 if *light height* is a control and step 2 if *light distance* is a control.

1) If *light height* is one of your controls:
   a. The value of light height that we will use is: 25 cm
   b. Circle the row that corresponds to your control value (see example right top)
2) If *light distance* is one of your controls:
   a. The value of light distance that we will use is: _____
   b. Circle the column that corresponds to your control value (see example right bottom)

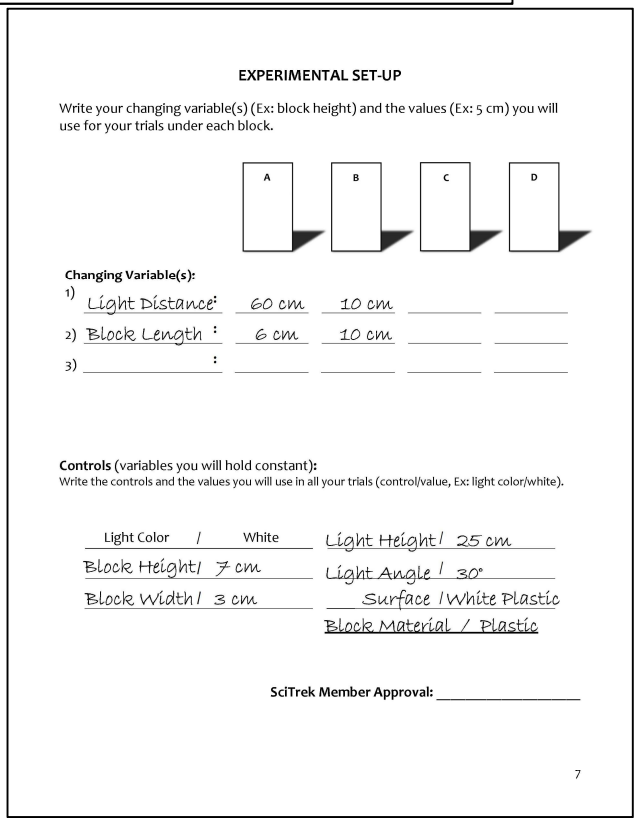
If you have *no circles* you can select/mark any value that is not greyed out.
If you have *one circle* you can only select/mark values within that circle.
If you have *two circles* you can only select the value that are circled by both circles.

Light Height (cm) (Distance from floor to flashlight.)
60 55 50 45 40 35 30 25 20
Original
B D C A
10 15 20 25 30 35 40 45 50 55 60
Light Distance (cm)
(Distance out along floor from the block to string hanging from the flashlight.)

Light Angle
Circle the light angle(s) you will be using between 20° - 160°. If the light angle that you want to use does not appear in the picture below (example: 30°) write in the angle in the appropriate location and circle it.

90° 60° (original) 120° 45° 135° (30°) 20° 160°

- Fill out the experimental set-up for the example experiment (only *Trials A* and *B* for the changing variable; notebook, page 7).
  - Draw an additional line under the controls list for another control and its value.
  - If students choose to change three variables, there will be two additional blanks for controls. Lead students to come up with "surface/white plastic" and "block material/ plastic."
- Read the example procedure step that includes the changing variable (notebook, page 8, top).



EXPERIMENTAL SET-UP

Write your changing variable(s) (Ex: block height) and the values (Ex: 5 cm) you will use for your trials under each block.

A B C D

Changing Variable(s):

1) Light Distance:	60 cm	10 cm		
2) Block Length :	6 cm	10 cm		
3) :				

Controls (variables you will hold constant):
Write the controls and the values you will use in all your trials (control/value, Ex: light color/white).

Light Color / White
Light Height / 25 cm
Block Height / 7 cm
Light Angle / 30°
Block Width / 3 cm
Surface / White Plastic
Block Material / Plastic

SciTrek Member Approval: _____

7

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

- Walk around and help subgroups who 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 subgroups 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), students are specific (they should write, "the shadow length or width" and not just "the shadow").

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

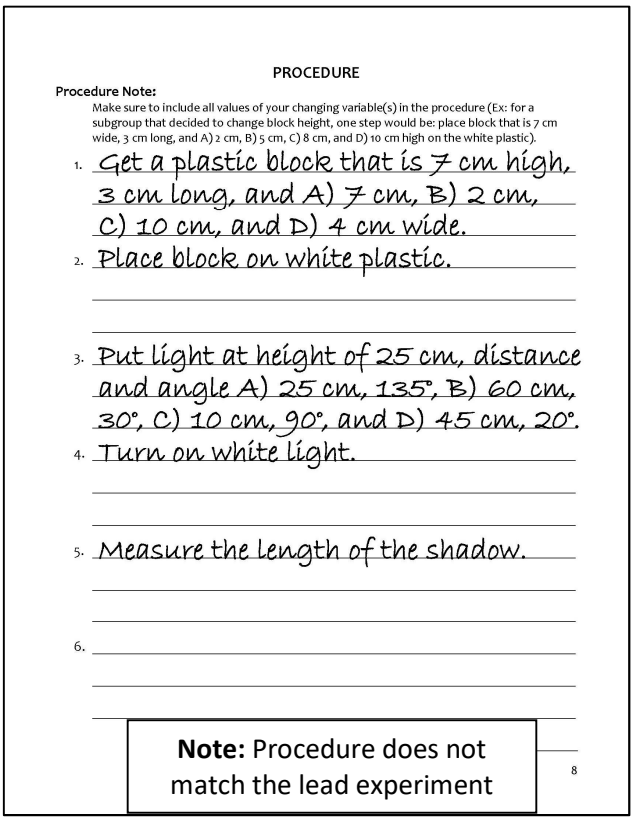
- Walk around and help subgroups who are struggling.
- Make sure subgroups are underlining their controls and circling their changing variable(s).
- Make sure subgroups are filling out the materials page correctly and completely.

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

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


PROCEDURE

Procedure Note:
Make sure to include all values of your changing variable(s) in the procedure (Ex: for a subgroup that decided to change block height, one step would be: place block that is 7 cm wide, 3 cm long, and A) 2 cm, B) 5 cm, C) 8 cm, and D) 10 cm high on the white plastic).

1. Get a plastic block that is 7 cm high, 3 cm long, and A) 7 cm, B) 2 cm, C) 10 cm, and D) 4 cm wide.
2. Place block on white plastic.
3. Put light at height of 25 cm, distance and angle A) 25 cm, 135°, B) 60 cm, 30°, C) 10 cm, 90°, and D) 45 cm, 20°.
4. Turn on white light.
5. Measure the length of the shadow.
6.

8

Note: Procedure does not match the lead experiment

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

- Go over what students will do next session.

Day 3: Results Table/Experiment/Graph/Conclusion Activity

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

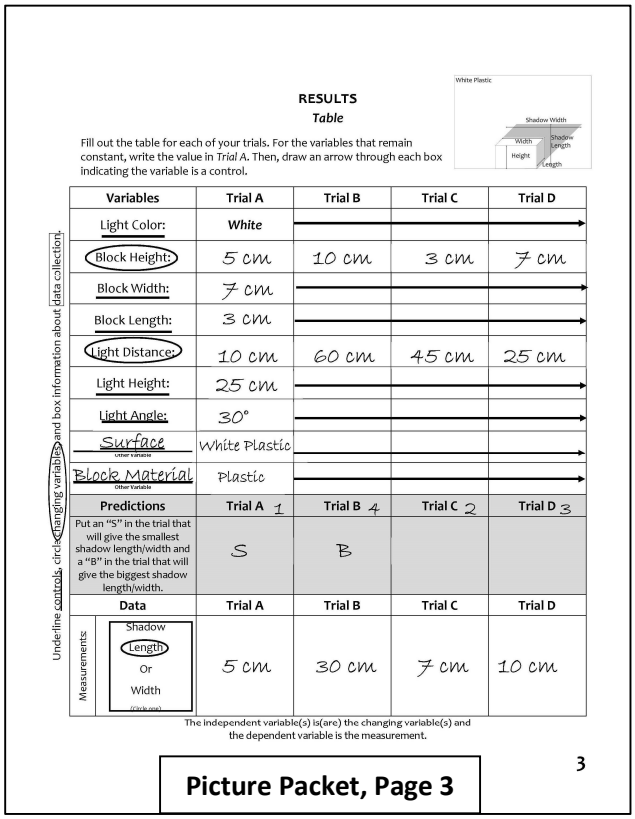
Introduction (SciTrek Lead) – 8 minutes
Results Table (SciTrek Volunteers) – 3 minutes
Experiment (SciTrek Volunteers) – 22 minutes
Graph (SciTrek Volunteers) – 10 minutes
Conclusion Activity (SciTrek Lead) – 15 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

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 for the filled-out results table (picture packet, page 3), graph (notebook, page 10), conclusion activity (notebook, page 11), and block measurement pictures (picture packet, page 1).
4. Have example block available to show students during the Introduction.

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

- Review the class question, as well as what students did and learned last session.
- Show students how to fill out the results table (picture packet, page 3).
- Use the checklist (notebook, page 10, top) to go over how to graph results.
  - Use the filled-out results table (picture packet, page 3) to fill out the graph (notebook, page 10).
  - Stress the importance of step 4 to ensure students' graphs are in increasing order.
  - Only graph the results for the 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 (picture packet, page 1).



RESULTS

Table

Fill out the table for each of your trials. For the variables that remain constant, write the value in *Trial A*. Then, draw an arrow through each box indicating the variable is a control.

Variables	Trial A	Trial B	Trial C	Trial D
Light Color:	White	→	→	→
Block Height:	5 cm	10 cm	3 cm	7 cm
Block Width:	7 cm	→	→	→
Block Length:	3 cm	→	→	→
Light Distance:	10 cm	60 cm	45 cm	25 cm
Light Height:	25 cm	→	→	→
Light Angle:	30°	→	→	→
Surface (Other Variable)	White Plastic	→	→	→
Block Material (Other Variable)	Plastic	→	→	→
Predictions	**Trial A** 1	**Trial B** 4	**Trial C** 2	**Trial D** 3
Put an "S" in the trial that will give the smallest shadow length/width and a "B" in the trial that will give the biggest shadow length/width.	S	B		
Data	**Trial A**	**Trial B**	**Trial C**	**Trial D**
Measurements: Shadow (Length) Or Width (circle one)	5 cm	30 cm	7 cm	10 cm

Underline controls, circle changing variable(s), and box information about data collection.

The independent variable(s) is(are) the changing variable(s) and the dependent variable is the measurement.

3

Picture Packet, Page 3

RESULTS

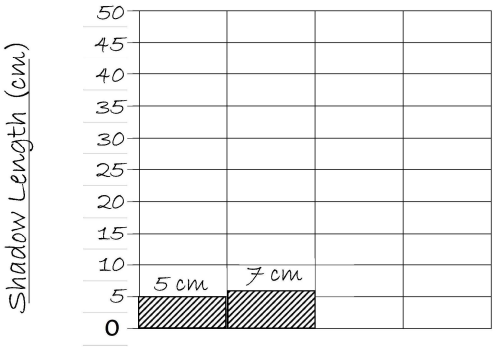
Graph

Set up your graph. (Check off the steps as you complete them.)

- ☒ Label the y-axis (vertical) with what you measured, including units (Ex: Shadow Length (cm)).
- ☒ Determine an appropriate scale which will allow you to graph all of your data points and write the numbers on the given lines.
- ☒ Label the x-axis (horizontal) with your changing variable(s) #1, #2, and #3 (Ex: Block Height). Changing variable #2 and #3 will only be filled in if you have 2 or 3 changing variables.
- ☒ On your results table, label your measurements from 1 to 4, with 1 being the trial with the smallest measurement, and 4 being the trial with the largest measurement.

Plot your data in increasing order.

- ☒ Write the changing variable value(s) (Ex: 3 cm) for the trial that you labeled 1 under the first column.
- ☒ Graph your data for that trial and write the measurement above the bar.
- ☒ Repeat the process for the other trials.



Block Height: (Changing Variable #1)	5 cm	3 cm		
Light Distance: (Changing Variable #2)	10 cm	45 cm		
: (Changing Variable #3)				

10

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

- Walk around and help subgroups who are struggling.
- Make sure students are underlining controls, circling the changing variable(s), and boxing data collection boxes.
- Make sure control values are written in the *Trial A* box with an arrow through the rest of the trials' boxes, while changing variable(s) values are written in each trial's box.
- Make sure students are making predictions for which trial they think will produce the smallest (S) and biggest (B), shadows.

Experiment: *(22 minutes – Subgroups – SciTrek Volunteers)*

- Walk around and help subgroups who 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.

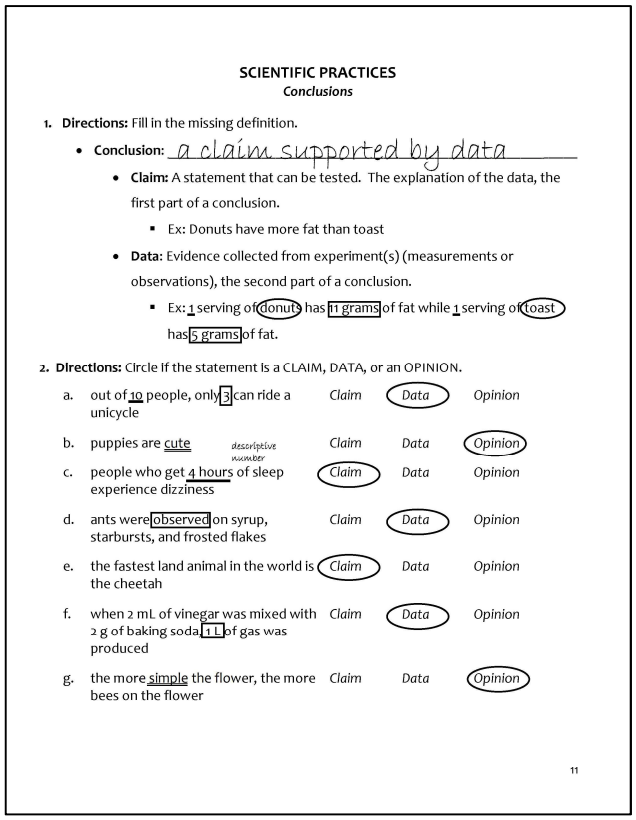
- Do not have students clean up their set-up until after they have made their graph. This allows them to check measurements, if necessary.

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

- Walk around and help subgroups who 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 session, even if students are not done with their graphs**.
- Review the definition of a conclusion (claim supported by data; notebook, page 11).
- 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, 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.



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.
            - Ex: Donuts have more fat than toast
        - **Data:** Evidence collected from experiment(s) (measurements or observations), the second part of a conclusion.
            - Ex: 1 serving of donuts has 11 grams of fat while 1 serving of toast has 5 grams of fat.

2. **Directions:** Circle if the statement is a CLAIM, DATA, or an OPINION.

a.	out of 10 people, only 3 can ride a unicycle	*Claim*	*Data*	*Opinion*
b.	puppies are cute (descriptive number)	*Claim*	*Data*	*Opinion*
c.	people who get 4 hours of sleep experience dizziness	*Claim*	*Data*	*Opinion*
d.	ants were observed on syrup, starbursts, and frosted flakes	*Claim*	*Data*	*Opinion*
e.	the fastest land animal in the world is the cheetah	*Claim*	*Data*	*Opinion*
f.	when 2 mL of vinegar was mixed with 2 g of baking soda, 1 L of gas was produced	*Claim*	*Data*	*Opinion*
g.	the more simple the flower, the more bees on the flower	*Claim*	*Data*	*Opinion*

11

        - *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
        - *b. puppies are cute*
            - Opinion
        - *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.

- *d. ants were observed on syrup, starbursts, and frosted flakes*
  - Data
    - Possible Claim: ants are attracted to sugar
- *e. the fastest land animal in the world is the cheetah*
  - Claim
    - Possible Data: time the animals running a specific distance
- *f. when 2 mL of vinegar was mixed with 2 g of baking soda, 1 L of gas was produced*
  - Data
    - Possible Claim: vinegar and baking soda undergo a chemical reaction when mixed
- *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)*

- Go over what students 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

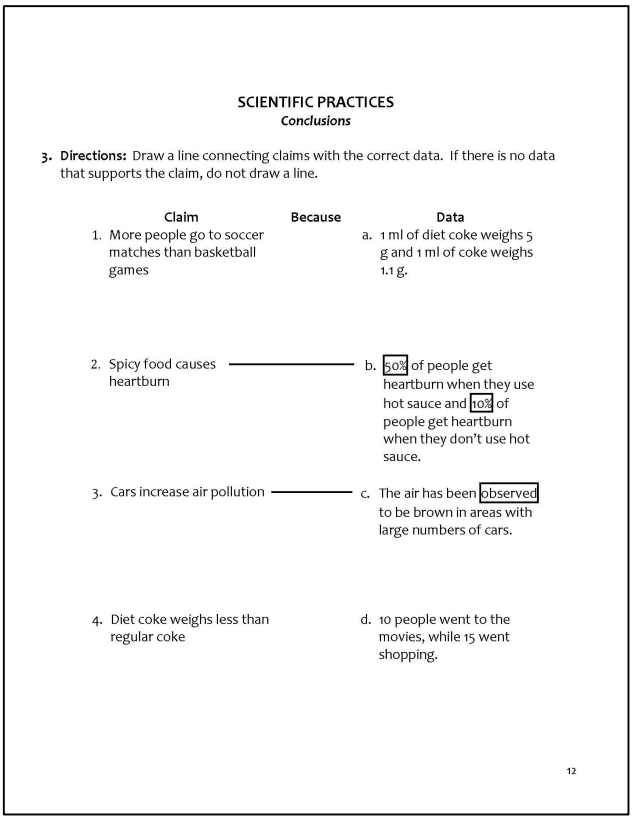
Preparation:

1. Make sure volunteers are passing out notebooks.
2. Set up the document camera for the conclusion activity (notebook, pages 12-15).

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

- Review the class question, and what students did, and learned, last session.

Conclusion Activity: *(30 minutes – Full Class – SciTrek Lead)*



SCIENTIFIC PRACTICES
Conclusions

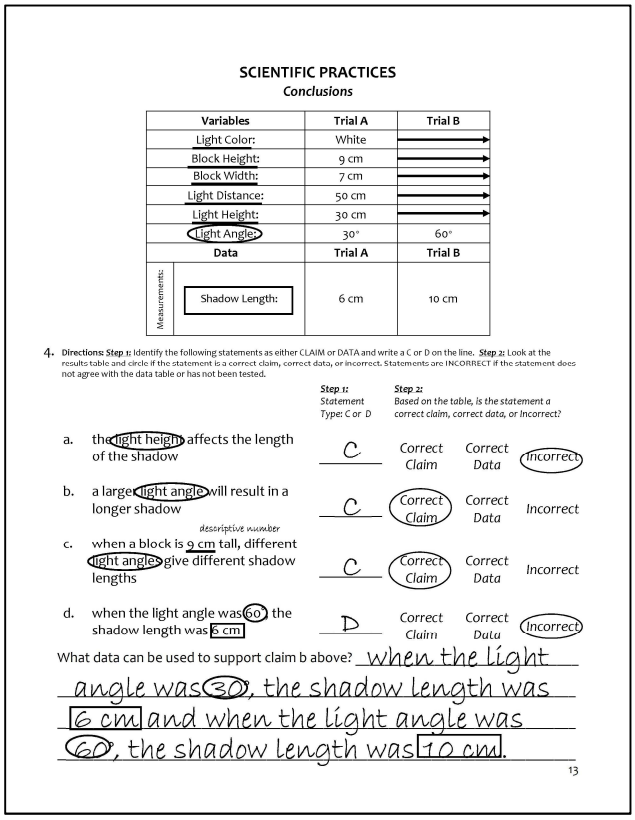
3. **Directions:** Draw a line connecting claims with the correct data. If there is no data that supports the claim, do not draw a line.

Claim	Because	Data
1. More people go to soccer matches than basketball games		a. 1 ml of diet coke weighs 5 g and 1 ml of coke weighs 1.1 g.
2. Spicy food causes heartburn	——	b. 50% of people get heartburn when they use hot sauce and 10% of people get heartburn when they don't use hot sauce.
3. Cars increase air pollution	——	c. The air has been observed to be brown in areas with large numbers of cars.
4. Diet coke weighs less than regular coke		d. 10 people went to the movies, while 15 went shopping.

12

- Read the directions (notebook, page 12).
- 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 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 (notebook, page 13).
- Read each statement.
    - As a class, discuss whether 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 determine whether 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?
- *a. the light height affects the length of the shadow*
    - Claim/Incorrect (Variable Held Constant)
- *b. a larger light angle will result in a longer shadow*
    - Claim/Correct Claim
- *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.
- *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



SCIENTIFIC PRACTICES
Conclusions

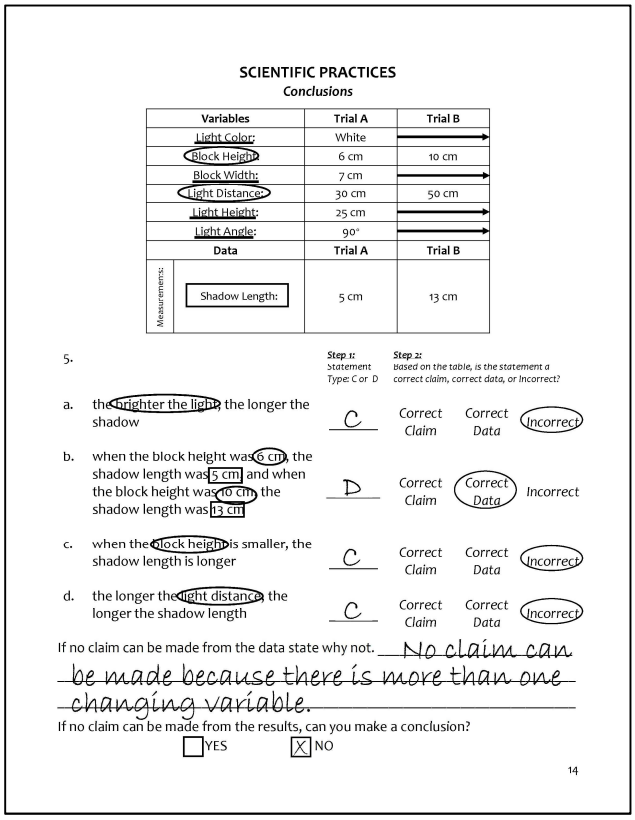
Variables	Trial A	Trial B
Light Color:	White	→
Block Height:	9 cm	→
Block Width:	7 cm	→
Light Distance:	50 cm	→
Light Height:	30 cm	→
Light Angle:	30°	60°
Data	**Trial A**	**Trial B**
Measurements: Shadow Length:	6 cm	10 cm

4. **Directions: Step 1:** Identify the following statements as either CLAIM or DATA and write a C or D on the line. **Step 2:** Look at the results table and circle if the statement is a correct claim, correct data, or incorrect. Statements are INCORRECT if the statement does not agree with the data table or has not been tested.

		Step 1: Statement Type: C or D	Step 2: Based on the table, is the statement a correct claim, correct data, or Incorrect?		
a.	the light height affects the length of the shadow	C	Correct Claim	Correct Data	Incorrect
b.	a larger light angle will result in a longer shadow	C	Correct Claim	Correct Data	Incorrect
c.	when a block is 9 cm (descriptive number) tall, different light angles give different shadow lengths	C	Correct Claim	Correct Data	Incorrect
d.	when the light angle was 60 the shadow length was 6 cm	D	Correct Claim	Correct Data	Incorrect

What data can be used to support claim b above? 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.

13



SCIENTIFIC PRACTICES
Conclusions

Variables	Trial A	Trial B
Light Color:	White	→
Block Height:	6 cm	10 cm
Block Width:	7 cm	→
Light Distance:	30 cm	50 cm
Light Height:	25 cm	→
Light Angle:	90°	→
Data	**Trial A**	**Trial B**
Measurements: Shadow Length:	5 cm	13 cm

5.

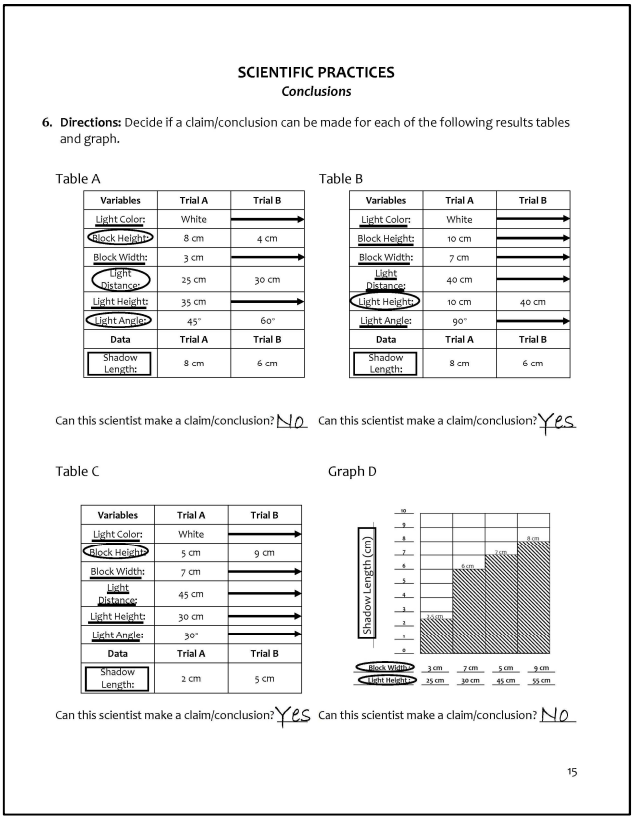
		Step 1: Statement Type: C or D	Step 2: Based on the table, is the statement a correct claim, correct data, or Incorrect?		
a.	the brighter the light, the longer the shadow	C	Correct Claim	Correct Data	Incorrect
b.	when the block height was 6 cm, the shadow length was 5 cm, and when the block height was 10 cm, the shadow length was 13 cm	D	Correct Claim	Correct Data	Incorrect
c.	when the block height is smaller, the shadow length is longer	C	Correct Claim	Correct Data	Incorrect
d.	the longer the light distance, the longer the shadow length	C	Correct Claim	Correct Data	Incorrect

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

If no claim can be made from the results, can you make a conclusion?
☐ YES ☒ NO

14

- Have students repeat the process for page 14.
- *a. the brighter the light, the longer the shadow*
  - Claim /Incorrect (No Data Gathered)
- *b. when the block height was 6 cm, the shadow length was 5 cm, and when the block height was 10 cm, the shadow length was 13 cm*
  - Data/Correct Data
- *c. when the block height is smaller, the shadow length is longer*
  - Claim/Incorrect (Inconsistent with Data)
- *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.
- Have students identify and underline the controls, circle the changing variable(s), and box information about data collection, and then determine whether the scientists can make a conclusion (notebook, page 15).
- Tell students, "You will now determine whether a conclusion can be made from your first experiment, then design another experiment."



SCIENTIFIC PRACTICES
Conclusions

6. **Directions:** Decide if a claim/conclusion can be made for each of the following results tables and graph.

Table A

Variables	Trial A	Trial B
Light Color:	White	→
Block Height:	8 cm	4 cm
Block Width:	3 cm	→
Light Distance:	25 cm	30 cm
Light Height:	35 cm	→
Light Angle:	45°	60°
Data	**Trial A**	**Trial B**
Shadow Length:	8 cm	6 cm

Can this scientist make a claim/conclusion? No

Table B

Variables	Trial A	Trial B
Light Color:	White	→
Block Height:	10 cm	→
Block Width:	7 cm	→
Light Distance:	40 cm	→
Light Height:	10 cm	40 cm
Light Angle:	90°	→
Data	**Trial A**	**Trial B**
Shadow Length:	8 cm	6 cm

Can this scientist make a claim/conclusion? Yes

Table C

Variables	Trial A	Trial B
Light Color:	White	→
Block Height:	5 cm	9 cm
Block Width:	7 cm	→
Light Distance:	45 cm	→
Light Height:	30 cm	→
Light Angle:	30°	→
Data	**Trial A**	**Trial B**
Shadow Length:	2 cm	5 cm

Can this scientist make a claim/conclusion? Yes

Graph D

Can this scientist make a claim/conclusion? No

15

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

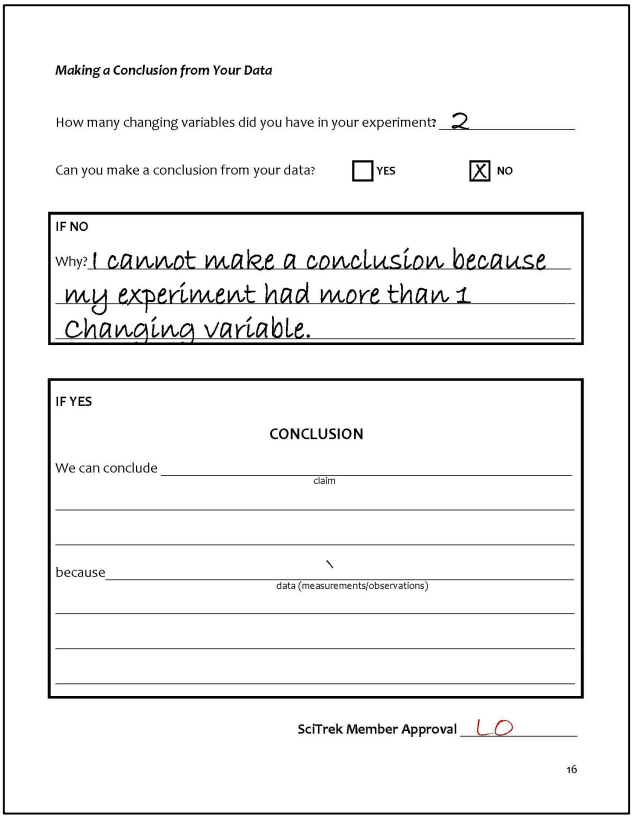
- If subgroups have not finished the graph **do not** make them go back and finish it. Most likely these subgroups will not be able to make a conclusion; therefore, they will not use the data from their first experiment.
- Walk around and help subgroups who are struggling.
- Subgroups who can make a conclusion will need more help than those who cannot.
    - If a subgroup can make a conclusion, make sure they are making a claim and using specific data to support that claim.

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

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



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 _____ (claim)

because _____ (data (measurements/observations))

SciTrek Member Approval LO

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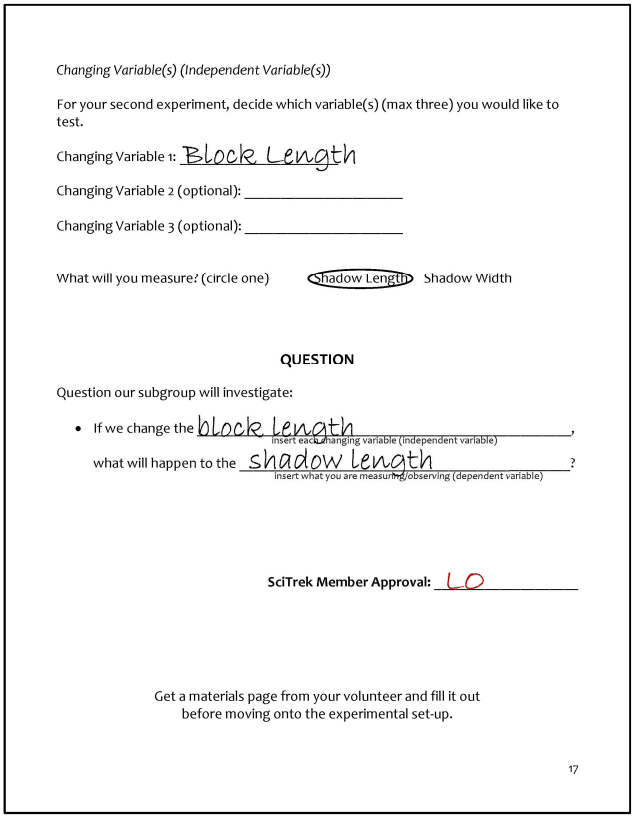

Changing Variable(s) (Independent Variable(s))

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

Changing Variable 1: Block Length

Changing Variable 2 (optional): _____

Changing Variable 3 (optional): _____

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

QUESTION

Question our subgroup will investigate:

- If we change the block length (insert each changing variable (independent variable)),
  what will happen to the shadow length (insert what you are measuring/observing (dependent variable))?

SciTrek Member Approval: LO

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

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Color (circle one): Orange Blue (Green)
Subgroup Number (circle one): (1) 2 3

MATERIALS PAGE

You will only have access to the following materials.

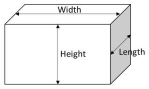
1) For each bolded word, underline if it is a control and circle if it is a changing variable. Example control: Block Width, Example changing variable: Block Length
2) For variables that are controls, choose 1 value.
3) For variables that are changing variables, choose 4 values and write the trial letter (A,B,C,D or E,F,G,H) next to each value. Ex: ☒ 2 cm A

General Materials:

☒ Flashlight ☒ Ring Stand with Clamp ☒ White Plastic
☒ Protractor ☒ Measuring Tape ☒ (3) Rulers

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

(Block Length) **Block Width** **Block Height**



The block's length will be:
can be a changing variable or a control

☐ 2 cm ☐ 5 cm (original) ☒ 8 cm G
☒ 3 cm E ☒ 6 cm H ☐ 9 cm
☐ 4 cm ☐ 7 cm ☒ 10 cm F

The block's height will be 7 cm.
must be a control

The block's width will be 3 cm.
must be a control

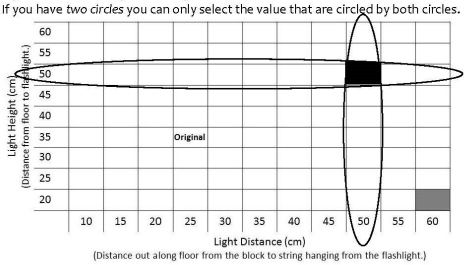
Materials Page

Light Distance and **Light Height**

Only fill out step 1 if *light height* is a control and step 2 if *light distance* is a control.

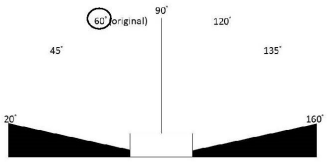
1) If *light height* is one of your controls:
   a. The value of light height that we will use is: 50 cm
   b. Circle the row that corresponds to your control value (see example right top)
2) If *light distance* is one of your controls:
   a. The value of light distance that we will use is: 50 cm
   b. Circle the column that corresponds to your control value (see example right bottom)

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 are circled by both circles.



Light Angle

Circle the light angle(s) you will be using between 20° - 160°. If the light angle that you want to use does not appear in the picture below (example: 30°) write in the angle in the appropriate location and circle it.

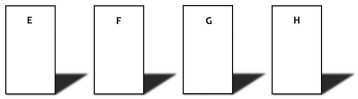


Experimental Set-Up: *(5 minutes – Subgroups – SciTrek Volunteers)*

- Walk around and help subgroups who 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.

EXPERIMENTAL SET-UP

Write your changing variable(s) (Ex: block height) and the values (Ex: 5 cm) you will use for your trials under each block.



Changing Variable(s):

1)	Block Length :	3 cm	10 cm	8 cm	6 cm
2)	:				
3)	:				

Controls (variables you will hold constant):
Write the controls and the values you will use in all your trials (control/value, Ex: light color/white).

Light Color / White Light Distance / 50 cm
Block Height / 7 cm Light Height / 50 cm
Block Width / 3 cm Light Angle / 60°

SciTrek Member Approval: LO

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PROCEDURE

Procedure Note:
Make sure to include all values of your changing variable(s) in the procedure (Ex: For a subgroup that decided to change block height, one step would be: Place block that is 7 cm wide, 3 cm long, and E) 2 cm, F) 5 cm, G) 8 cm, and H) 10 cm high on the white plastic.).

1. Get a plastic block that is 7 cm high, 3 cm wide, and E) 3 cm, F) 10 cm, G) 8 cm, and H) 6 cm long.
2. Place block on white plastic.
3. Set up light with distance of 50 cm, height 50 cm, and angle 60°.
4. Turn on white light.
5. Measure the length of the shadow.
6.

SciTrek Member Approval: LO

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Procedure: *(6 minutes – Subgroups – SciTrek Volunteers)*

- Walk around and help subgroups who are struggling.
- Make sure procedures are concise, but still include all values of the controls and changing variable, as well as the data that 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)*

- Go over what students 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 passing out notebooks.
2. Make sure volunteers are setting up for the experiment.
3. Set up the document camera for the conclusion example (notebook, page 20) and the block measurement pictures (picture packet, page 1).
4. Have example block available to show students during the Introduction.

Introduction: *(10 minutes – Full Class – SciTrek Lead)*

- Review the class question, as well as what students did and learned last session.
- Review the definition of a conclusion (a claim supported by data).
- On the data table (notebook, page 20), 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 for a given block dimension, the shadow length will be the same, regardless of the block material, because the metal and the foam blocks both had a shadow length of 12 cm.

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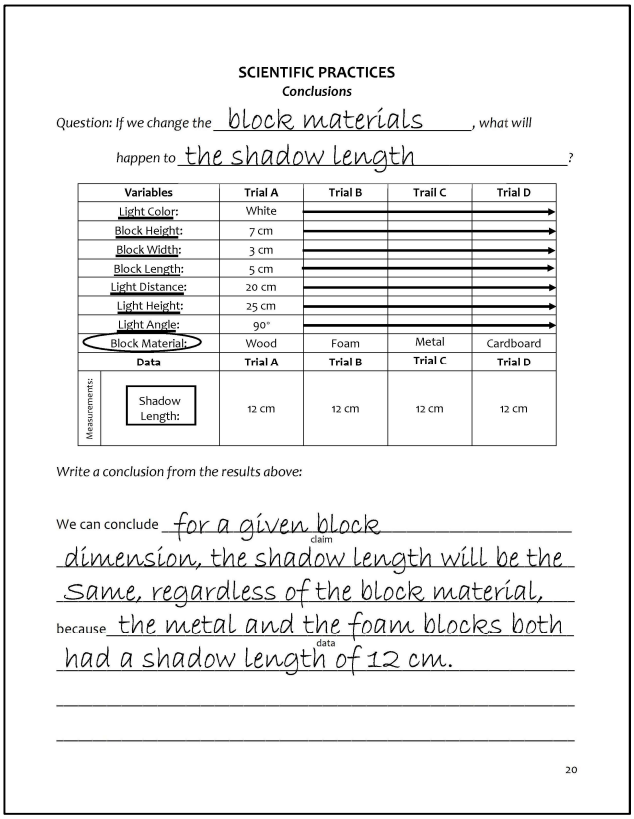


SCIENTIFIC PRACTICES
Conclusions

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

Variables	Trial A	Trial B	Trail C	Trial D
Light Color:	White	→	→	→
Block Height:	7 cm	→	→	→
Block Width:	3 cm	→	→	→
Block Length:	5 cm	→	→	→
Light Distance:	20 cm	→	→	→
Light Height:	25 cm	→	→	→
Light Angle:	90°	→	→	→
Block Material:	Wood	Foam	Metal	Cardboard
Data	**Trial A**	**Trial B**	**Trial C**	**Trial D**
Measurements: Shadow Length:	12 cm	12 cm	12 cm	12 cm

Write a conclusion from the results above:

We can conclude (claim) for a given block dimension, the shadow length will be the same, regardless of the block material, because (data) the metal and the foam blocks both had a shadow length of 12 cm.

20

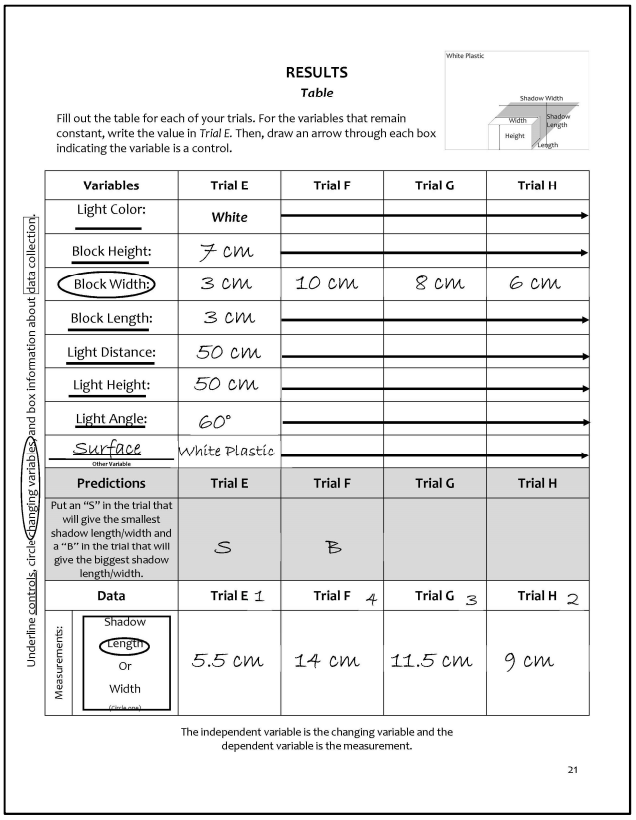
- Using an example block, review how the block dimensions are defined.
- Have students raise their hand to identify whether they are measuring shadow length or width.
- Review how to measure shadow lengths and widths (picture packet, page 1).

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

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

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

- Walk around and help subgroups who are struggling.
- Make sure students are underlining controls, circling the changing variable, and boxing data collection boxes.
- Make sure control values are written in the *Trial E* box with an arrow through the rest of the trials' boxes, while changing variable values are written in each trial's box.
- Make sure students are making predictions for which trial they think will produce the smallest (S) and biggest (B), shadows.



RESULTS

Table

Fill out the table for each of your trials. For the variables that remain constant, write the value in *Trial E*. Then, draw an arrow through each box indicating the variable is a control.

Underline controls, circle changing variable, and box information about data collection.

Variables	Trial E	Trial F	Trial G	Trial H
Light Color:	White	→	→	→
Block Height:	7 cm	→	→	→
Block Width:	3 cm	10 cm	8 cm	6 cm
Block Length:	3 cm	→	→	→
Light Distance:	50 cm	→	→	→
Light Height:	50 cm	→	→	→
Light Angle:	60°	→	→	→
Surface (Other Variable)	White Plastic	→	→	→
Predictions	**Trial E**	**Trial F**	**Trial G**	**Trial H**
Put an "S" in the trial that will give the smallest shadow length/width and a "B" in the trial that will give the biggest shadow length/width.	S	B		
Data	**Trial E** 1	**Trial F** 4	**Trial G** 3	**Trial H** 2
Measurements: Shadow (Length) Or Width (Circle one)	5.5 cm	14 cm	11.5 cm	9 cm

The independent variable is the changing variable and the dependent variable is the measurement.

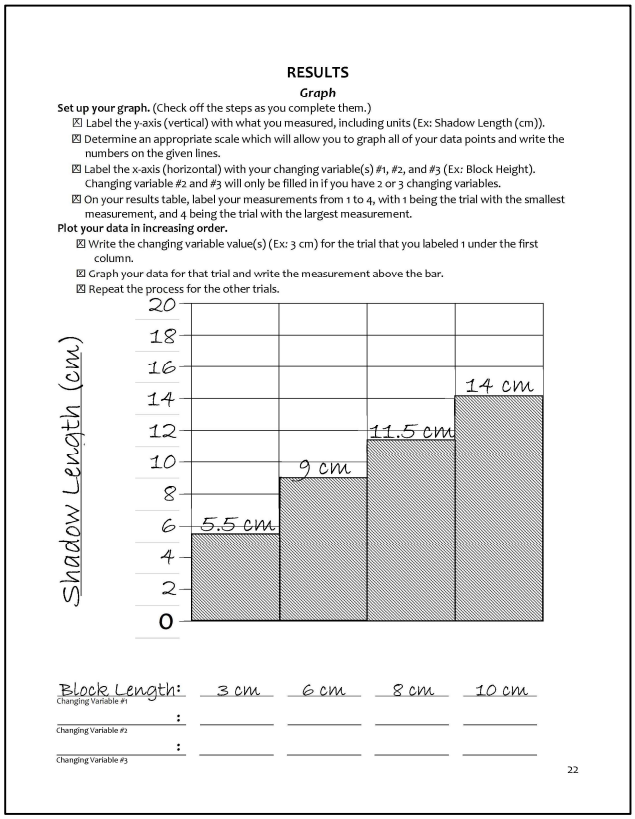
21

Experiment: *(25 minutes – Subgroups – SciTrek Volunteers)*

- Walk around and help subgroups who 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 who 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 E), on the x-axis.
- Make sure students are writing the numerical value of the shadow lengths/widths on top of each column.



RESULTS

Graph

Set up your graph. (Check off the steps as you complete them.)

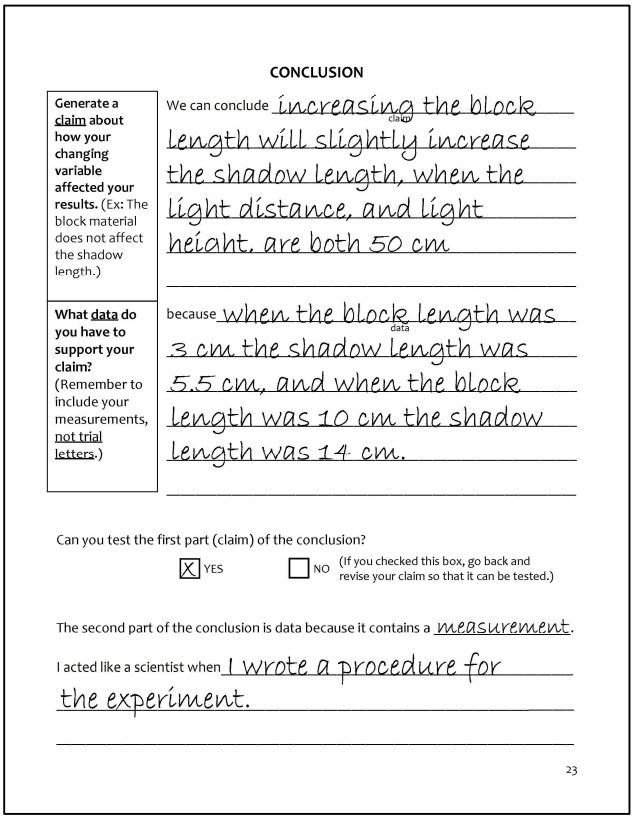
- ☒ Label the y-axis (vertical) with what you measured, including units (Ex: Shadow Length (cm)).
- ☒ Determine an appropriate scale which will allow you to graph all of your data points and write the numbers on the given lines.
- ☒ Label the x-axis (horizontal) with your changing variable(s) #1, #2, and #3 (Ex: Block Height). Changing variable #2 and #3 will only be filled in if you have 2 or 3 changing variables.
- ☒ On your results table, label your measurements from 1 to 4, with 1 being the trial with the smallest measurement, and 4 being the trial with the largest measurement.

Plot your data in increasing order.

- ☒ Write the changing variable value(s) (Ex: 3 cm) for the trial that you labeled 1 under the first column.
- ☒ Graph your data for that trial and write the measurement above the bar.
- ☒ Repeat the process for the other trials.

Block Length:	3 cm	6 cm	8 cm	10 cm
Changing Variable #1 :				
Changing Variable #2 :				
Changing Variable #3				

22



CONCLUSION

Generate a claim about how your changing variable affected your results. (Ex: The block material does not affect the shadow length.)

We can conclude increasing the block length will slightly increase the shadow length, when the light distance, and light height, are both 50 cm (claim)

What data do you have to support your claim? (Remember to include your measurements, not trial letters.)

because when the block length was 3 cm the shadow length was 5.5 cm, and when the block length was 10 cm the shadow length was 14 cm. (data)

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.

23

Conclusion: *(8 minutes – Subgroups – SciTrek Volunteers)*

- Walk around and help subgroups who 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.
    - Subgroups will be using measurements as their data, make sure they are including numerical values in their data statement.
    - Do not let subgroups reference trial letters in their conclusions.
- Volunteers struggle with conclusions, so you should 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)*

- Go over what students 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:

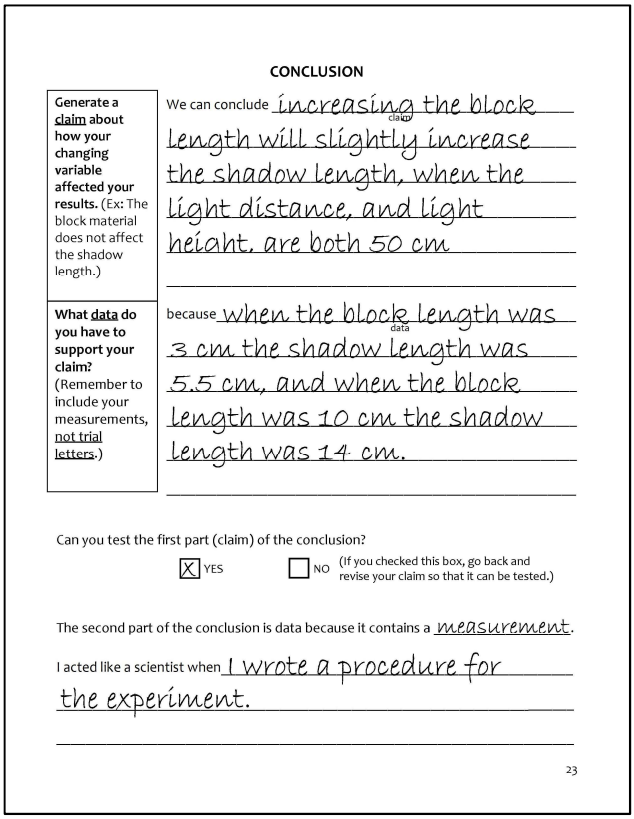
1. Make sure volunteers are setting out notebooks.
2. Find a place to leave student posters.

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

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

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

- Walk around and help subgroups who 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.
    - Subgroups will be using measurements as their data, make sure they are including numerical values in their data statement.
    - Do not let subgroups reference trial letters in their conclusions.
- Volunteers struggle with conclusions, so you should check at least one conclusion from each group.
- Make sure students fill out the sentence frame (notebook, page 23, bottom) *I acted like a scientist when*.



CONCLUSION

Generate a claim about how your changing variable affected your results. (Ex: The block material does not affect the shadow length.)

We can conclude increasing the block length will slightly increase the shadow length, when the light distance, and light height, are both 50 cm (claim)

What data do you have to support your claim? (Remember to include your measurements, not trial letters.)

because when the block length was 3 cm the shadow length was 5.5 cm, and when the block length was 10 cm the shadow length was 14 cm. (data)

Can you test the first part (claim) of the conclusion?

[X] 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.

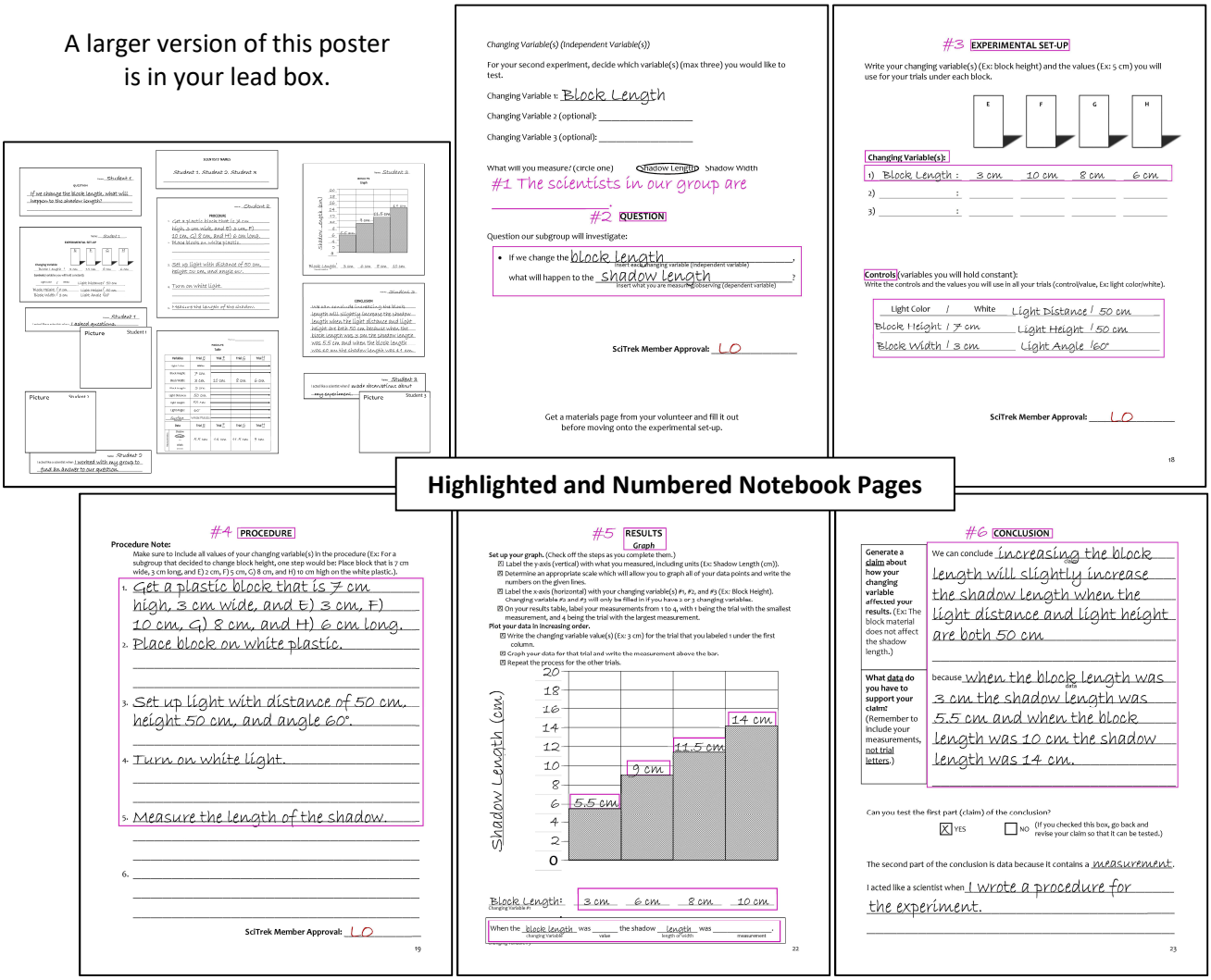
I acted like a scientist when I wrote a procedure for the experiment.

23

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 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 a volunteer has gone over how to present the four sentences with the student several times.
- Each student should have the part(s) 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 below).
    - Remind volunteers if a student is presenting multiple parts, they should have multiple sections highlighted and numbered in their notebook and the sections should be paperclipped together.
- Volunteers often forget to highlight notebooks, so make sure this gets done before Day 7.

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



Highlighted and Numbered Notebook Pages

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 passing out notebooks.
2. Set up the document camera for the *Notes on Presentations* (picture packet, pages 4 and 5).

3. Organize posters so experiments featuring the same changing variable will be presented back-to-back and posters are presented from simplest to understand, to most difficult to understand (suggested order: block height, block width, block length, light height, light distance, light angle).

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

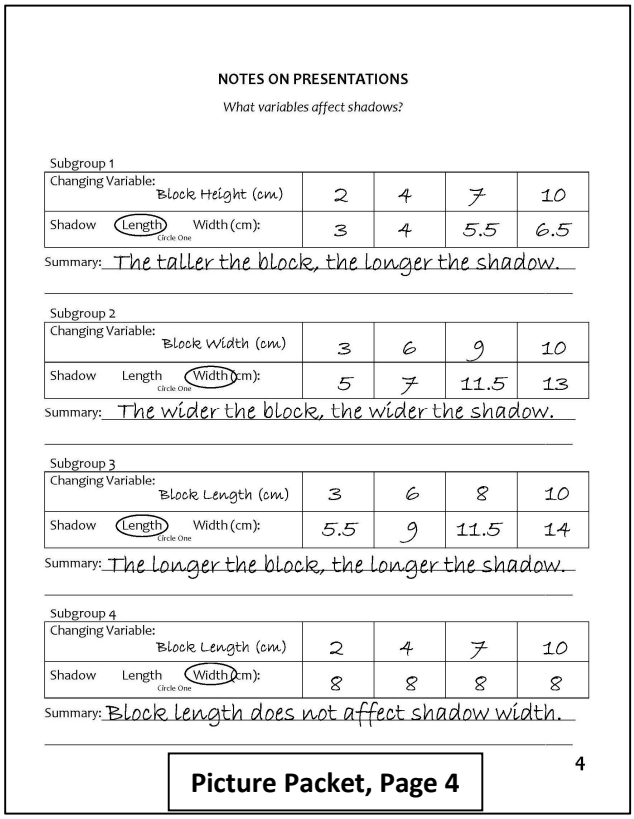
- Review the class question, as well as what students did and learned last session.

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 notebooks, and practicing the posters 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 tables from their posters.

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

- Inform students if they ask a scientific question (a question that helps summarize what the subgroup did/learned or requires them to make a prediction based on their data) 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 (picture packet, pages 4 and 5) while students do the same (notebook, pages 24 and 25).
    - After a subgroup reads their question, stop the presentation and have the class identify the changing variable, as well as what shadow measurement the subgroup made. Then, record it in the picture packet.
    - When a subgroup reads 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?
- Once students have asked their questions (make sure each student answers a question; you should ask at least one question per presentation), have students summarize what they learned and record it (picture packet, pages 4 and 5); while students do the same (notebook, pages 24 and 25).
    - If students are unable to do this, encourage them to ask more questions.
- Students will not record information about their own subgroup's poster presentation.
- After all presentations are over, have students tell you the variable values they would select to cause the longest shadow.



NOTES ON PRESENTATIONS

What variables affect shadows?

Subgroup 1

Changing Variable: Block Height (cm)	2	4	7	10
Shadow (Length) Width (cm):	3	4	5.5	6.5

Summary: The taller the block, the longer the shadow.

Subgroup 2

Changing Variable: Block Width (cm)	3	6	9	10
Shadow Length (Width) (cm):	5	7	11.5	13

Summary: The wider the block, the wider the shadow.

Subgroup 3

Changing Variable: Block Length (cm)	3	6	8	10
Shadow (Length) Width (cm):	5.5	9	11.5	14

Summary: The longer the block, the longer the shadow.

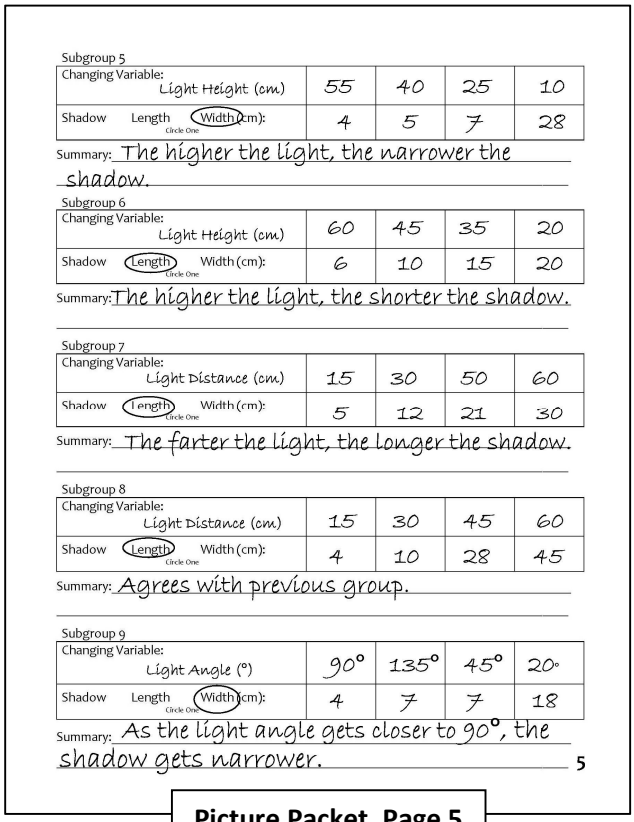
Subgroup 4

Changing Variable: Block Length (cm)	2	4	7	10
Shadow Length (Width) (cm):	8	8	8	8

Summary: Block length does not affect shadow width.

4

Picture Packet, Page 4



Subgroup 5

Changing Variable: Light Height (cm)	55	40	25	10
Shadow Length (Width) (cm):	4	5	7	28

Summary: The higher the light, the narrower the shadow.

Subgroup 6

Changing Variable: Light Height (cm)	60	45	35	20
Shadow (Length) Width (cm):	6	10	15	20

Summary: The higher the light, the shorter the shadow.

Subgroup 7

Changing Variable: Light Distance (cm)	15	30	50	60
Shadow (Length) Width (cm):	5	12	21	30

Summary: The farter the light, the longer the shadow.

Subgroup 8

Changing Variable: Light Distance (cm)	15	30	45	60
Shadow (Length) Width (cm):	4	10	28	45

Summary: Agrees with previous group.

Subgroup 9

Changing Variable: Light Angle (°)	90°	135°	45°	20°
Shadow Length (Width) (cm):	4	7	7	18

Summary: As the light angle gets closer to 90°, the shadow gets narrower.

5

Picture Packet, Page 5

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

- Tell students, "The mentors who have been working with you are undergraduate and graduate students who volunteer their time so you can do experiments. This is the last day you will see your volunteers, so we should say thank you and goodbye."
- Have volunteers give students SciTrek pencils.
- Have students remove the paper parts of their nametags (which they can keep) from the plastic holders and return the plastic holders to their volunteers.

Day 8: Conclusion Assessment/Tie to Standards

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

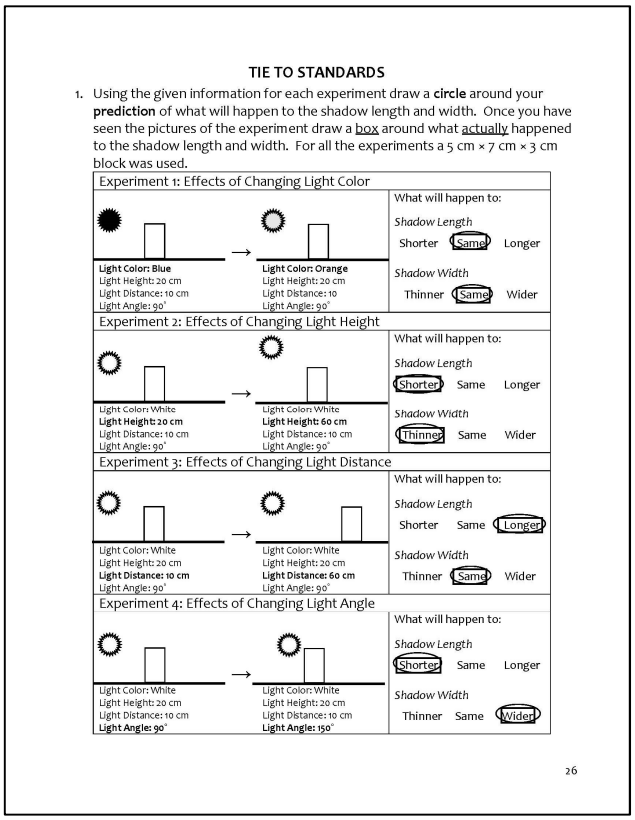
Conclusion Assessment (SciTrek Lead) – 10 minutes
Tie to Standards (SciTrek Lead) – 50 minutes

Preparation:

1. If the teacher is not leading the tie to standards activity, do the following:
    a. Give the teacher an extra 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 (notebook, pages 26-28 and picture packet, pages 6-11).
4. Put your lab coat in the lead box at the end of the day.

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

- Page 1 (top): Read the two questions aloud and have students fill them in.
- Page 1 (bottom): Read each statement and have students circle whether the statement is a claim, data, or opinion.
- Page 2 (top): 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 (bottom): 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

1. Using the given information for each experiment draw a **circle** around your **prediction** of what will happen to the shadow length and width. Once you have seen the pictures of the experiment draw a box around what actually happened to the shadow length and width. For all the experiments a 5 cm × 7 cm × 3 cm block was used.

Experiment 1: Effects of Changing Light Color

Light Color: Blue | **Light Color: Orange**
Light Height: 20 cm | Light Height: 20 cm
Light Distance: 10 cm | Light Distance: 10
Light Angle: 90˚ | Light Angle: 90˚

What will happen to:
Shadow Length: Shorter (Same) Longer
Shadow Width: Thinner (Same) Wider

Experiment 2: Effects of Changing Light Height

Light Color: White | Light Color: White
Light Height: 20 cm | **Light Height: 60 cm**
Light Distance: 10 cm | Light Distance: 10 cm
Light Angle: 90˚ | Light Angle: 90˚

What will happen to:
Shadow Length: (Shorter) Same Longer
Shadow Width: (Thinner) Same Wider

Experiment 3: Effects of Changing Light Distance

Light Color: White | Light Color: White
Light Height: 20 cm | Light Height: 20 cm
Light Distance: 10 cm | **Light Distance: 60 cm**
Light Angle: 90˚ | Light Angle: 90˚

What will happen to:
Shadow Length: Shorter Same (Longer)
Shadow Width: Thinner (Same) Wider

Experiment 4: Effects of Changing Light Angle

Light Color: White | Light Color: White
Light Height: 20 cm | Light Height: 20 cm
Light Distance: 10 cm | Light Distance: 10 cm
Light Angle: 90˚ | **Light Angle: 150˚**

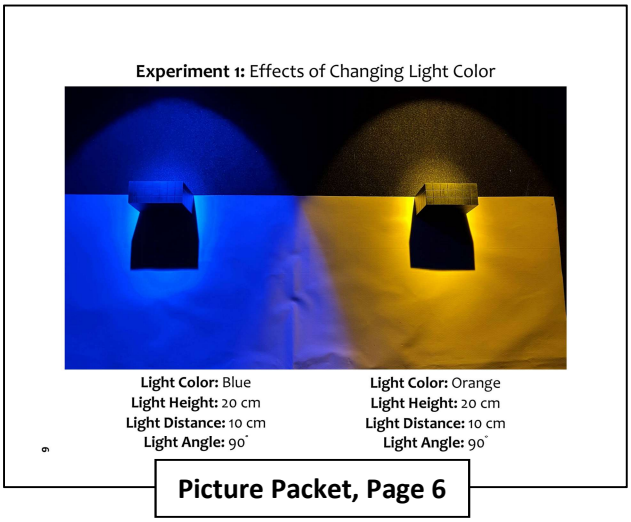
What will happen to:
Shadow Length: (Shorter) Same Longer
Shadow Width: Thinner Same (Wider)

26

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 (picture packet, pages 6-9).
- Box what happened to the shadow length/width.
    - It might be necessary to measure the shadow width in experiment 3 (light distance).



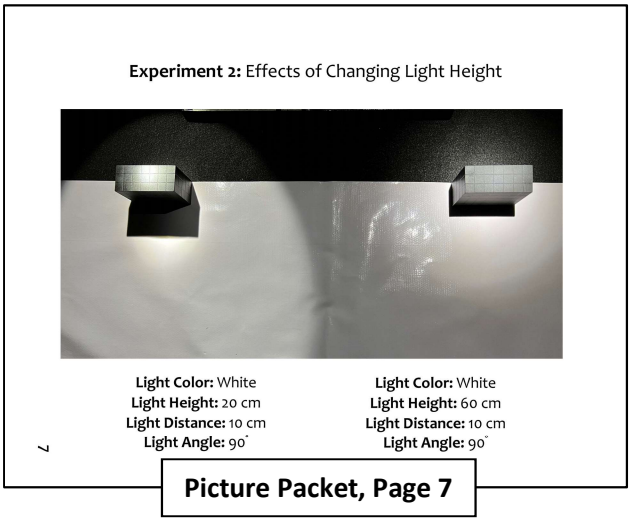
Experiment 1: Effects of Changing Light Color

Light Color: Blue
Light Height: 20 cm
Light Distance: 10 cm
Light Angle: 90˚

Light Color: Orange
Light Height: 20 cm
Light Distance: 10 cm
Light Angle: 90˚

6

Picture Packet, Page 6



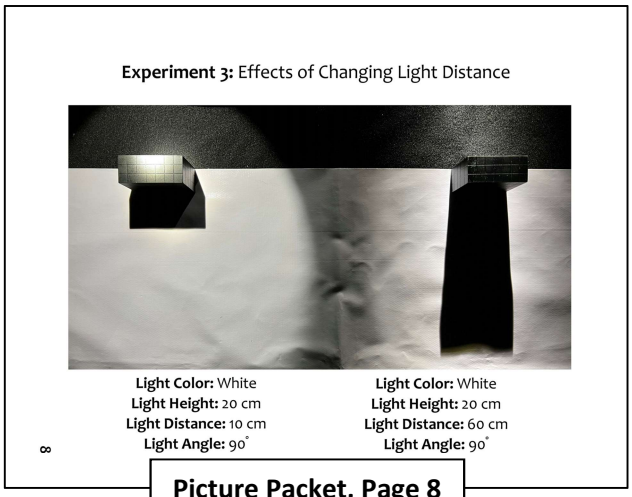
Experiment 2: Effects of Changing Light Height

Light Color: White
Light Height: 20 cm
Light Distance: 10 cm
Light Angle: 90˚

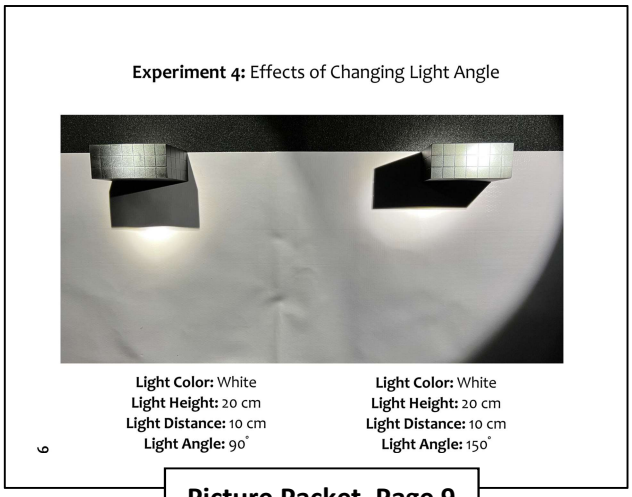
Light Color: White
Light Height: 60 cm
Light Distance: 10 cm
Light Angle: 90˚

7

Picture Packet, Page 7



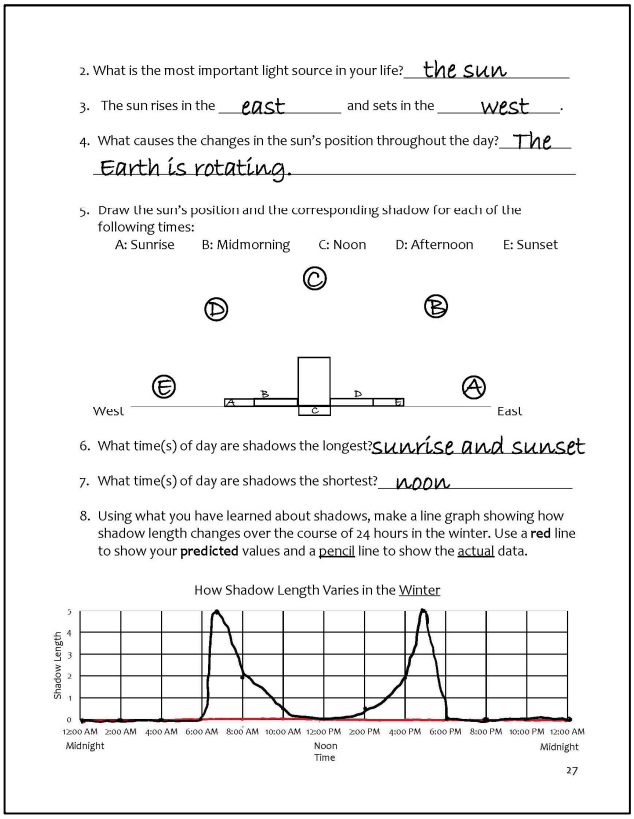
Picture Packet, Page 8



Picture Packet, Page 9

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 and midmorning with students and label it.
- Have students try to fill in the other shadows on their own, then share their drawing and their reasoning.
- Draw in other shadows.
- Have students fill in questions 6 and 7.



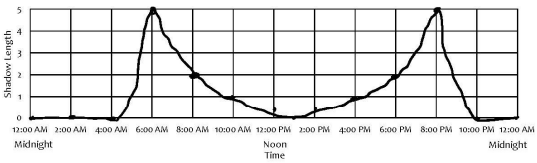
Seasonal Shadows (23 minutes)

- Pass out red pens.
- Tell students, "You are now going to draw, with the red pen, what you 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 put that value on the graph.
- Tell students, "If you thought the shadow length was 0 over the full 24 hours, you would draw a straight line with your 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 (picture packet, page 10).
- Determine the number of daylight hours in the winter (10 hours).
- Point out the graph is symmetric.
- Tell students, "You are now going to draw, with the red pen, what you 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 (picture packet, page 11).
- Determine the number of daylight hours in the summer (14 hours).
- As a class, fill in the conclusion about number of daylight hours.

9. Using what you have learned about shadows, make a line graph showing how shadow length changes over the course of 24 hours in the summer. Use a **red** line to show your **predicted** values and a pencil line to show the actual data.

How Shadow Length Varies in the Summer



10. What conclusion can you make from the graphs about the amount of daylight throughout the year?

We can conclude that the number of daylight hours in the summer is more than in the winter because in the summer there were 14 hours of daylight, in the winter there were 10 hours of daylight.

11. Using the sundials below, determine what time of day it is (morning / noon / afternoon).

What time of day is it? noon

What time of day is it? morning

What time of day is it? afternoon

28

How Shadow Length Varies in the Winter

Time	Shadow Length
12:00 am	0
2:00 am	0
4:00 am	0
6:00 am	0
7:00 am	5
8:00 am	2
10:00 am	0.5
12:00 pm	0
2:00 pm	0.5
4:00 pm	2
5:00 pm	5
6:00 pm	0
8:00 pm	0
10:00 pm	0
12:00pm	0

10

Picture Packet, Page 10

How Shadow Length Varies in the Summer

	Shadow Length
12:00 am	0
2:00 am	0
4:00 am	0
6:00 am	5
8:00 am	2
10:00 am	1
12:00 pm	0.5
1:00 pm	0
2:00 pm	0.5
4:00 pm	1
6:00 pm	2
8:00 pm	5
10:00 pm	0
12:00pm	0

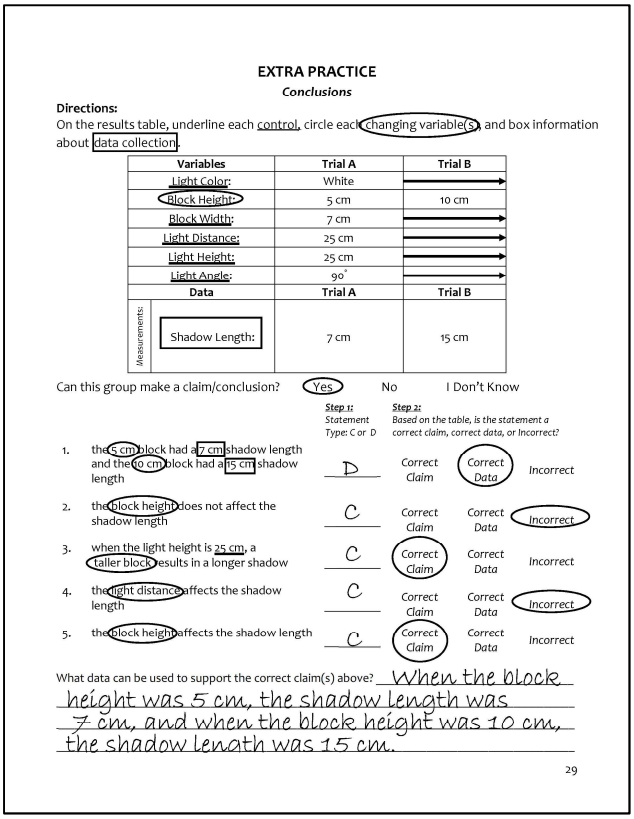
11

Picture Packet, Page 11

Sundials (2 minutes)

- Tell students, "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

Conclusions

Directions:
On the results table, underline each control, circle each changing variable(s), and box information about data collection.

Variables	Trial A	Trial B
Light Color:	White	→
Block Height:	5 cm	10 cm
Block Width:	7 cm	→
Light Distance:	25 cm	→
Light Height:	25 cm	→
Light Angle:	90°	→
Data	**Trial A**	**Trial B**
Measurements: Shadow Length:	7 cm	15 cm

Can this group make a claim/conclusion? (Yes) No I Don't Know

		Step 1: *Statement Type: C or D*	***Step 2:*** *Based on the table, is the statement a correct claim, correct data, or incorrect?*		
1.	the 5 cm block had a 7 cm shadow length and the 10 cm block had a 15 cm shadow length	D	Correct Claim	(Correct Data)	Incorrect
2.	the block height does not affect the shadow length	C	Correct Claim	Correct Data	(Incorrect)
3.	when the light height is 25 cm, a taller block results in a longer shadow	C	(Correct Claim)	Correct Data	Incorrect
4.	the light distance affects the shadow length	C	Correct Claim	Correct Data	(Incorrect)
5.	the block height affects the shadow length	C	(Correct Claim)	Correct Data	Incorrect

What data can be used to support the correct claim(s) above? When the block height was 5 cm, the shadow length was 7 cm, and when the block height was 10 cm, the shadow length was 15 cm.

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