Group Color: ____________________
Subgroup Number: ____________________
Team/Subgroup Symbol: ______________ /_____

How Science Works

Grade 6

Module 1

Class Question:

Scientist (Your Name): ____

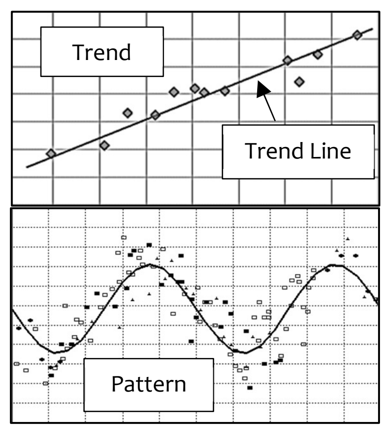
Teacher's Name: ____

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 <u>or</u> 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:

____

____

Describe what happened during the experiment.

____

____

____

____

____

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).

a) Class Solar Panel	b) Round Batteries
$I =$ ____________ $V =$ ____________ $P =$ ____________ × ____________ $=$ ____________	$I =$ ____________ $V =$ ____________ $P =$ ____________ × ____________ $=$ ____________
c) Rectangular batteries	d) Your Solar Panel
$I =$ ____________ $V =$ ____________ $P =$ ____________ × ____________ $=$ ____________	$I =$ ____________ $V =$ ____________ $P =$ ____________ × ____________ $=$ ____________

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 a solar panel?

Experimental Considerations:

1. You will only have access to the materials on the materials page.
2. If you are not changing lamp height, the lamp height must be 14 cm.
3. 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) you would like to test. For each changing variable 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 calculating

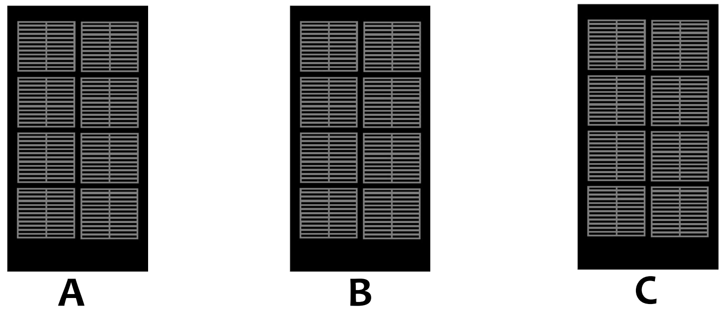
  ____?

SciTrek Member Approval: ______________________

Get a materials page from your 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 trials under each solar panel.



Changing Variable(s):

1) ______________________**:** ______________ ______________ ______________

2) ______________________**:** ______________ ______________ ______________

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

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

Power Source / Solar Panel ______________ / ______________

______________ / ______________

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 A) 30°, B) 45°, and C) 60°.

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

5. ______________________________

____

6. ______________________________

____

7. ______________________________

____

8. ______________________________

____

SciTrek Member Approval: ____________________

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. Remember to record 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**
	Power Source:	***Solar panel*** →	→	→
	Panel Angle:			
	Shading Amount:			
	Temperature: Room Temp: ______			
	________________: other variable			
	Predictions	**Trial A**	**Trial B**	**Trial C**
	Put an "S" in the trial that will give the smallest power and an "L" in the trial that will give the largest power.			
	Data and Calculations	**Trial A**	**Trial B**	**Trial C**
Measurements:	Current (mA):			
Measurements:	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**
Measurements/ Observations:	Power:	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 higher the number of generators, the great the power produced, 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:		3,200 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**
Measurements/ Observations:	Power:	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: The more people working at the power plant, the more power produce, 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**
Measurements/ Observations:	Power:	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: The greater the amount of coal burned in the power plant, the more polluted the air, 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? ____.

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**
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 water amount the smaller the amount of power produced.

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**
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 water amount used in the power plant, the more power produced, because when 4,000 L 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 in order 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 (measurements/observations/calculations)

____

____

____

SciTrek Member Approval: ____________________

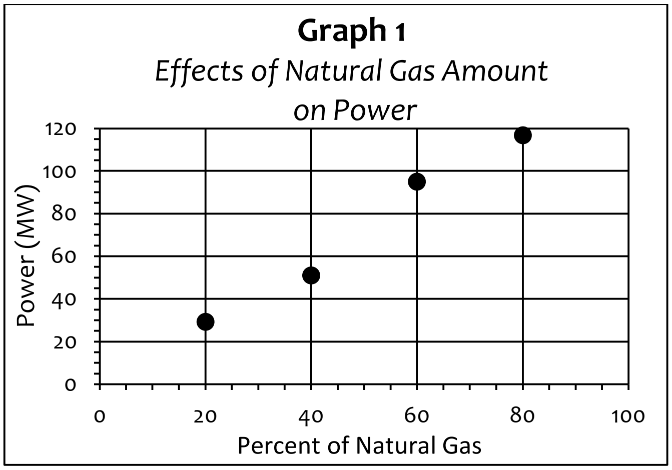
TECHNIQUE

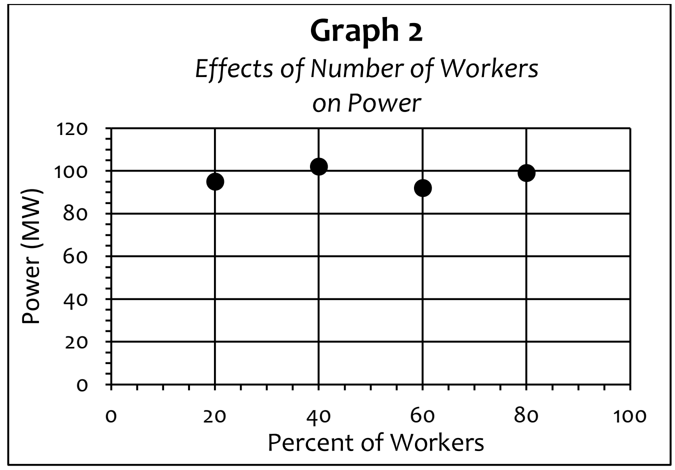
Trend Lines

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

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.

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

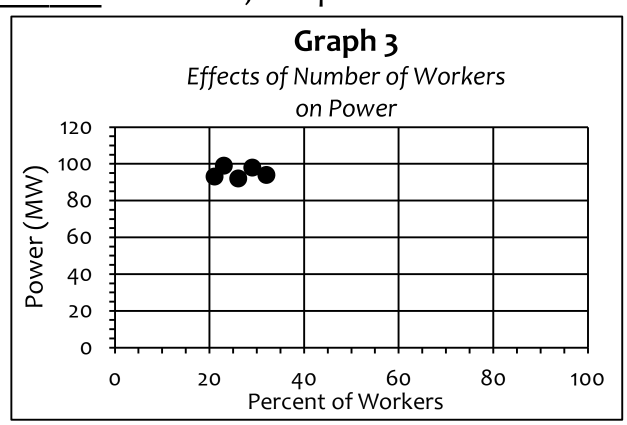
a) Which graph(s) represent a changing variable that affects the data? **1** **2**

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

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

As the percentage of ________________________ increases, the power ____________________.

2. Directions: *Answer the question using Graph 3.* What is the challenge in drawing a trend line on this graph?



____

____

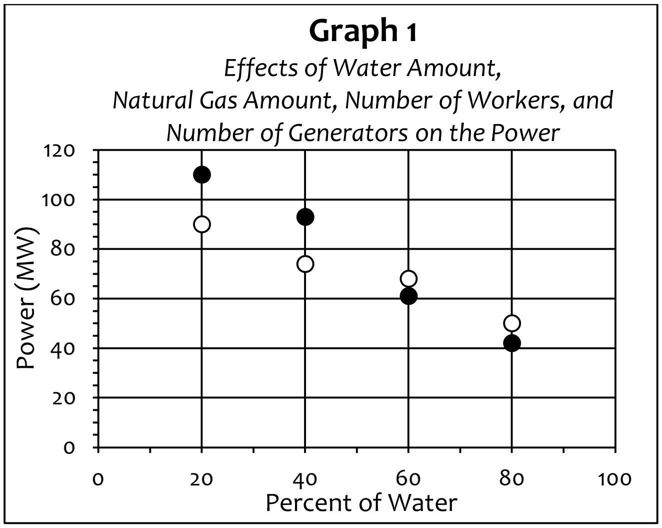
____

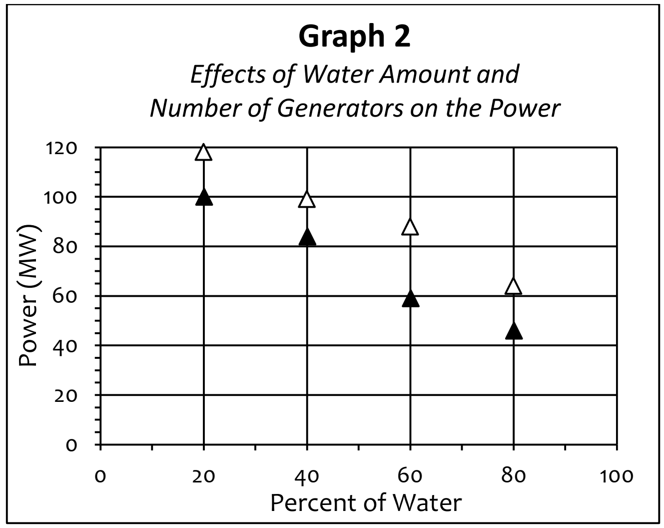
TECHNIQUE

Designing Experiments

Four UCSB engineers were studying the amount of power being produced by natural gas power plants by examining natural gas amount, water amount, number of workers, and 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).

3. 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 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 ________________________________.

b) What is the power for a power plant that uses 70% of the water, burns 3,200 Mg of natural gas, has 8 workers, and had 2 generators? **<u>Expected Power</u>:** ____________

- Why are trend lines important? ____.

c) Can you predict what the power 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**

<u>Expected Power</u>: ____________

d) What does this mean for your experimental design? ______________________________________

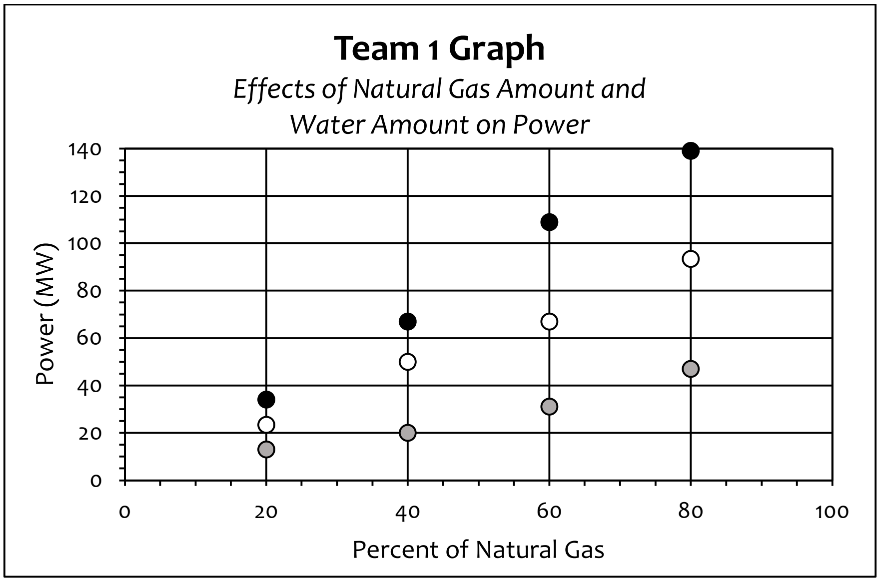
____

SCIENTIFIC PRACTICES

Analyzing & Interpreting Data

A large group of engineers collaborated by dividing into three teams to study the effects of water amount, natural gas amount, number of workers, and number of generators on the power of natural gas power plants. The three 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
◉ (gray)	4,800 L	9

a) Does percentage of natural gas affect the power 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 ________________________.

b) What power would you expect to calculate with the following specifications?

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

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

● ○ ◉ (gray)

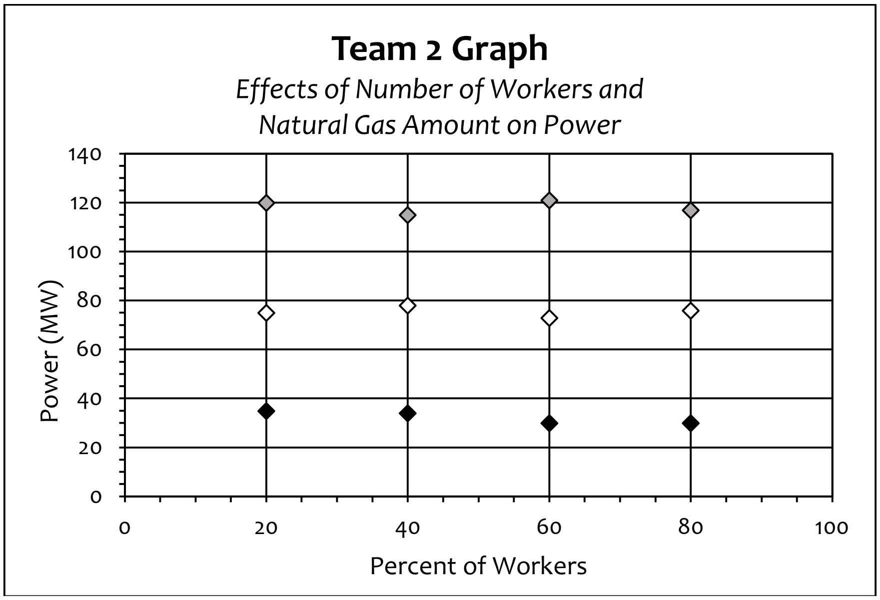
Expected Power:

____

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 workers affect the power 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 ________________________.

b) What power would you expect to calculate with the following specifications?

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

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

◆ ◇ ◈

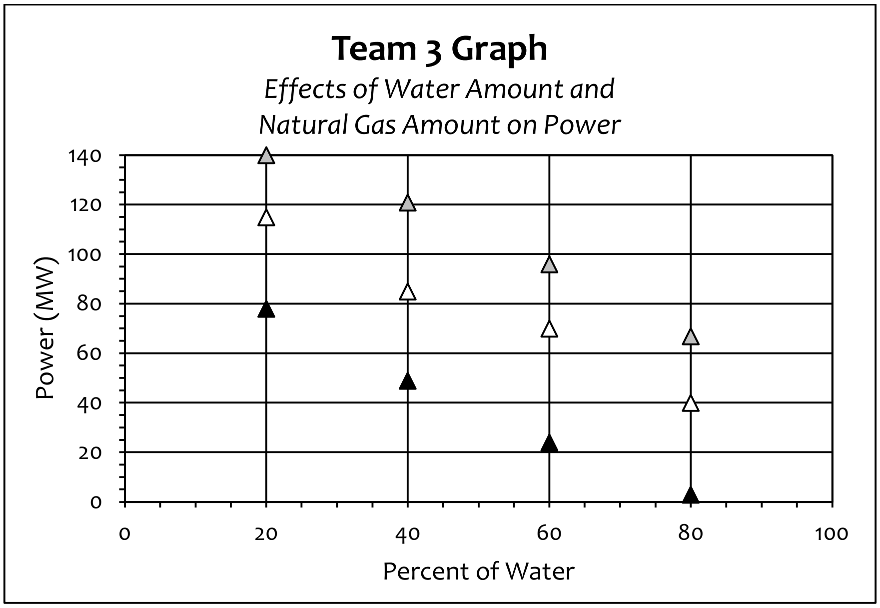
Expected Power:

____

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 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 ______________________.

b) What power would you expect to calculate with the following specifications?

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

Expected Power:

____

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

▲ △ ▲

c) What power would you expect to calculate with the following specifications?

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

Expected Power:

____

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

▲ △ ▲

SCIENTIFIC PRACTICES

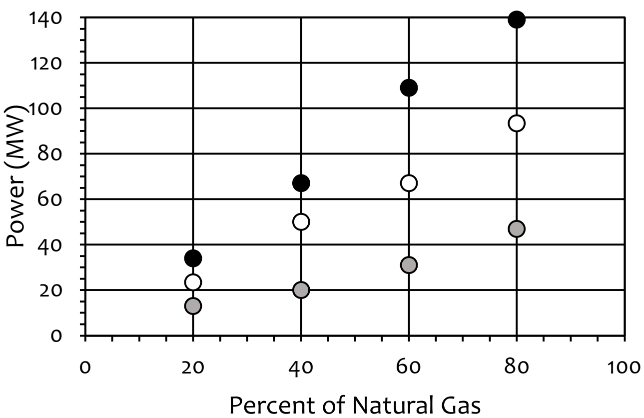
Analyzing & Interpreting Data

A natural gas power plant wants to know if the trends in their data can be used to predict the power for different combinations of natural gas amount, and water amount, which have not been tested yet. Use teams' 1 and 3 graphs to help the power plant interpret the data.

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

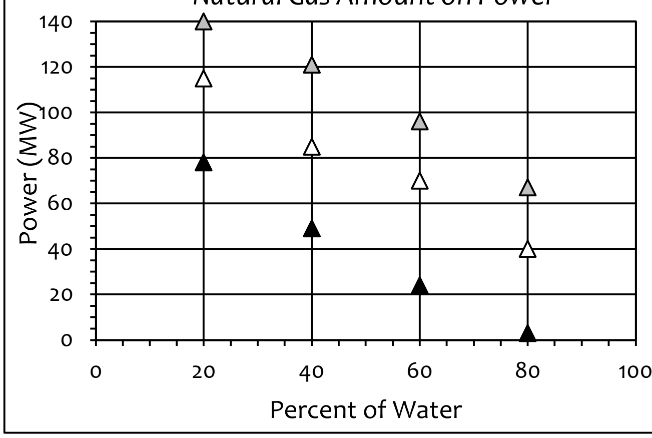
Team 1 Graph

Effects of Natural Gas Amount and Water Amount on Power



Team 3 Graph

Effects of Water Amount and Natural Gas Amount on Power



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

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

a) Using <u>both</u> of the graphs above, what power would you expect to calculate 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: ● ○ ● (gray)

Team 3: ▲ △ ▲ (gray)

<u>Expected Power:</u>

____

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:**

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

Step 3. Calculate the **percentage**:

Round the percentage to the nearest whole number. Percentages have units of %.

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

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

1) Panel Angle: 50°	**2) Shading Amount**: $\frac{6}{8}$
Allowed values for each variable:	
Step 1: Panel Angle: (30° – 75°)	Shading Amount: $(\frac{0}{8} - \frac{8}{8})$
Step 2: Range = _______ – _______ *Step 3:* = _______ %Angled = $100\times\left(\frac{\_\_\_\_ - \_\_\_\_}{\_\_\_\_}\right)$ = _______	Range = _______ – _______ = _______ %Shaded = $100\times\left(\frac{\_\_\_\_ - \_\_\_\_}{\_\_\_\_}\right)$ = _______

Our subgroup is on team: ____

Variables	Min Value	Max Value
Panel Angle:	30°	75°
Shading Amount:	$\frac{0}{8}$	$\frac{8}{8}$
Temperature:	19°C	44°C

The range for our changing variable is:

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

1. As a subgroup select and record the values of your changing variable in the table below.

   Team Temperature: Choose any whole number temperatures between 25°C and 44°C. You may also choose room temperature (ranges from 19°C - 24°C) as one of your four values. If you select this value, write "RT" on the line; you will record the numerical value of the room temperature and determine the percent temperature on the experiment day.

2. Use the following equation to calculate the percent of your change variable values.

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

1) Changing Variable Value 1: ________________	2) Changing Variable Value 2: ________________
% Changing Variable = $100 \times \left(\frac{\_\_\_\_\_ - \_\_\_\_\_}{\_\_\_\_\_}\right) =$ ________	% Changing Variable = $100 \times \left(\frac{\_\_\_\_\_ - \_\_\_\_\_}{\_\_\_\_\_}\right) =$ ________
3) Changing Variable Value 3: ________________	**4) Changing Variable Value 4:** ________________
% Changing Variable = $100 \times \left(\frac{\_\_\_\_\_ - \_\_\_\_\_}{\_\_\_\_\_}\right) =$ ________	% Changing Variable = $100 \times \left(\frac{\_\_\_\_\_ - \_\_\_\_\_}{\_\_\_\_\_}\right) =$ ________

QUESTION

Question our subgroup will investigate:

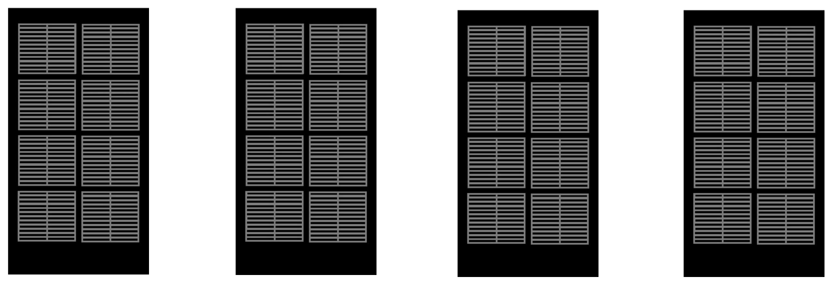
- If we change the ____,
  insert each changing variable (independent variable)

  what will happen to the ____
  insert what you are calculating

  ____?

EXPERIMENTAL SET-UP

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



D E F G

Changing Variable(s):

1) __________________ : __________ __________ __________ __________

2) __________________ : __________ __________ __________ __________

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

____

____

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

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

Class and Team Controls: (same vlaues between subgroups)	**Subgroup Control:** (differnet values between subgroups)
Power Source / Solar Panel	____________ / ____________
____________ / ____________	
____________ / ____________	

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 D) 30°, E) 45°, F) 60°, and G) 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 table for each of your trials. For the variables that remain constant, write the value in *Trial D*. Then, draw an arrow through each box indicating the variable is a control. Remember to record 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 D	Trial E	Trial F	Trial G
	Power Source:	***Solar panel***	→	→	→
	Panel Angle:				
	Shading Amount:				
	Temperature: Room Temp: ______				
	____________________: other variable				
	Predictions	**Trial D**	**Trial E**	**Trial F**	**Trial G**
	Put an "S" in the trial that will give the smallest power and an "L" in the trial that will give the largest power.				
	Data and Calculations	**Trial D**	**Trial E**	**Trial F**	**Trial G**
Measurements:	Current (mA):				
Measurements:	Voltage (V):				
Calculations:	Percent Changing Variable: (get values from pg. 20)				
Calculations:	Power (mW): $P = I \times V$				

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

Modified Name of Changing Variable:
Panel Angle: Percent Angled
Shading Amount: Percent Shaded
Temperature: Percent Heated

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.
- ☐ Label the y-axis (vertical) with what you calculated, including units (Ex: Power (mW)).
- ☐ Label the x-axis (horizontal) with your modified name of changing variable, including units (Ex: Percent Angled (%)).
- ☐ Select your subgroup control in the legend by checking the appropriate box. Then, put <u>your</u> subgroup control value next to your subgroup symbol.

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 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 subgroup <u>in your team</u>.

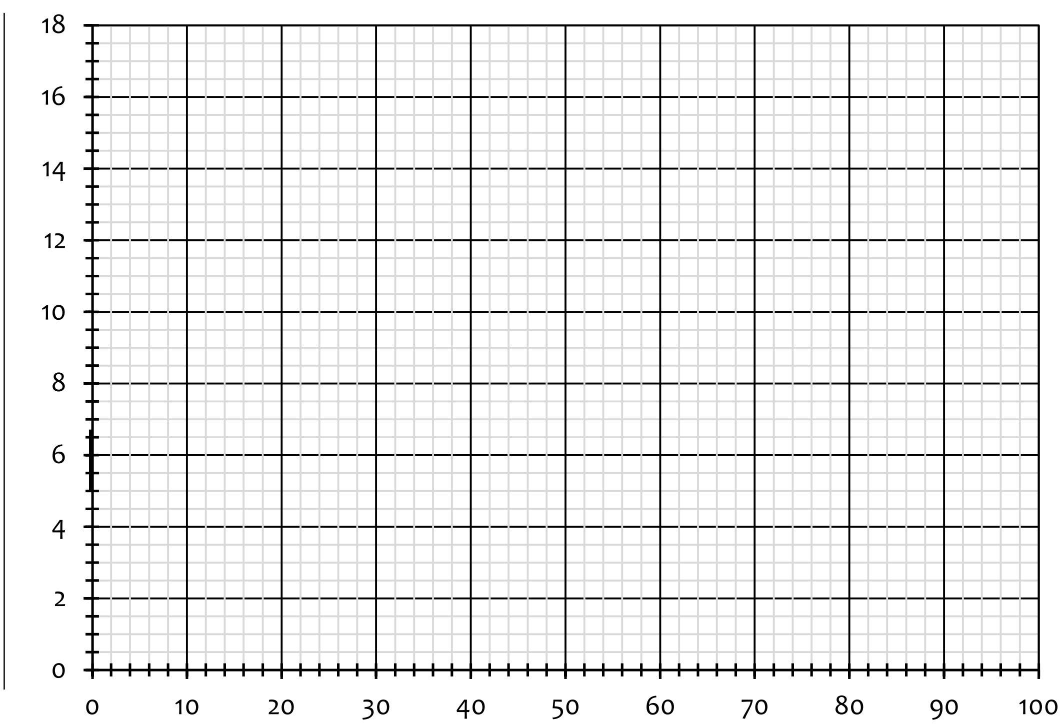
- ☐ Complete the legend for the other subgroup in your team by writing their subgroup control value next to their subgroup symbol.
- ☐ Graph the other subgroup's 4 points using their symbol as the markers (**do not label these points**). Then, draw a trend line that best fits their data.

Effects of ______________________________ ***and*** ______________________________

insert changing variable *insert subgroup control*

on the ______________________________

insert what you calculated



Legend	
Subgroup Control: ☐ Panel Angle ☐ Shading Amount ☐ Temperature	
Subgroup Symbol	*Subgroup Control Value*
○	
△	

____

CONCLUSION

Generate a <u>claim</u> about how your changing variable affected your team's results. (Ex: The larger the size of the solar panel the larger the power produced.)	We can conclude ____________________ claim ____________________ ____________________ ____________________ ____________________
What <u>data</u> do you have to support your claim? (Remember to include your calculations, <u>not trial letters</u>.)	because ____________________ data ____________________ ____________________ ____________________ ____________________

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.

Percent Changing Variable: 55%	
Subgroup Symbol	***Prediction***
○	
△	

NOTES ON PRESENTATIONS

What variables affect the power produced by a solar panel?

Percent Changing Variable:	☐ Panel Angle ☐ Shading Amount ☐ Temperature				
Power (mW):					

Question: ____

____

Summary: ____

____

____

____

Percent Changing Variable:	☐ Panel Angle ☐ Shading Amount ☐ Temperature				
Power (mW):					

Question: ____

____

Summary: ____

____

____

____

TIE TO STANDARDS

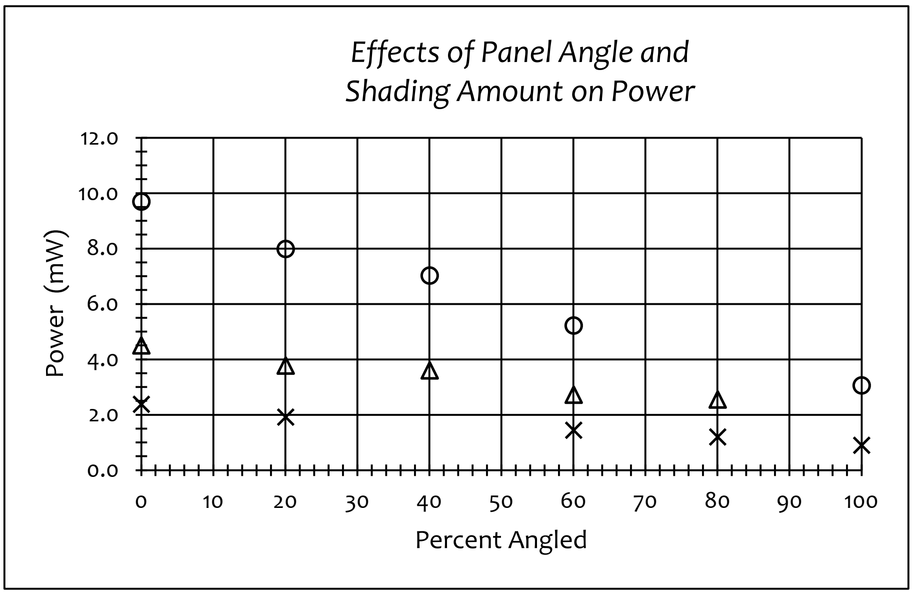
1. What is **power**? ____

Predicting Power

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

Green LED: 3.6 mW **White LED:** 64.6 mW

2. Annotate the graph below, draw trend lines, label subgroup controls, and answer the questions.



Controls		
Engineer Symbol	*Shading Amount*	*Temperature*
○	$\frac{0}{8}$	RT
△	$\frac{4}{8}$	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 the graph, what power would you expect to calculate if you used a solar panel that was $\frac{2}{8}$ shaded, 40% angled (50°), and at room temperature?

Which experiment(s) should you look at?

○ △ **X** Prediction: ____________

Actual:
(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
    2. Non-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).

    b. A source that produces energy that is not used up or can be replenished within a human's lifetime.

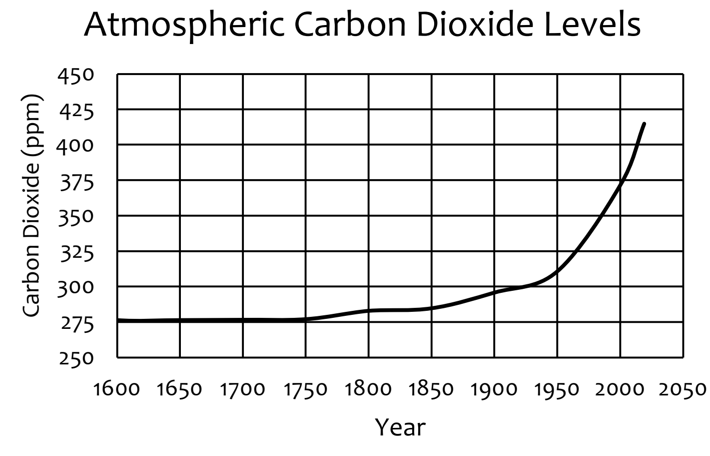
Renewable Energy Sources	Non-renewable Energy Sources
______________________	______________________
______________________	______________________
______________________	______________________

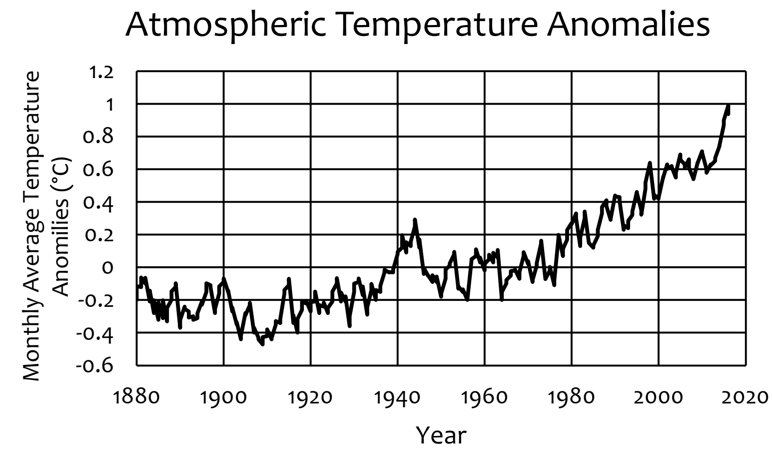
Effects of Power Use

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_2) levels and temperature. Using the graphs below, determine how the two are related.





12. As CO_2 levels increase, atmospheric temperature ________________________, because

____

____

____

____

____.

13. If California uses non-renewable energy sources for power, what will happen to the amount of CO_2 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_2 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 NO **(Circle one)**

18. Temperature: ____

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

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

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

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.

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

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**
Measurements/ Observations:	Power (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**
Measurements/ Observations:	Power (MW):	27 MW	60 MW	92 MW
	Other:	Air around plant is light brown	Air around plant is light brown	Air around plant is light 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, 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**
Measurements/ Observations	Power (MW):	42 MW	58 MW	75 MW
	Other:	Air around plant is light brown	Air around plant is light brown	Air around plant is light 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 was 75 MW, and when the water amount was 4,800 L the power was 42 MW, because the more water used in the power plant, the lower the power.

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

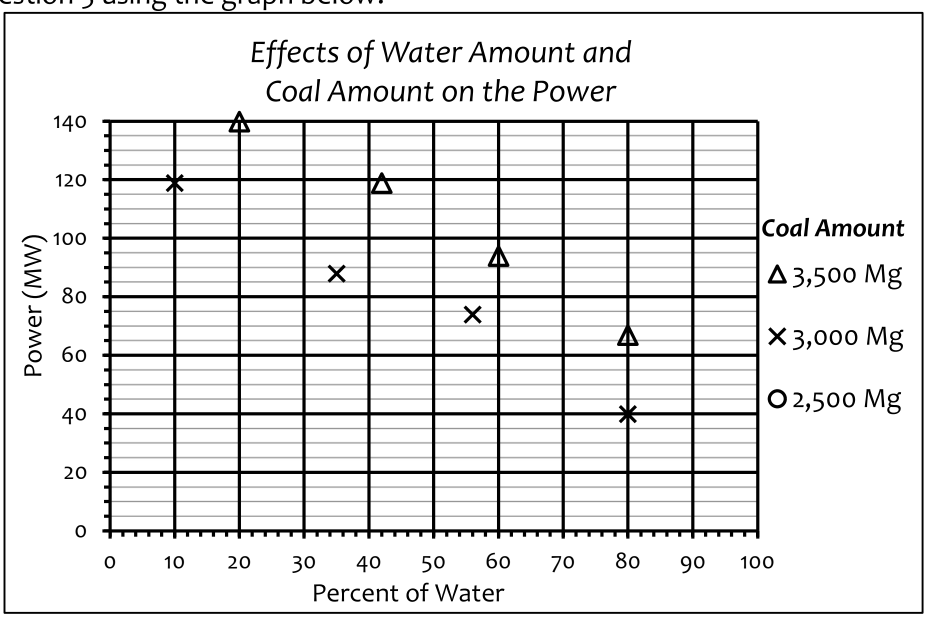
If NO, what is wrong with the conclusion? ____.

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 amounts 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	
% of Water	**Power (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 be if a power plant uses 3,000 Mg of coal and 20% water amount?

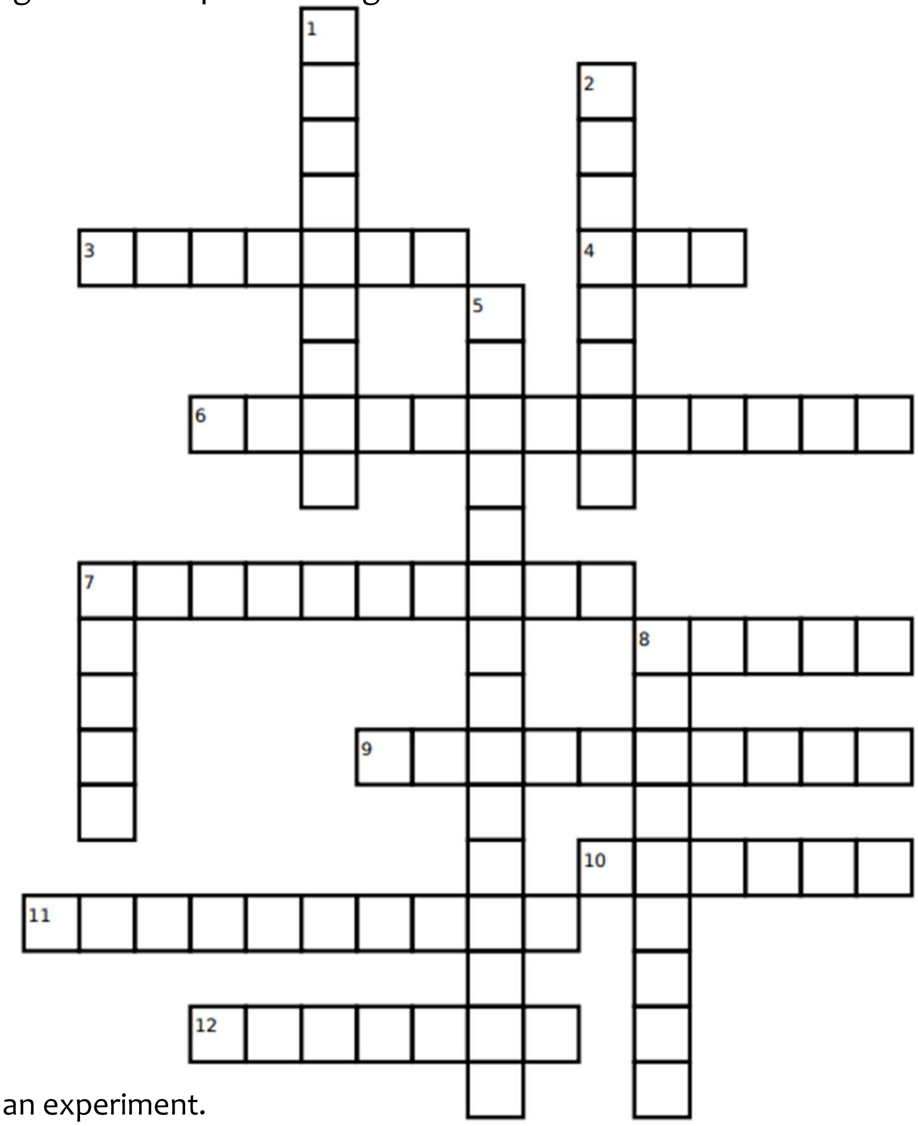
____

f) What will the power 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

SciTrek is an educational outreach program that is dedicated to allowing 2nd - 12th grade students to experience scientific practices firsthand. SciTrek partners with local teachers to present student-centered inquiry-based modules that not only emphasize the process of science but also specific grade level NGSS performance expectations. Each module allows students to design, carry out, and present their experiments and findings.

For more information, please feel free to visit us on the web at *scitrek.chem.ucsb.edu* or contact us by e-mail at scitrekelementary@chem.ucsb.edu.

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