

Group Color: \_\_\_\_\_  
Subgroup Number: \_\_\_\_\_  
Team/Subgroup Symbol: \_\_\_\_\_ / \_\_\_\_\_



## How Science Works

Grade 6

Module 1

*Class Question:*

Scientist (Your Name): \_\_\_\_\_

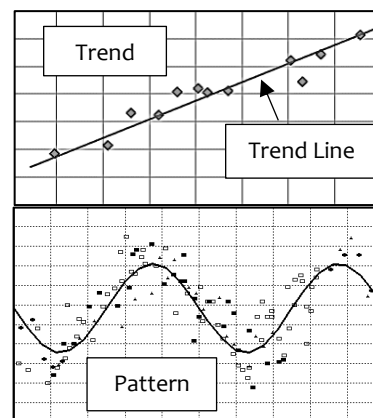
Teacher's Name: \_\_\_\_\_

SciTrek Volunteer's Name: \_\_\_\_\_

# VOCABULARY

**Science:** The study of the material world using human reason. The scientific method is the way humans reason and apply logic to data to help gain knowledge of the world.

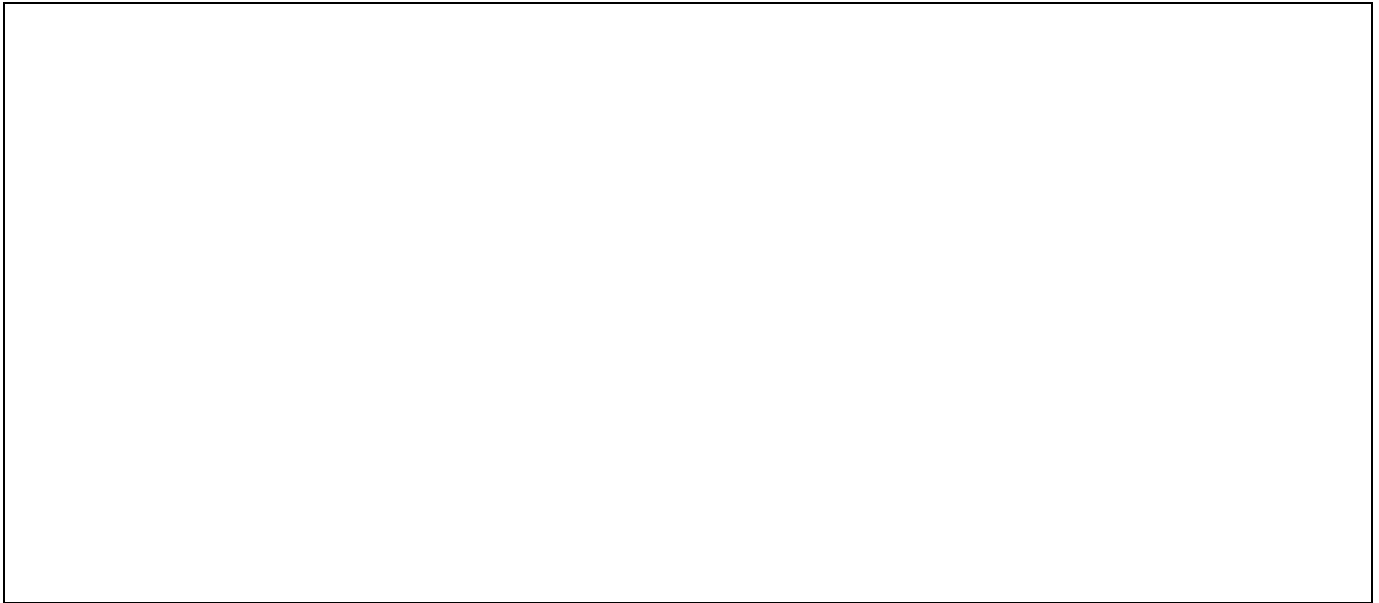
- **Observation:** A description using your five senses. This could include contents, mass, size, color, temperature, smell, texture ...
- **Opinion:** Something you believe or feel. Not a fact or observation.
- **Inference:** A guess based on past experiences.
- **Testable Question:** A question for which an experiment can be designed to answer.
- **Non-Testable Question:** A question for which an experiment cannot be designed to answer. For example, questions involving things that cannot be measured/observed or things that are not well defined/opinions.
- **Experimental Set-Up:** The materials, changing variable, and controls that are needed for an experiment.
- **Experiment:** A test or trial to discover something unknown.
- **Procedure:** A set of steps to conduct an experiment.
- **Controls:** The variables that are not changed in an experiment.
- **Class Control:** A control that everyone in the class has the same value for.
- **Team Control:** A control that everyone in a team has the same value for, but values vary for different teams within a class.
- **Subgroup Control:** A control that everyone in a subgroup has the same value for, but values vary for different subgroups within a team.
- **Changing Variable (Independent Variable):** The variable that is purposely changed in an experiment.
- **Results/Data (Dependent Variable):** The measurements/observations of the experiment, which are influenced/determined by the changing variable.
- **Prediction:** What you expect to happen based off of previous measurements/observations.
- **Scientific Practices:** A series of activities that scientists participate in to both understand the world around them and to communicate their results with others. The specific practice worked on in this module is analyzing and interpreting data.
- **Technique:** A method for a specific task.
- **Conclusion:** A claim supported by data.
- **Claim:** A statement that can be tested. The explanation of the data, the first part of a conclusion.
- **Data:** Evidence collected from experiment(s) (measurements or observations); the second part of a conclusion.
- **Analysis:** A scientific practice involving examining data critically and looking for patterns and trends.
- **Trend:** When data changes in one general direction; can go up or down.
- **Trend Line:** A line drawn on a graph to represent the direction of a trend
- **Pattern:** When data repeats in a predictable manner; can go up, down, and up again.
- **Solar Panel:** A piece of equipment designed to absorb the sun's rays as a source of energy for generating electricity or heat.
- **Angle:** A measurement telling the separation between two lines that meet at one point.
- **Multimeter:** A tool used to measure voltage, current, or resistance. For this module we will use it to measure the current and voltage produced by a solar panel.
- **Current:** A measure of the amount of flowing electricity. The units for current in this module are milliamps (mA).
- **Voltage:** A measure of the force that makes electricity move. The units for voltage are volts (V).
- **Energy:** The ability of an object to do work. Energy can be transferred, but it cannot be created or destroyed.
- **Power:** A measure of the energy of a system over time, calculated by multiplying the current and voltage together. The units for power in this module are milliwatts (mW).
- **Range:** The difference between the biggest and smallest measurements.
- **Renewable Energy:** Energy from some source that can be replenished within a human's lifetime.



# OBSERVATIONS

Experimental Set-Up:

Draw a picture of the experimental set-up below and label the parts of the system.



Other observations of the experimental set up:

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Describe what happened during the experiment.

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Solar Panel Measurements	
Current (mA)	
Voltage (V)	

When the red LED was hooked up to the solar panel it

lit    did not light .  
(circle one)

When the blue LED was hooked up to the solar panel it

lit    did not light .  
(circle one)

## TECHNIQUE

### Calculating Power

One way to measure the energy of our system over time is by calculating the **power** of the system. Power ( $P$ ) can be found by multiplying the current ( $I$ ) measured in milliamps (mA) and voltage ( $V$ ) measured in volts (V) of the system together:

$$P = I \times V$$

For this experiment, power is calculated in units called **milliwatts** (mW).

**Directions:** Calculate the power produced by each system. Round your answer to the nearest tenth (Ex: 9.5 mW).

<p>a) Class solar panel</p> <p><math>I =</math> _____</p> <p><math>V =</math> _____</p> <p><math>P =</math> _____ <math>\times</math> _____</p> <p><math>=</math> _____</p>	<p>b) Your solar panel</p> <p><math>I =</math> _____</p> <p><math>V =</math> _____</p>
<p>c) Round batteries</p> <p><math>I =</math> _____</p> <p><math>V =</math> _____</p>	<p>d) Rectangular battery</p> <p><math>I =</math> _____</p> <p><math>V =</math> _____</p>

1. What does our experiment tell us about the red and blue LEDs?  
\_\_\_\_\_
2. What happens when the blue LED is touched to the round batteries? \_\_\_\_\_
3. What happens when the blue LED is touched to the rectangular battery? \_\_\_\_\_
4. Why does this happen? \_\_\_\_\_
5. What does this tell us about lights/devices? \_\_\_\_\_  
\_\_\_\_\_
6. How can we monitor the amount of power used by a device? \_\_\_\_\_  
\_\_\_\_\_

# VARIABLES

Variable	How will changing this variable affect the power produced by the solar panel?
	<hr/> <hr/> <hr/> <hr/>
	<hr/> <hr/> <hr/> <hr/>
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## Experimental Considerations:

1. You will only have access to the materials on the materials page.
2. See materials page for restrictions on experimental design.

### *Changing Variable(s) (Independent Variable(s))*

You will get to perform two experiments. For your first experiment, decide which variable(s) (max two) that you would like to test. For each changing variable that you select, discuss with your subgroup why you think that variable will affect the power produced by the solar panel.

Changing Variable 1: \_\_\_\_\_

Discuss with your subgroup how you think **changing variable 1** will affect the power produced by the solar panel.

Changing Variable 2 (optional): \_\_\_\_\_

Discuss with your subgroup how you think **changing variable 2** will affect the power produced by the solar panel.

## QUESTION

Question our subgroup will investigate:

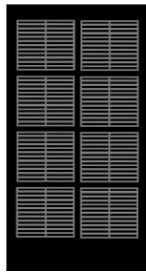
- If we change the \_\_\_\_\_,  
insert each changing variable (independent variable)  
what will happen to the \_\_\_\_\_  
\_\_\_\_\_?  
insert what you are measuring/observing (dependent variable)

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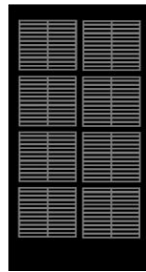
Get a materials page from your SciTrek volunteer and fill it out before moving onto the experimental set-up.

## EXPERIMENTAL SET-UP

Write your changing variable(s) (Ex: panel angle) and the values (Ex: 45°) you will use for your four trials under each solar panel.



A



B



C



D

**Changing Variable(s):**

1)	:	_____	_____	_____	_____
2)	:	_____	_____	_____	_____

**Controls** (variables you will hold constant):

Write the controls and the values you will use in all your trials (control/value, Ex: power source/solar panel).

Power Source	/	Solar Panel	_____	/	_____
_____	/	_____	_____	_____	_____

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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 panel angle, one step would be: place the panel at an angle of A) 30°, B) 45°, C) 60°, and D) 75°).

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_  
\_\_\_\_\_
6. \_\_\_\_\_  
\_\_\_\_\_
7. \_\_\_\_\_  
\_\_\_\_\_
8. \_\_\_\_\_  
\_\_\_\_\_

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# RESULTS

*Table*

Fill out the table for each of your trials. For the variables that remain constant, write the value in trial A and then draw an arrow through each box indicating that this variable is a control. Remember to record data measurements to the nearest tenth (Ex. 4.1 mA) and calculate power to the nearest tenth (Ex. 13.2 mW).

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

Variables	Trial A	Trial B	Trial C	Trial D
Power Source:	<i>Solar panel</i> →			
Panel Angle:				
Shading Amount:				
Temperature:				
_____ : other variable				
<b>Predictions</b>	<b>Trial A</b>	<b>Trial B</b>	<b>Trial C</b>	<b>Trial D</b>
Put an "S" in the trial that will give the smallest power output and an "L" in the trial that will give the largest power output.				
<b>Data and Calculations</b>	<b>Trial A</b>	<b>Trial B</b>	<b>Trial C</b>	<b>Trial D</b>
Measurements	Room Temperature (°C)			
	Current (mA):			
	Voltage (V):			
Calculations	Power (mW): $P = I \times V$			

The independent variable(s) is(are) the changing variable(s) and the dependent variables are the current and voltage.

## SCIENTIFIC PRACTICES

### Analyzing & Interpreting Data

1. **Directions:** Fill in the missing definitions.

- **Conclusion:** \_\_\_\_\_
- **Claim:** A statement that can be tested. The explanation of the data, the first part of a conclusion.
  - Ex: Increased amounts of fertilizer runoff in lakes kills wildlife.
  - A claim in a scientific experiment often includes the \_\_\_\_\_.
- **Data:** Evidence collected from experiment(s) (measurements or observations), the second part of a conclusion.
  - Ex: We observed that in lakes with large amounts of fertilizer runoff, there were no living organisms, while in lakes with a little fertilizer runoff, there were many living organisms.
  - Data in a scientific experiment includes \_\_\_\_\_ or \_\_\_\_\_.
  - Data statements also often include values of the \_\_\_\_\_.

2. **Directions:** On the results tables and conclusions below, underline control(s), circle changing variable(s), and box information about data collection. Then, decide if the possible conclusion is correct or not.

a)

Variables		Trial A	Trial B	Trial C	Trial D
Power Plant Type:		Coal	_____	_____	_____
Substance Amount:		3,000 Mg	_____	_____	_____
Number of Generators:		2	3	4	5
Water Amount:		4,500 L	_____	_____	_____
Number of Workers:		10	_____	_____	_____
Data		Trial A	Trial B	Trial C	Trial D
Final Measurements/ Observations:	Power Output:	103 MW	126 MW	135 MW	150 MW
	Other:	Air around plant is dark brown	Air around plant is dark brown	Air around plant is dark brown	Air around plant is dark brown

**Possible Conclusion:** The greater the number of generators in the power plant the higher the power output, because when 2 generators were used, 103 MW of power were produced, and when 5 generators were used, 150 MW of power were produced.

Is this a correct conclusion?                      YES                      NO                      I DON'T KNOW

If NO, what is wrong with the conclusion? \_\_\_\_\_.

## SCIENTIFIC PRACTICES

### Analyzing & Interpreting Data

b)

Variables		Trial A	Trial B	Trial C	Trial D
Power Plant Type:		Natural Gas	—————→	—————→	—————→
Substance Amount:		3200 Mg	—————→	—————→	—————→
Number of Generators:		3	—————→	—————→	—————→
Water Amount:		4,200 L	—————→	—————→	—————→
Number of Workers:		8	10	12	14
Data		Trial A	Trial B	Trial C	Trial D
Final Measurements/ Observations:	Power Output:	140 MW	139 MW	140 MW	141 MW
	Other:	Air around plant is clear	Air around plant is clear	Air around plant is clear	Air around plant is clear

**Possible Conclusion:** Having more people working the power plant will produce more power, because when 8 people were working, 140 MW of power were produced, and when 14 people were working, 141 MW of power were produced.

Is this a correct conclusion?                      YES                      NO                      I DON'T KNOW

If NO, what is wrong with the conclusion? \_\_\_\_\_.

c)

Variables		Trial A	Trial B	Trial C	Trial D
Power Plant Type:		Coal	—————→	—————→	—————→
Substance Amount:		2,700 Mg	3,100 Mg	3,600 Mg	4,200 Mg
Number of Generators:		3	—————→	—————→	—————→
Water Amount:		4,500 L	—————→	—————→	—————→
Number of Workers:		10	—————→	—————→	—————→
Data		Trial A	Trial B	Trial C	Trial D
Final Measurements/ Observations:	Power Output:	131 MW	140 MW	147 MW	155 MW
	Other:	Air around plant is light brown	Air around plant is brown	Air around plant is brown	Air around plant is dark brown

**Possible Conclusion:** As more coal is burned in the power plant the air will become more polluted, because we observed when 2,700 Mg of coal were burned, the air was light brown, and when 4,200 Mg of coal were burned, the air was dark brown.

Is this a correct conclusion?                      YES                      NO                      I DON'T KNOW

If NO, what is wrong with the conclusion? \_\_\_\_\_.

## SCIENTIFIC PRACTICES

### Analyzing & Interpreting Data

d)

Variables		Trial A	Trial B	Trial C	Trial D
Power Plant Type:		Natural Gas	—————→		
Substance Amount:		3,100 Mg	—————→		
Number of Generators:		3	—————→		
Water Amount:		4,200 L	4,400 L	4,600 L	4,800 L
Number of Workers:		10	—————→		
Data		Trial A	Trial B	Trial C	Trial D
Final Measurements/ Observations:	Power:	155 MW	147 MW	140 MW	128 MW
	Other:	Air around plant is clear	Air around plant is clear	Air around plant is clear	Air around plant is clear

**Possible Conclusion:** When 4,200 L of water were used, 155 MW of power were produced, and when 4,800 L of water were used, 128 MW of power were produced, because the greater the amount of water the lower the power output.

Is this a correct conclusion?                      YES                      NO                      I DON'T KNOW

If NO, what is wrong with the conclusion? \_\_\_\_\_.

e)

Variables		Trial A	Trial B	Trial C	Trial D
Power Plant Type:		Coal	—————→		
Substance Amount:		2,800 Mg	3,200 Mg	3,600 Mg	4,000 Mg
Number of Generators:		3	—————→		
Water Amount:		4,000 L	4,200 L	4,500 L	4,700 L
Number of Workers:		8	—————→		
Data		Trial A	Trial B	Trial C	Trial D
Final Measurements/ Observations:	Power:	130 MW	139 MW	145 MW	155 MW
	Other:	Air around plant is brown	Air around plant is brown	Air around plant is brown	Air around plant is brown

**Possible Conclusion:** The greater the amount of water used in the power plant the higher the power output, because when 4,000L of water were used 130 MW of power were produced, and when 4,700 L of water were used, 155 MW of power were produced.

Is this a correct conclusion?                      YES                      NO                      I DON'T KNOW

If NO, what is wrong with the conclusion? \_\_\_\_\_.

3. How many changing variables can you have to make a conclusion? \_\_\_\_\_

# CONCLUSION

## *Making a Conclusion from Your Data*

How many changing variables did you have in your experiment? \_\_\_\_\_

Can you make a conclusion from your data?       YES       NO

### IF NO

Why? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### IF YES

We can conclude \_\_\_\_\_  
claim

because \_\_\_\_\_  
data (measurement/observation)

SciTrek Member Approval \_\_\_\_\_

# TECHNIQUE

## Calculating Percentages

Percentages are used to compare a portion of a system to a whole system. This is done by making the amount of the whole system equal to 100%. The closer the value is to 100%, the larger the portion of the system.

*How to calculate a percentage:*

**Step 1.** Define your system:

- a. Determine the number you want to change into a percent (*value*).
- b. Determine the smallest number in your system (*min value*).
- c. Determine the largest number in your system (*max value*).

**Step 2.** Calculate the **range** using Eq. 1. The range is equal to the difference between the largest and smallest accepted values in your system.

**Step 3.** Use Eq. 2 to calculate the percentage and round to the nearest whole number. Percentages are unitless.

**Equation 1.**

$$range = max\ value - min\ value$$

**Equation 2.**

$$\% = 100 \times \left( \frac{value - min\ value}{range} \right)$$

**Directions:** Find the percent for each of the following values in the table.

<b>1) Panel Angle:</b> 50°	<b>2) Shading Amount:</b> $\frac{3}{8}$
Allowed values for each variable:	
Step 1: Panel Angle: (30° – 90°)	Shading Amount: $\left(\frac{0}{8} - \frac{8}{8}\right)$
Step 2: Range = _____ – _____ = _____	Range =
Step 3: %Angled = $100 \times \left( \frac{\underline{\hspace{1cm}} - \underline{\hspace{1cm}}}{\underline{\hspace{1cm}}} \right)$ = _____	%Shaded =
<b>3) Natural Gas Amount:</b> 2500 Mg	<b>4) Number of Workers:</b> 7
Allowed values for each variable:	
Natural Gas Amount: 1,500 Mg – 3,500Mg	Number of Workers: 5 – 12
Range =	Range =
%Natural Gas =	%Number of Workers =

# TECHNIQUE

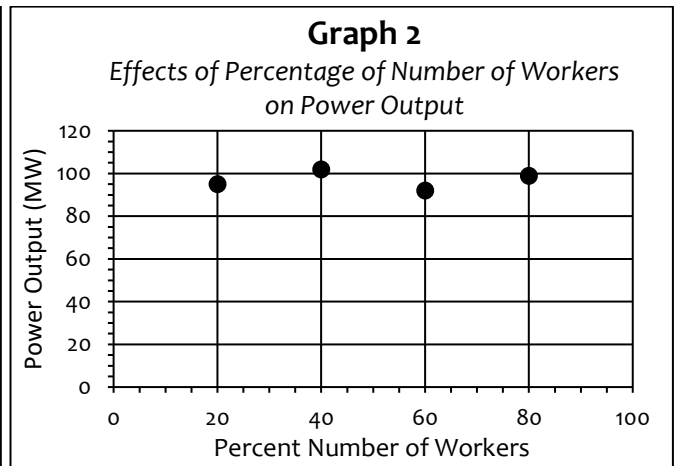
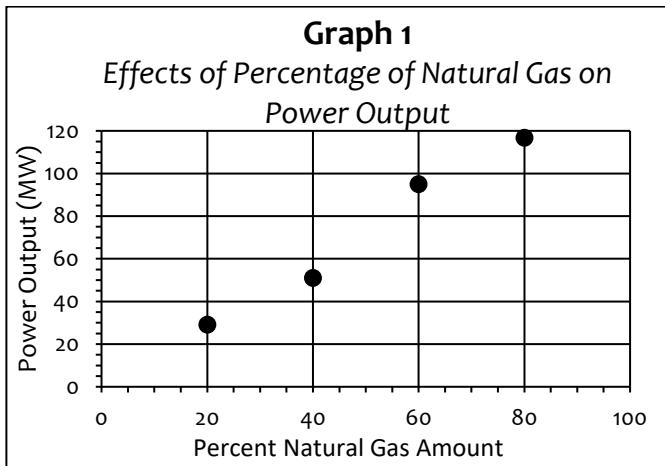
## Trend Lines

Trend lines are used to find trends in data on graphs.

**1. Directions:** Annotate the graphs and draw trend lines for each experiment.

How to draw a trend line:

1. Position your ruler on the graph so it goes along with the direction of the points and places half the points above the ruler and half the points below the ruler. When positioned correctly all points should be as close as possible to the ruler.
2. Trace along the ruler with your pencil. Always extend trend lines to both edges of the graph.



How to interpret trend lines:

- If the line is increasing ( ) or decreasing ( ), there is a trend.
- If the line is flat ( ), there is no trend.

**2. Directions:** Answer the following questions using Graphs 1 and 2.

a) Which graph(s) represent a changing variable that affects the data?                      **1**                      **2**

b) Which changing variable affects the data?                      **% Natural Gas Amount**                      **% Number of Workers**

- Describe the trend by filling in the following sentence frame:

As the percentage of \_\_\_\_\_ increases, the power output \_\_\_\_\_.

**3. Directions:** Annotate Graph 3.

What is the challenge in drawing a trend line on this graph?

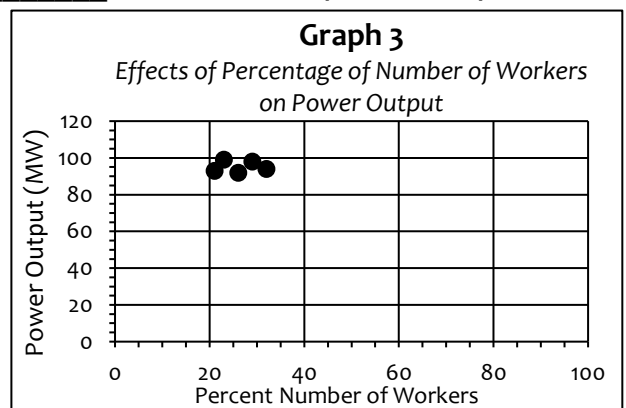
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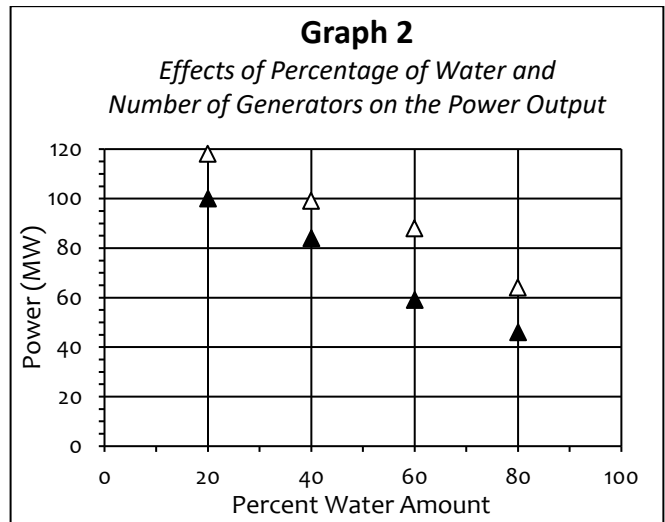
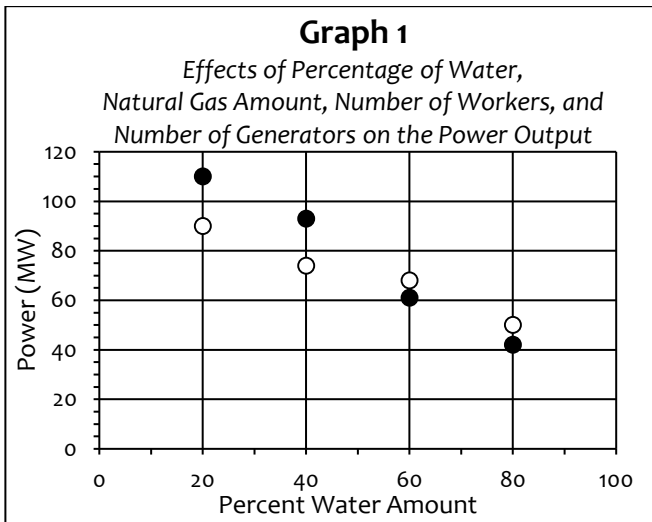


# TECHNIQUE

## Designing Experiments

Four UCSB engineers were studying the amount of power being produced by natural gas power plants by examining the amount of natural gas burned, the amount of water used, the number of workers, and the number of generators. They all picked water amount as their changing variable. Two engineers worked independently, and they used different control values for the natural gas amount, number of workers, and number of generators (Graph 1). The other two engineers collaborated, and they picked the same control values for the natural gas amount, number of workers, and number of generators (Graph 2).

**4. Directions:** Annotate the graphs and draw trend lines for each experiment.



Controls			
Engineer Symbol	Natural Gas Amount	Number of Workers	Number of Generators
●	3,200 Mg	8	2
○	2,800 Mg	10	3

Controls			
Engineer Symbol	Natural Gas Amount	Number of Workers	Number of Generators
▲	3,200 Mg	10	2
△	3,200 Mg	10	4

- a) Does percentage of water affect the power output of the power plant? **YES**      **NO**  
 If YES, describe the trend by filling in the following sentence frame:  
 • As percentage of water increases, the power output \_\_\_\_\_.
- b) What is the power output for a power plant that uses 70% of the water, burns 3,200 Mg of natural gas, has 8 workers, and 2 generators? **Expected Power Output:** \_\_\_\_\_  
 • Why are trend lines important? \_\_\_\_\_.
- c) Can you predict what the power output would be if the engineers studied a power plant that used 60% of the water, burned 3,200 Mg of natural gas, had 10 workers, and 3 generators in the power plant? **YES**      **NO**  
 • If YES, which graph is more useful to make your prediction? **1**      **2**  
**Expected Power Output:** \_\_\_\_\_
- d) What does this mean for your experimental design? \_\_\_\_\_

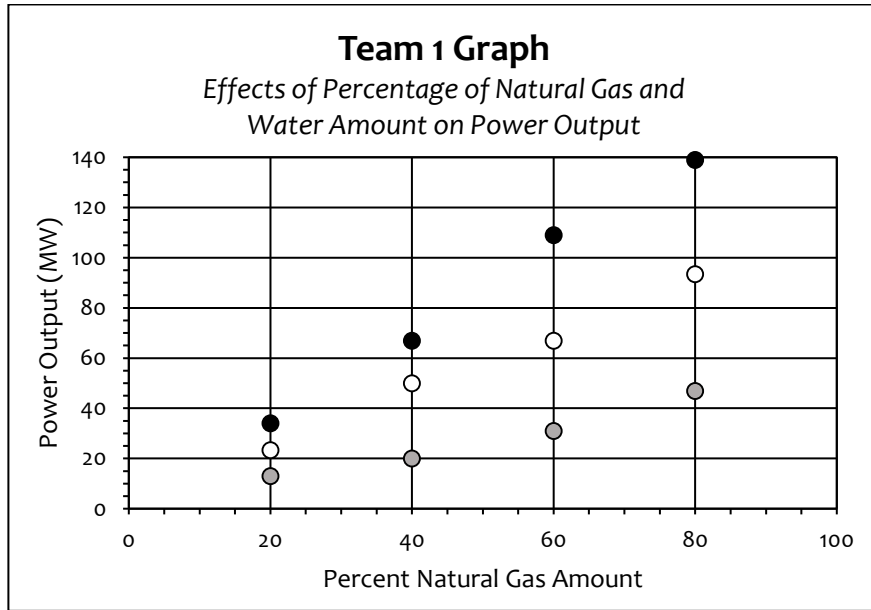


## SCIENTIFIC PRACTICES

### Analyzing & Interpreting Data

A large group of engineers collaborated by diving into 3 teams to study the effects of water amount, natural gas amount, number of workers, and number of generators on the power output of natural gas power plants. The 3 teams agreed to keep the number of generators running in the plants constant at 3 for ALL experiments/trials. Now, they need your help to analyze the data.

**1. Directions:** Annotate the graph, draw trend lines for each experiment, and label trend lines with subgroup control values.



Controls		
Engineer Symbol	Water Amount	Number of Workers
●	4,000 L	9
○	4,400 L	9
●	4,800 L	9

a) Does percentage of natural gas affect the power output of the plant? **YES**    **NO**

If YES, describe the trend by filling in the following sentence frame:

- As the percentage of natural gas increases, the power output \_\_\_\_\_.

b) What power output would you expect to measure if you studied a power plant with the following specifications?

% Natural Gas	50%
Water Amount	4,000 L
Number of Workers	9

**Expected Power Output:**

\_\_\_\_\_

What experiment(s) do you need to look at?



c) What power output would you expect to measure if you studied a power plant with the following specifications?

% Natural Gas	70%
Water Amount	4,200 L
Number of Workers	9

**Expected Power Output:**

\_\_\_\_\_

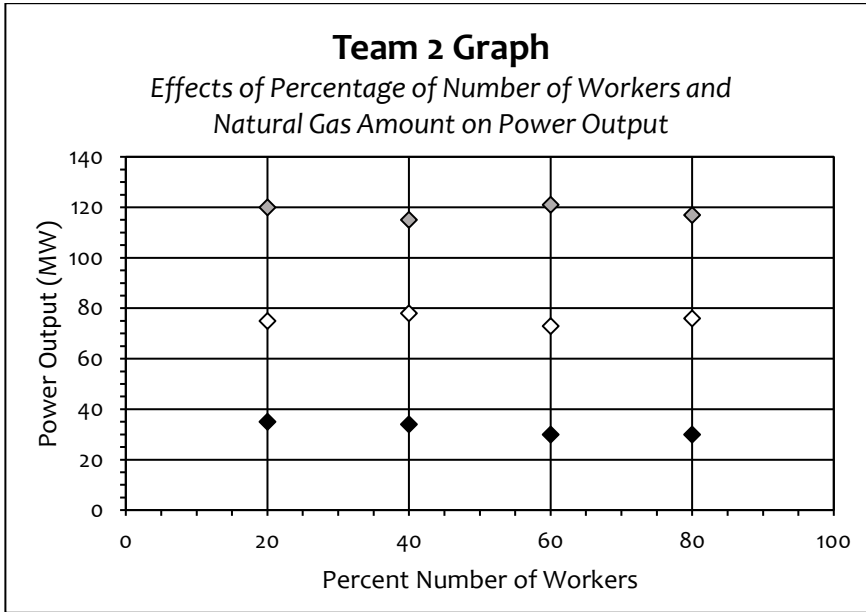
What experiment(s) do you need to look at?



## SCIENTIFIC PRACTICES

### Analyzing & Interpreting Data

2. **Directions:** Annotate the graph, draw trend lines for each experiment, and label trend lines with subgroup control values.



Controls		
Engineer Symbol	Water Amount	Natural Gas Amount
◆	4,200 L	2,000 Mg
◇	4,200 L	2,500 Mg
◐	4,200 L	3,000 Mg

a) Does percentage of the number of workers affect the power output of the plant? **YES**      **NO**  
If YES, describe the trend by filling in the following sentence frame:

- As the percentage of the number of workers increases, the power output \_\_\_\_\_.

b) What power output would you expect to measure if you studied a power plant with the following specifications?

Natural Gas Amount	2,000 Mg
Water Amount	4,200 L
% Number of Workers	65%

**Expected Power Output:**

\_\_\_\_\_

What experiment(s) do you need to look at?



c) What power output would you expect to measure if you studied a power plant with the following specifications?

Natural Gas Amount	2,750 Mg
Water Amount	4,200 L
% Number of Workers	30%

**Expected Power Output:**

\_\_\_\_\_

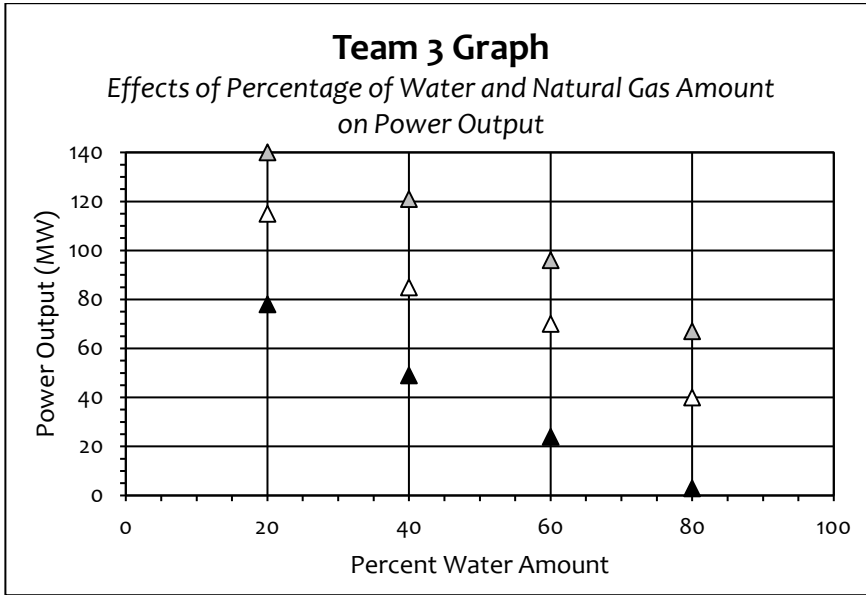
What experiment(s) do you need to look at?



## SCIENTIFIC PRACTICES

### Analyzing & Interpreting Data

3. **Directions:** Annotate the graph, draw trend lines for each experiment, and label trend lines with subgroup control values.



Controls		
Engineer Symbol	Natural Gas Amount	Number of Workers
▲	2,500 Mg	10
△	3,000 Mg	10
▲	3,500 Mg	10

a) Does percentage of water affect the power output of the plant?      **YES**      **NO**  
If YES, describe the trend by filling in the following sentence frame:

- As the percentage of water increases, the power output \_\_\_\_\_.

b) What power output would you expect to measure if you studied a power plant with the following specifications?

Natural Gas Amount	3,000 Mg
% Water	35%
Number of Workers	8

What experiment(s) do you need to look at?



**Expected Power Output:**

\_\_\_\_\_

c) What power output would you expect to measure if you studied a power plant with the following specifications?

Natural Gas Amount	3,400 Mg
% Water	75%
Number of Workers	10

What experiment(s) do you need to look at?



**Expected Power Output:**

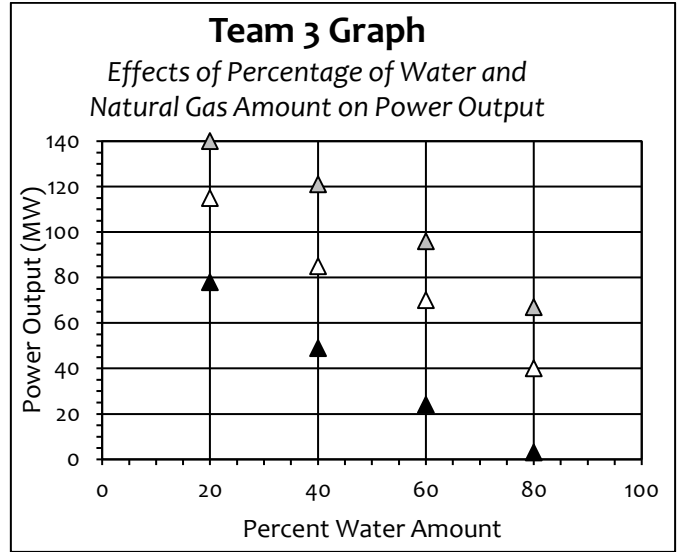
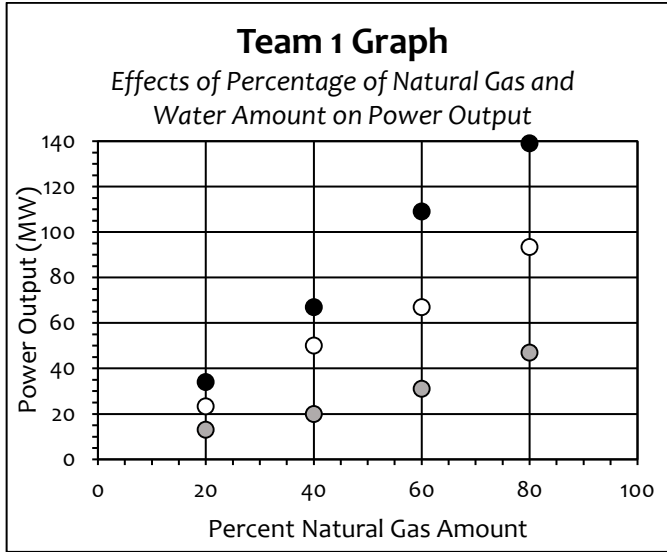
\_\_\_\_\_

## SCIENTIFIC PRACTICES

### Analyzing & Interpreting Data

A natural gas power plant wants to know if the trends in their data can be used to predict the power output for different combinations of natural gas amount and water amount that have not been tested yet. The Team 1 and 3 graphs are shown again below so you can help interpret the data.

**4. Directions:** Annotate the graph, draw trend lines for each experiment, and label trend lines with subgroup control values.



Controls		
Engineer Symbol	Water Amount	Number of Workers
●	4,000 L	9
○	4,400 L	9
●	4,800 L	9

Controls		
Engineer Symbol	Natural Gas Amount	Number of Workers
▲	2,500 Mg	10
△	3,000 Mg	10
▲	3,500 Mg	10

a) Using both of the graphs above, what power would you expect to measure if you studied a power plant with the following specifications?

Natural Gas Amount	2,600 Mg	~45%
Water Amount	4,600 L	~60%
Number of Workers	8	~43%

Team 1 Prediction: \_\_\_\_\_

Team 3 Prediction: \_\_\_\_\_

What experiment(s) do you need to look at?

Team 1:    ●            ○            ●

Team 3:    ▲            △            ▲

**Expected Power Output:**

\_\_\_\_\_

*Changing Variables (Independent Variable(s))*

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

Changing Variable 1: \_\_\_\_\_

Changing Variable 2 (optional): \_\_\_\_\_

**QUESTION**

Question our subgroup will investigate:

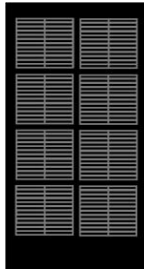
- If we change the \_\_\_\_\_,  
insert each changing variable (independent variable)  
what will happen to the \_\_\_\_\_  
insert what you are measuring/observing (dependent variable)  
\_\_\_\_\_?

**SciTrek Member Approval** \_\_\_\_\_

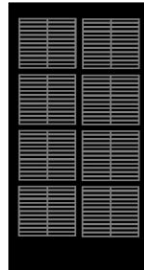
Get a materials page from your SciTrek volunteer and fill it out before moving onto the experimental set-up.

## EXPERIMENTAL SET-UP

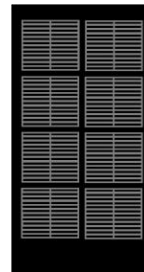
Write your changing variable(s) (Ex: panel angle) and the values (Ex: 45°) you will use for your four trials under each solar panel.



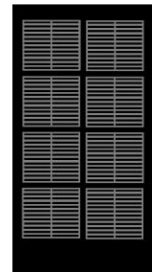
E



F



G



H

**Changing Variable(s):**

1) \_\_\_\_\_ : \_\_\_\_\_

2) \_\_\_\_\_ : \_\_\_\_\_

Why did your subgroup choose these values of the changing variable? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Controls** (variables you will hold constant):

Write the controls and the values you will use in all your trials (control/value, Ex: power source/solar panel).

**Class and Team Controls:**

Power Source / Solar Panel

\_\_\_\_\_ / \_\_\_\_\_

\_\_\_\_\_ / \_\_\_\_\_

**Subgroup Control:**

\_\_\_\_\_ / \_\_\_\_\_

SciTrek Member Approval \_\_\_\_\_

# 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 panel angle, one step would be: place the panel at an angle of E) 30°, F) 45°, G) 60°, and H) 75°).

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_  
\_\_\_\_\_
6. \_\_\_\_\_  
\_\_\_\_\_
7. \_\_\_\_\_  
\_\_\_\_\_
8. \_\_\_\_\_  
\_\_\_\_\_

SciTrek Member Approval \_\_\_\_\_

# RESULTS

## Table

Check the box of your subgroup control and write your subgroup symbol on the line. Then, fill out the chart for each of your trials. For the variables that remain constant, write the value in trial E and then draw an arrow through each box indicating that this variable is a control. Remember to record data measurements to the nearest tenth (Ex. 4.1 mA), calculate power to the nearest tenth (Ex. 13.2 mW), and percentages to the nearest whole number (Ex. 75%).

**Subgroup Control:**  Panel Angle  Shading Amount  Temperature    **Subgroup Symbol:** \_\_\_\_\_

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

Variables	Trial E	Trial F	Trial G	Trial H
Power Source:	<i>Solar panel</i>	→		
Panel Angle:				
Shading Amount:				
Temperature:				
_____ : other variable				
Predictions	Trial E	Trial F	Trial G	Trial H
Put an "S" in the trial that will give the smallest power output and an "L" in the trial that will give the largest power output.				
Data and Calculations	Trial E	Trial F	Trial G	Trial H
Measurements	Room Temperature (°C)			
	Current (mA):			
	Voltage (V):			
Calculations	Power (mW): $P = I \times V$			
	Percent CV: $\% CV = 100 \times \left( \frac{\text{your value} - \text{min value}}{\text{range}} \right)$			
<b>Allowed values for each variable:</b> Panel Angle: (30° - 90°)    Shading Amount: ( $\frac{0}{8} - \frac{8}{8}$ )    Temperature: (19°C - 44°C) <b>Range:</b> Panel Angle: 60°    Shading Amount: 1    Temperature: 25°				

The independent variable is the changing variable and the dependent variables are the current and voltage.



# RESULTS

## Graph

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

- Write the title for your graph by filling in the blanks (the first blank should be *Percentage of changing variable*).
- Label the y-axis (vertical) with what you calculated, including units (Ex: power (mW))
- Label the x-axis (horizontal) with “Percent (your changing variable)” (Ex: Percent Panel Angle).
- Select your subgroup control in the legend by checking the appropriate box. Then put your subgroup control value next to your subgroup symbol.
- List your class and team controls below the graph.

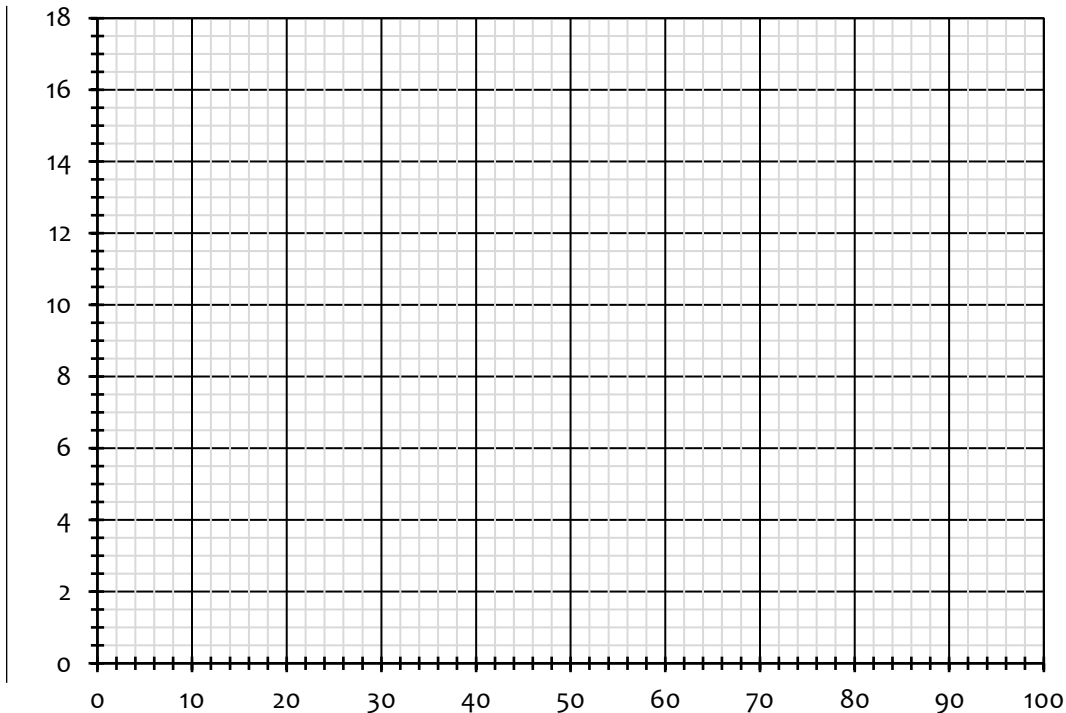
**Plot your data.**

- On the x-axis, circle your 4 changing variable values (as percentages). If a value is not there, write it in.
- Starting with the smallest changing variable value, determine the power and put your subgroup symbol at the appropriate level. Write the value of the power next to the point.
- Once you have plotted all 4 points, draw a trend line that best fits your data.

**Plot the data collected by the other subgroups in your team.**

- Complete the legend for one of the other subgroups in your team by writing their subgroup control value next to their subgroup symbol.
- Graph the subgroup’s 4 points using their symbol as the markers (you do not need to label these points). Then draw a trend line that best fits their data.
- Repeat the process to graph the data for the third subgroup in your team.

**Effects of** \_\_\_\_\_ *insert changing variable* **and** \_\_\_\_\_ *insert subgroup control*  
**on the** \_\_\_\_\_ *insert what you measured/observed*



Legend	
Subgroup Control:	
<input type="checkbox"/> Panel Angle	
<input type="checkbox"/> Shading Amount	
<input type="checkbox"/> Temperature	
Subgroup Symbol	Subgroup Control Value
○	
△	
X	

**Class and Team Controls:** Power Source / Solar Panel \_\_\_\_\_ /  
 \_\_\_\_\_ /  
 \_\_\_\_\_

## CONCLUSION

**Generate a claim about how your changing variable affected your subgroup's results.** (Ex: The larger the size of the solar panel the larger the power produced.)

---

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

We can conclude \_\_\_\_\_ claim

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because \_\_\_\_\_ data

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I acted like a scientist when \_\_\_\_\_

---

## TEAM PREDICTIONS

Use your team graph to predict the power for each subgroup if you were to use 55% of your changing variable. Write your predictions in the table below.

<b>Percent Changing Variable:</b>	
55%	
<i>Subgroup Symbol</i>	<i>Prediction</i>
○	
△	
x	

## NOTES ON PRESENTATIONS

*What variables affect the power produced by a solar panel?*

Percent Changing Variable:	<input type="checkbox"/> Panel Angle <input type="checkbox"/> Shading Amount <input type="checkbox"/> Temperature				
Power (mW):					

**Question:** \_\_\_\_\_

\_\_\_\_\_

**Summary:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Percent Changing Variable:	<input type="checkbox"/> Panel Angle <input type="checkbox"/> Shading Amount <input type="checkbox"/> Temperature				
Power (mW):					

**Question:** \_\_\_\_\_

\_\_\_\_\_

**Summary:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## TIE TO STANDARDS

1. What is **power**? \_\_\_\_\_

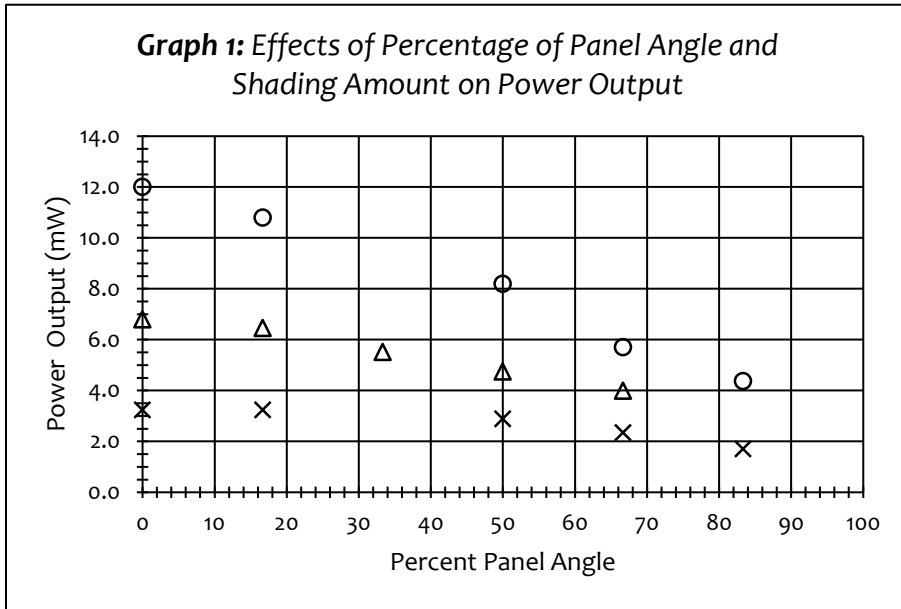
### Predicting Power

We know that different colored LEDs will turn on at different powers. The power required to turn on a white and green LED is given below.

**White LED: 64.6 mW**

**Green LED: 3.6 mW**

2. Annotate Graph 1, draw trend lines, label subgroup controls, and answer the question.



Graph 1 Controls		
Engineer Symbol	Shading Amount	Temperature
O	$\frac{0}{8}$	RT
Δ	$\frac{4}{8}$	RT
X	$\frac{6}{8}$	RT

Does this graph show a trend that is consistent with the class findings?

YES                  NO

3. Using data from Graph 1, what power would you expect to calculate if you used a solar panel that was  $\frac{2}{8}$  shaded, 33% angled (50°), and at room temperature?

Which experiment(s) should you look at?

O    Δ    X

Prediction: \_\_\_\_\_

**Actual Output:**

(Round to the nearest tenth)

Current: \_\_\_\_\_

Voltage: \_\_\_\_\_

Power: \_\_\_\_\_

4. Would this be enough power to light the green LED?

**YES                  NO**

5. Would this be enough power to light the white LED?

**YES                  NO**

## Power Sources/Uses

6. What is **power consumption**? \_\_\_\_\_
7. What would we need to do if we wanted to monitor the power consumption in this classroom? \_\_\_\_\_  
\_\_\_\_\_
8. Why is it useful for us to be able to monitor the power consumption?  
\_\_\_\_\_
9. What is the main way we monitor our monthly power consumption?  
\_\_\_\_\_

In California, we are able to produce power from different energy sources. Some are **renewable** and some are **non-renewable**.

10. Match the definitions:

- |                                |   |
|--------------------------------|---|
| 1. Renewable Energy Source     | a. A source that is not replenished as fast as it is consumed (i.e. cannot be replenished within a human's lifetime). |
| 2. Non-renewable Energy Source | b. A source that produces energy that is not used up or can be replenished within a human's lifetime.                 |

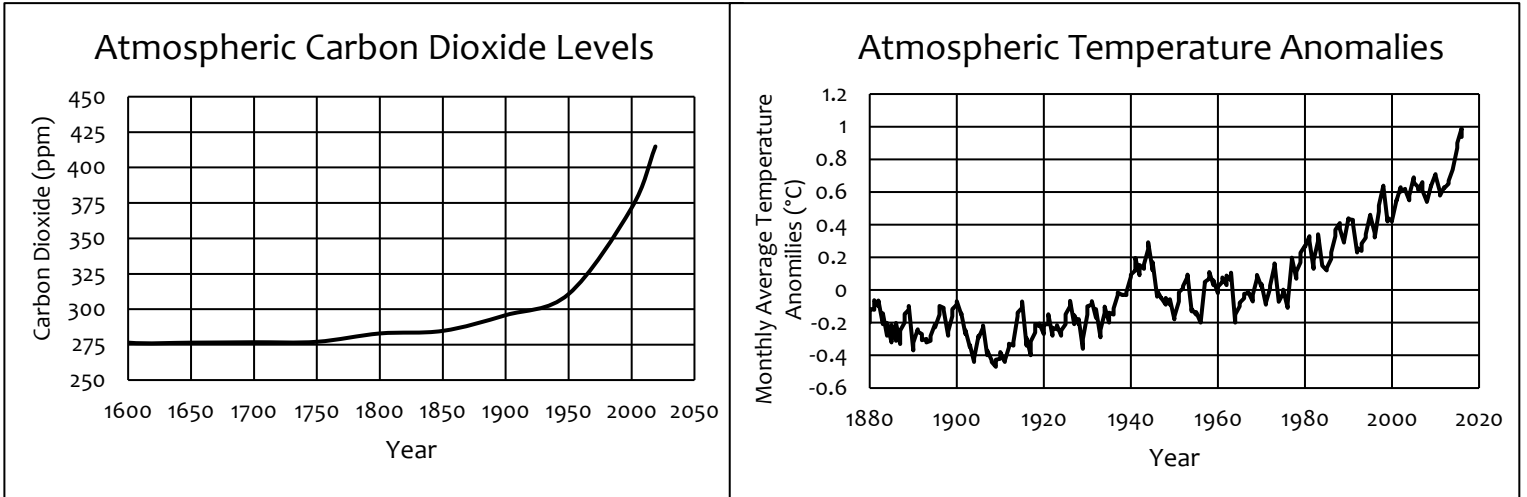
Renewable Energy Sources	Non-renewable Energy Sources
_____	_____
_____	_____
_____	_____

## Effects of Power Use

In the table above, circle all energy sources that are burned to obtain energy.

11. When energy sources are burned, \_\_\_\_\_ is produced.

Scientists have found a link between carbon dioxide (CO<sub>2</sub>) levels and temperature. Using the graphs below, determine how the two are related.



12. As CO<sub>2</sub> levels increase, atmospheric temperature \_\_\_\_\_, because

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13. If California uses non-renewable energy sources for power, what will happen to the amount of CO<sub>2</sub> in the atmosphere? \_\_\_\_\_

14. What will this mean about average atmospheric temperatures? \_\_\_\_\_

15. In California, 47% of our electrical energy comes from \_\_\_\_\_.

**Bright Choices**

16. How can we minimize our impact on our CO<sub>2</sub> production?  
\_\_\_\_\_

We will look at 3 different types of lightbulbs:

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_

17. Lumens: \_\_\_\_\_

Is this important to hold constant when comparing lightbulbs? YES (Circle one) NO

18. Temperature: \_\_\_\_\_

Is this important to hold constant when comparing lightbulbs? YES (Circle one) NO

Will lightbulbs with the same number of lumens need different amounts of power to light?

			
<b>Type of lightbulb:</b>	LED	CFL	Incandescent/Halogen
<b>Voltage:</b>			
<b>Current:</b>			
<b>Power:</b>			

19. Which bulb is “best?” \_\_\_\_\_

The box for each of the lightbulbs is shown below. Compare the information on the boxes and answer the questions below.

**Lighting Facts**  
Per Bulb

---

**Brightness** 550 lumens

**Estimated Yearly Energy Cost** \$0.84  
Based on 3 hrs/day, 11¢/kWh. Cost depends on rates and use

**Life** 10 years  
Based on 3 hrs/day

**Light Appearance**  
Warm \_\_\_\_\_ Cool  
5000 K

**Energy Used** 7 watts

LED

**Lighting Facts**  
Per Bulb

---

**Brightness** 550 lumens

**Estimated Yearly Energy Cost** \$1.08  
Based on 3 hrs/day, 11¢/kWh. Cost depends on rates and use

**Life** 9.1 years  
Based on 3 hrs/day

**Light Appearance**  
Warm \_\_\_\_\_ Cool  
5000 K

**Energy Used** 9 watts

**Contains Mercury**  
For more on clean up and safe disposal, visit [epa.gov/cfl](http://epa.gov/cfl).

CFL

**Lighting Facts**  
Per Bulb

---

**Brightness** 550 lumens

**Estimated Yearly Energy Cost** \$4.82  
Based on 3 hrs/day, 11¢/kWh. Cost depends on rates and use

**Life** 2.3 years  
Based on 3 hrs/day

**Light Appearance**  
Warm \_\_\_\_\_ Cool  
2800 K

**Energy Used** 40 watts

Incandescent/Halogen

20. What does the life of the lightbulb tell us? \_\_\_\_\_

21. What does the estimated yearly energy cost of the lightbulb tell us?

\_\_\_\_\_

22. The \_\_\_\_\_ lightbulb is best because \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## EXTRA PRACTICE

### Directions:

Circle if the statement is a CLAIM, DATA, or an OPINION.

- |    |    |  |              |             |                |
|----|----|--|--------------|-------------|----------------|
| 1. | a. | The Nile River is 6,650 km long and the Amazon River is 6,575 km long.   | <i>Claim</i> | <i>Data</i> | <i>Opinion</i> |
|    | b. | McDonalds French fries have more salt than In-N-Out French fries.        | <i>Claim</i> | <i>Data</i> | <i>Opinion</i> |
|    | c. | Dogs weighing over 50 lbs sleep more than smaller dogs.                  | <i>Claim</i> | <i>Data</i> | <i>Opinion</i> |
|    | d. | 30 people used a black pen and 12 people used a blue pen.                | <i>Claim</i> | <i>Data</i> | <i>Opinion</i> |
|    | e. | Peaches are most delicious fruit.  | <i>Claim</i> | <i>Data</i> | <i>Opinion</i> |
|    | f. | The car door handle was observed to be warmer after sitting in sunlight. | <i>Claim</i> | <i>Data</i> | <i>Opinion</i> |
|    | g. | The tallest building in the world is in Dubai.                           | <i>Claim</i> | <i>Data</i> | <i>Opinion</i> |
|    | h. | The more interesting the story, the longer the student will read.        | <i>Claim</i> | <i>Data</i> | <i>Opinion</i> |



**Directions for annotating:** Underline control(s), circle changing variable(s), and box information about data collection.

2. a) Annotate the following results table.

Variables		Trial 1	Trial 2	Trial 3
Coal Amount:		1,500 Mg	2,500 Mg	3,500 Mg
Number of Generators:		3	→	
Water Amount:		4,400 L	→	
Data		Trial 1	Trial 2	Trial 3
Final Measurements/ Observations:	Power Output (MW):	51 MW	67 MW	93 MW
	Other:	Air around plant is light brown	Air around plant is brown	Air around plant is dark brown

b) Can this group make a conclusion? YES NO I DON'T KNOW

c) Annotate the following possible conclusion.

**Possible Conclusion:** When less coal is burned in the power plant the air will be less polluted, because when the amount of coal was 1,500 Mg the air around the plant was observed to be light brown, and when the amount of coal was 3,500 Mg the air around the plant was observed to be dark brown.

d) Is this a correct conclusion for the results table? YES NO I DON'T KNOW  
If NO, what is wrong with the conclusion? \_\_\_\_\_.

3. a) Annotate the following results table.

Variables		Trial A	Trial B	Trial C
Coal Amount:		2,000 Mg	2,500 Mg	3,000 Mg
Number of Generators:		4	→	
Water Amount:		4,800 L	4,400 L	4,000 L
Data		Trial A	Trial B	Trial C
Final Measurements/ Observations:	Power Output (MW):	27 MW	60 MW	92 MW
	Other:	Air around plant is brown	Air around plant is brown	Air around plant is brown

b) Can this group make a conclusion? YES NO I DON'T KNOW

c) Annotate the following possible conclusion.

**Possible Conclusion:** The less water used in the power plant the higher the power output, because when 4,800 L of water were used, 27 MW of power were produced, and when 4,000 L of water were used, 92 MW of power were produced.

d) Is this a correct conclusion for the results table? YES NO I DON'T KNOW  
If NO, what is wrong with the conclusion? \_\_\_\_\_.

4. a) Annotate the following results table.

Variables		Trial A	Trial B	Trial C
Coal Amount:		2,500 Mg	→	→
Number of Generators:		4	→	→
Water Amount:		4,800 L	4,400 L	4,400 L
Data		Trial A	Trial B	Trial C
Final Observations/ Measurements:	Power Output (MW):	42 MW	58 MW	75 MW
	Other:	Air around plant is brown	Air around plant is brown	Air around plant is brown

b) Can this group make a conclusion? YES NO I DON'T KNOW

c) Annotate the following possible conclusion.

**Possible Conclusion:** When the water amount was 4,400 L the power output was 75 MW, and when the water amount was 4,800 L the power output was 42 MW, because the more water used in the power plant, the lower the power output.

d) Is this a correct conclusion for the results table? YES NO I DON'T KNOW

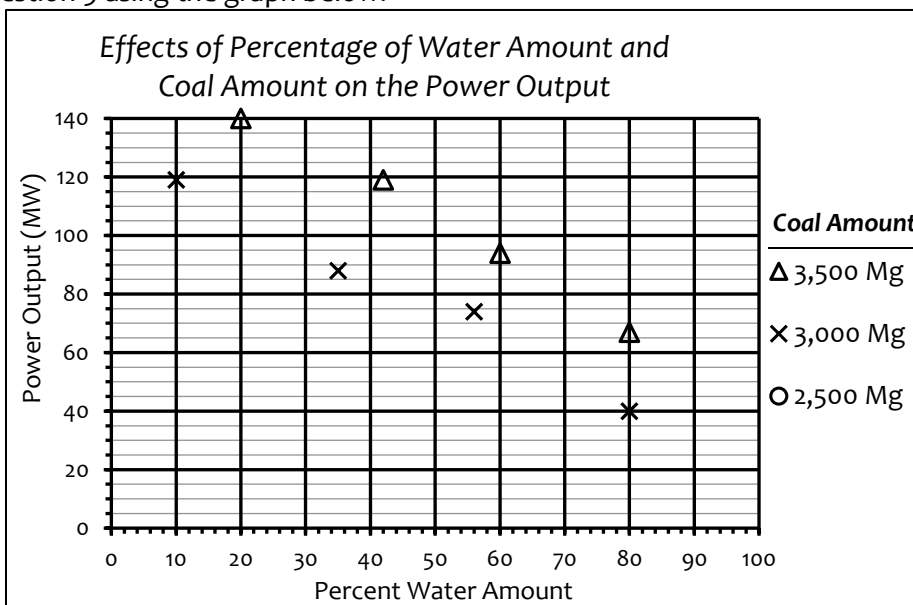
If NO, what is wrong with the conclusion? \_\_\_\_\_.

**Directions:** Some engineers wanted to know how changing the percentage of water amount would affect the power produced by a power plant. They did 3 experiments, using a different coal amount each time, and plotted most of their data on a graph. Answer question 5 using the graph below.

5. a) Annotate the graph.

b) Plot the data points from the chart below on the graph using circles (O) as markers.

Coal Amount: 2,500 Mg	
% Water Amount	Power Output (MW)
20	80
40	60
60	25
78	5



c) Draw trend lines on the graph for each data set.

d) In general for all coal amounts, what happens as the percentage of water amount increases?

\_\_\_\_\_

e) What will the power output be if a power plant uses 3,000 Mg of coal and 20% water amount?

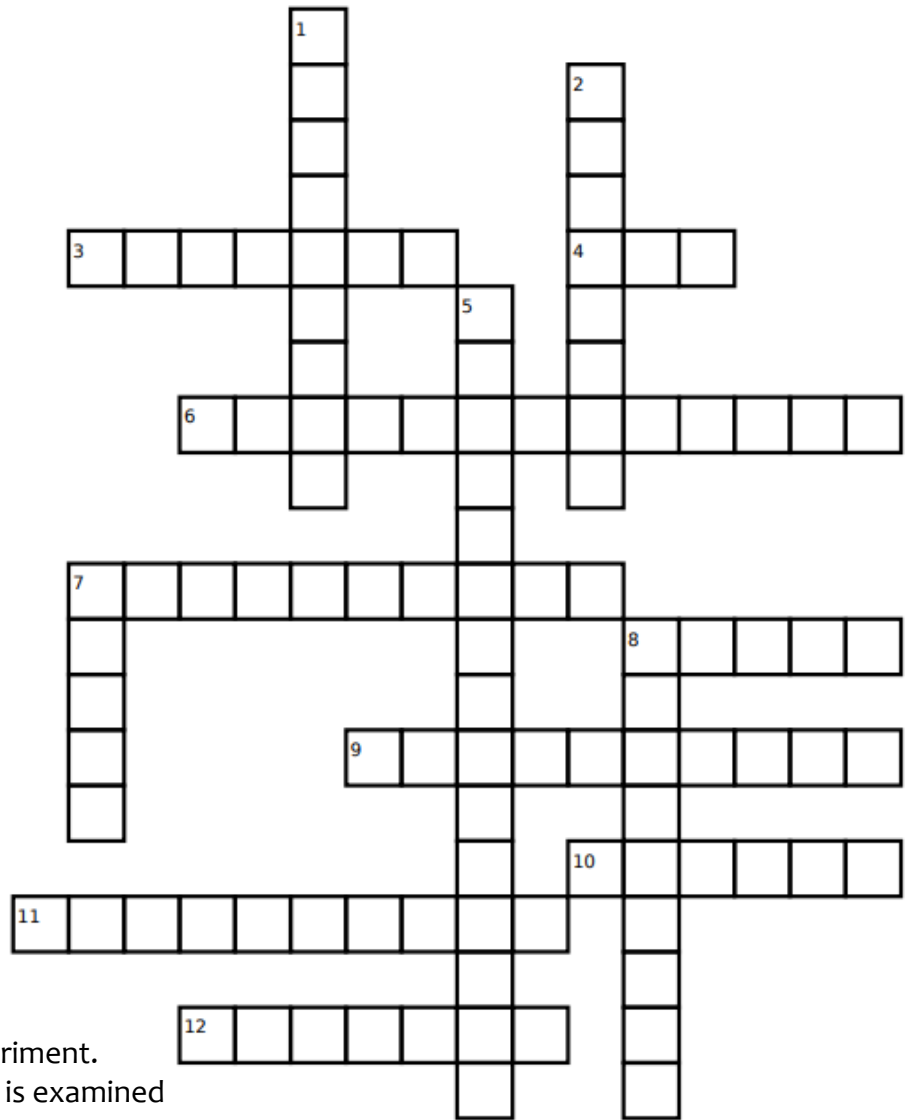
\_\_\_\_\_

f) What will the power output be if a power plant uses 3,250 Mg of coal and 50% water amount?

\_\_\_\_\_

## CROSSWORD PUZZLE

**Directions:** Fill out the following crossword puzzle using the clues below.



### Down

1. A set of steps to conduct an experiment.
2. A scientific practice in which data is examined for patterns and trends.
5. Solar power, wind power, and hydroelectric power are all examples of \_\_\_\_\_.
7. A measure of the energy of a system over time.
8. A method for a specific task.

### Across

3. When data repeats in a predictable manner there is a \_\_\_\_\_.
4. A \_\_\_\_\_ is an example of an energy efficient lightbulb.
6. When nonrenewable energy sources are burned \_\_\_\_\_ is produced.
7. A \_\_\_\_\_ is used to compare a portion of a system to a whole system.
8. If all data points are increasing, there is a \_\_\_\_\_.
9. What you expect to happen based off of previous measurements/observations.
10. The ability of an object to do work.
11. A piece of equipment that can convert the light energy from the sun into electrical energy or heat energy.
12. A measure of the force that makes electricity move.



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