Group Color: _____

Subgroup Number: _____

Team/Subgroup Symbol: _____ /_____

How Science Works

Grade 6

Module 2

Class Question:

Scientist (Your Name): _____

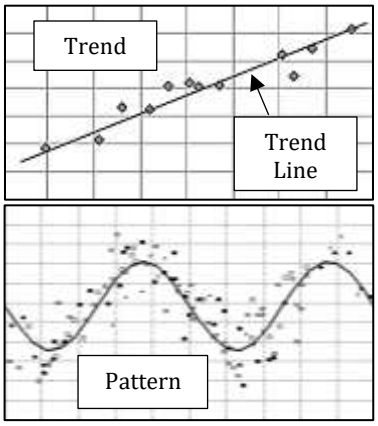
Teacher's Name: _____

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.



- **Chemical Reaction:** A process where one or more substances are altered into one or more different substances. Evidence of a chemical reaction can include: formation of a gas, and/or a change in color, smell, or temperature.
- **Graduated Cylinder:** A piece of laboratory equipment used to measure the volume of a liquid.
- **Beaker:** A piece of laboratory equipment used to contain chemicals and conduct chemical reactions.
- **Tare:** To zero the scale.
- **Heat:** A form of energy associated with the movement of particles in a material (also called "thermal energy"). When two systems are in contact, heat flows from the hotter system to the cooler system.
- **Kinetic Energy:** Energy of motion.
- **Temperature:** A physical property which measures the kinetic energy of particles in a substance; the faster the particles are moving, the higher the temperature.
- **Median:** The middle number in a series of measurements.
- **Range:** The difference between the biggest and smallest measurements.

OBSERVATIONS

Experimental Set-Up**:**

Formula	Substance Name	Physical Description	Amount

Initial Water Temperature: _____

_____

_____

_____

_____

_____

Describe what happened during the experiment.

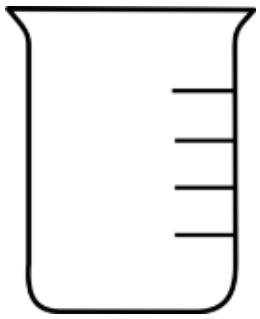
_____

_____

_____

_____

_____



_____

_____

_____

_____

_____

_____

VARIABLES

Variable	How will changing this variable affect the temperature change of the reaction?
	_____ _____ _____ _____
	_____ _____ _____ _____
	_____ _____ _____ _____
	_____ _____ _____ _____
	_____ _____ _____ _____

Experimental Considerations:

1. You will only have access to the materials on the materials page.
2. If you are not changing stir speed, the stir speed must be level 2.
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 temperature change.

Changing Variable 1: _____
Discuss with your subgroup how you think **changing variable 1** will affect the temperature change.

Changing Variable 2 (optional): _____
Discuss with your subgroup how you think **changing variable 2** will affect the temperature change.

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: NaCl mass) and the values (Ex: 2.0 g) you will use for your trials under each beaker.

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: container type/beaker).

Container Type /	Beaker	/	
/		/	

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 sodium chloride (NaCl) mass one step would be: Measure A) 2.0 g, B) 4.5 g, and C) 8.0 g of NaCl in a weigh boat.

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. 2.1 g).

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

Variables		**Trial A**	**Trial B**	**Trial C**
Container Type:		***Beaker*** →		
Water Volume:				
$CaCl_2$ Mass:				
$NaHCO_3$ Mass:				
NaCl Mass:				
_____ Other Variable				
Predictions		**Trial A**	**Trial B**	**Trial C**
Put an "S" in the trial that will give the smallest temperature change and an "L" in the trial that will give the largest temperature change.				
Data and Calculations		**Trial A**	**Trial B**	**Trial C**
Measurements:	Initial Temperature (℃):			
	Maximum Temperature (℃):			
Observations:	Other:			
Calculations:	Temperature Change (℃): $\Delta T = T_{max} - T_{min}$			

The independent variable(s) is(are) the changing variable(s) and the dependent variables are the maximum temperature and other.

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:* The ball mass does not affect the speed at which it rolls down a ramp.
     - 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:* When the ball mass was 360 g its speed was 1.2 $\frac{m}{s}$, and when the ball mass was 100 g, its speed was 1.1 $\frac{m}{s}$.
     - 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**
Container Type:		Beaker	→	→	→
Solid A Mass:		2.0 g	→	→	→
Solid B Mass:		6.0 g	→	→	→
Solid C Mass:		5.0 g	7.0 g	9.0 g	11.0 g
Stir Speed:		Medium	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**
Measurements/ Observations:	Temperature Change:	8.5°C	10.5°C	18.1°C	22.7°C
	Other:	Made a little foam	Made foam	Foam filled to the top	Overflowed with foam

Possible Conclusion: The greater the solid C mass, the higher the temperature change, because when the solid C mass was 5.0 g, the temperature change was 8.5°C, and when the solid C mass was 11.0 g, the temperature change was 22.7°C.

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**
Container Type:		Beaker	→	→	→
Solid A Mass:		6.0 g	→	→	→
Solid B Mass:		10.0 g	→	→	→
Solid C Mass:		8.0 g	→	→	→
Stir Speed:		Slow	Medium	Fast	Super-Fast
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**
Measurements/ Observations:	Temperature Change:	13.0°C	12.1°C	11.3°C	10.2°C
	Other:	Made foam	Made a little foam	Made foam	Made a little foam

Possible Conclusion: The greater the stir speed, the higher the temperature change, because when the stir speed was slow, the temperature change was 13.0°C, and when the stir speed was super-fast, the temperature change was 10.2°C.

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**
Container Type:		Beaker	→	→	→
Solid A Mass:		2.0 g	4.0 g	6.0 g	8.0 g
Solid B Mass:		5.0 g	→	→	→
Solid C Mass:		5.0 g	→	→	→
Stir Speed:		Medium	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**
Measurements/ Observations:	Temperature Change:	7.1°C	5.8°C	3.7°C	2.9°C
	Other:	Overflowed with foam	Foam filled to the top	Made foam	Made a little foam

Possible Conclusion: The greater the solid A mass, the less foam is produced, because We observed when the solid A mass was 2.0 g, the beaker overflowed with foam, but when the solid A mass was 8.0 g the beaker had only a little bit of foam.

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
Container Type:		Beaker	→	→	→
Solid A Mass:		6.0 g	→	→	→
Solid B Mass:		10.0 g	12.0 g	14.0 g	16.0 g
Solid C Mass:		8.0 g	→	→	→
Stir Speed:		Medium	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**
Measurements/ Observations:	Temperature Change:	11.5°C	10.2°C	12.0°C	10.8°C
	Other:	Made a little foam	Made more foam	Foam filled to the top	Overflowed with foam

Possible Conclusion: We observed, when there were 16.0 g of solid B, the reaction overflowed with foam, and when there were 10.0 g of solid B, the reaction made a little foam, because the greater the solid B mass, the more foam is made.

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
Container Type:		Beaker	→	→	→
Solid A Mass:		2.0 g	3.0 g	4.0 g	5.0 g
Solid B Mass:		5.0 g	→	→	→
Solid C Mass:		8.0 g	6.0 g	4.0 g	2.0 g
Stir Speed:		Fast	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**
Measurements/ Observations:	Temperature Change:	13.3°C	10.8°C	8.1°C	5.9°C
	Other:	Overflowed with foam	Foam filled to the top	Made foam	Made a little foam

Possible Conclusion: The smaller the solid A mass, the higher the temperature change, because when the solid A mass was 2.0 g, the temperature change was 13.3°C, and when the solid A mass was 5.0 g, the temperature change was 5.9°C.

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: _____

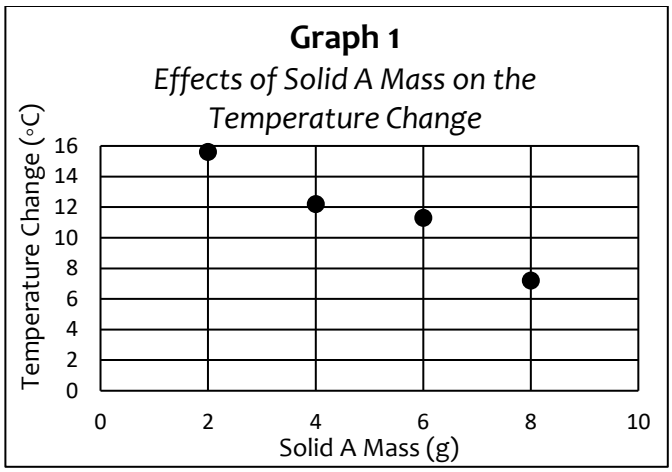
TECHNIQUE

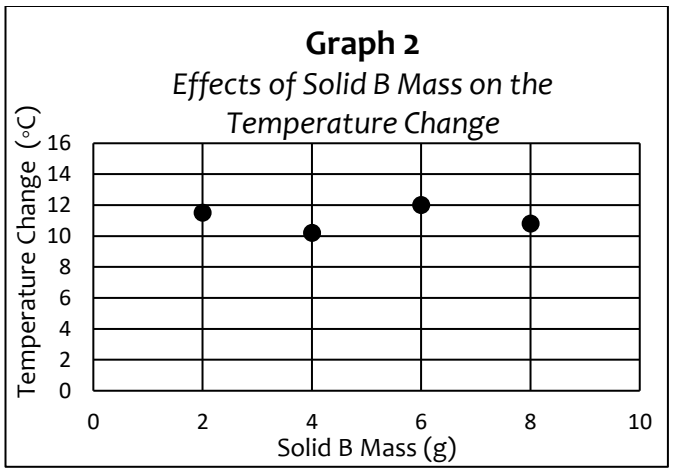
Trend Lines

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? **A** **B**

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

  As solid _____ mass increases, the temperature change _____.

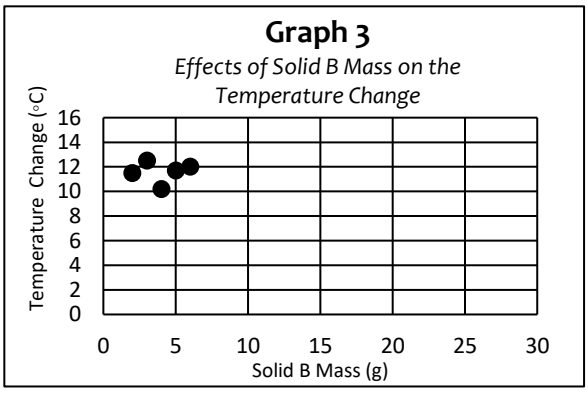
2. Directions: *Answer the question using Graph 3.*

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

_____

_____

_____



TECHNIQUE

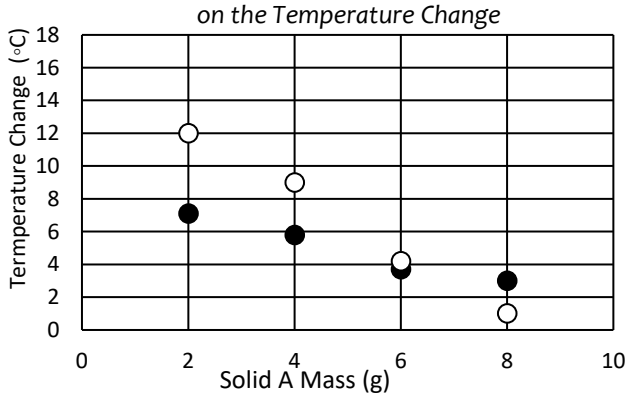
Designing Experiments

Four UCSB scientists were studying the temperature change in a chemical reaction by examining solid A mass, solid B mass, solid C mass, and the water volume used. They all picked solid A mass as their changing variable. Two scientists worked independently, and they used different control values for solid B mass, solid C mass, and water volume (Graph 1). The other two scientists collaborated, and they picked the same control values for solid B mass and water volume (Graph 2).

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

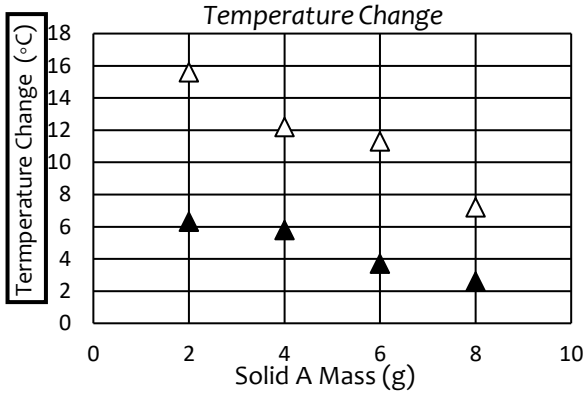
Graph 1

Effects of Solid A Mass, Solid B Mass, Solid C Mass, and Water Volume on the Temperature Change



Graph 2

Effects of Solid A Mass and Solid C Mass on the Temperature Change



Controls			
Scientist Symbol	*Solid B Mass*	*Solid C Mass*	*Water Volume*
●	6.0 g	5.0 g	60 mL
○	10.0 g	8.0 g	100 mL

Controls			
Scientist Symbol	*Solid B Mass*	*Solid C Mass*	*Water Volume*
▲	6.0 g	5.0 g	70 mL
△	6.0 g	8.0 g	70 mL

a) Does solid A mass affect the temperature change of the reaction? **YES** **NO**

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

- As solid A mass increases, the temperature change _____.

b) What is the temperature change when the following are mixed: 3.0 g of A, 6.0 g of B, 5.0 g of C, and 60 mL of water? **<u>Expected Temperature Change</u>:** _____

- Why are trend lines important? _____

c) Can you predict what the temperature change would be if the scientists mixed 6.0 g of A, 6.0 g of B, 6.0 g of C, and 70 mL of water? **YES** **NO**

- If YES, which graph is more useful to make your prediction? **1** **2**

<u>Expected Temperature Change</u>: _____

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

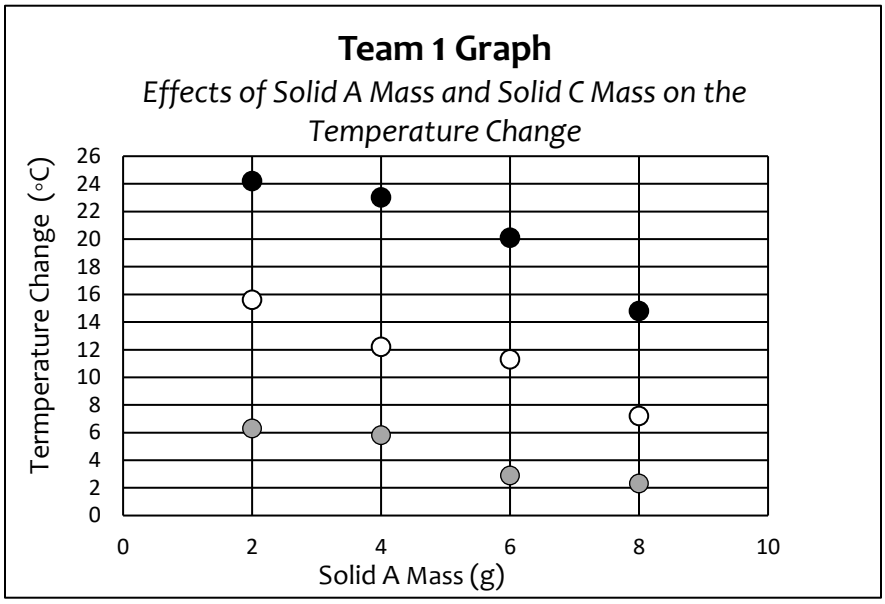
_____

SCIENTIFIC PRACTICES

Analyzing & Interpreting Data

A large group of scientists collaborated by dividing into three teams to study the effects of solid A mass, solid B mass, solid C mass, and water volume on the temperature change in a chemical reaction. The three teams agreed to keep the water volume constant at 70 mL 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		
Scientist Symbol	*Solid B Mass*	*Solid C Mass*
●	6.0 g	12.0 g
○	6.0 g	8.0 g
●	6.0 g	5.0 g

a) Does solid A mass affect the temperature change of the reaction? **YES** **NO**

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

- As solid A mass increases, the temperature change _____.

b) What temperature change would you expect to calculate with the following amounts?

Solid A Mass	5.0 g
Solid B Mass	6.0 g
Solid C Mass	8.0 g

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

● ○ ●

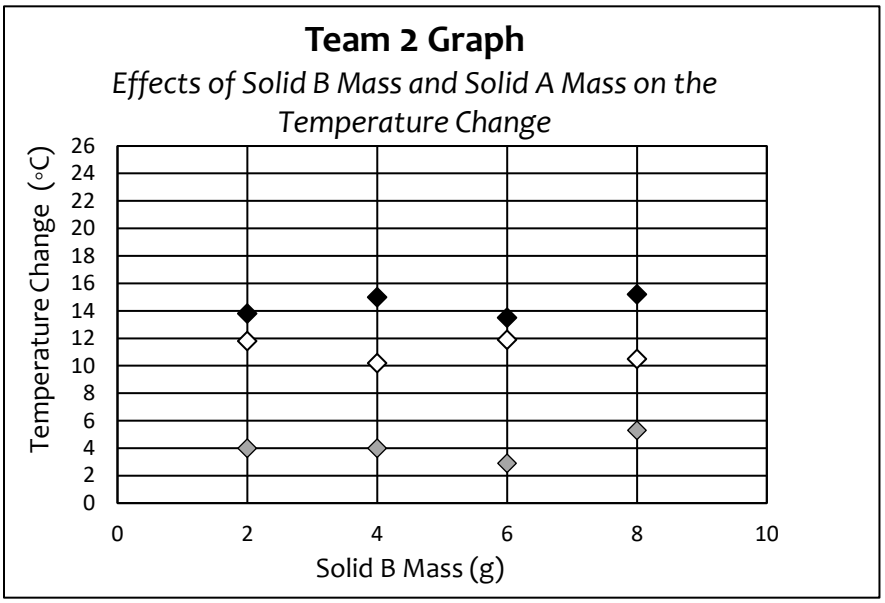
Expected Temperature Change:

_____

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		
Scientist Symbol	*Solid A Mass*	*Solid C Mass*
◆	3.0 g	8.0 g
◇	6.0 g	8.0 g
◆	9.0 g	8.0 g

a) Does solid B mass affect the change in temperature of the reaction? **YES** **NO**

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

- As solid B mass increases, the temperature change _____.

b) What temperature change would you expect to calculate with the following amounts?

Solid A Mass	7.5 g
Solid B Mass	5.0 g
Solid C Mass	8.0 g

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

◆ ◇ ◆

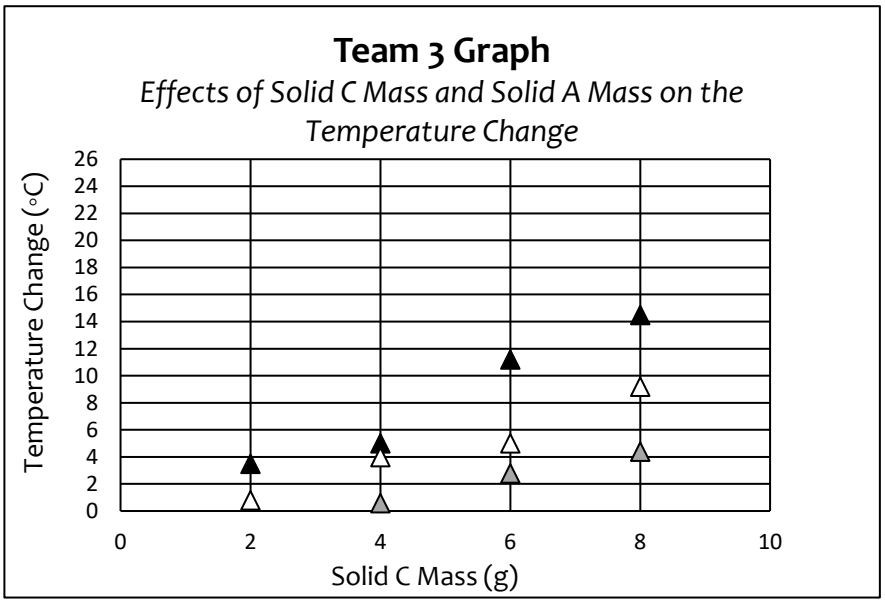
<u>Expected Temperature Change:</u>

_____

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		
Scientist Symbol	*Solid A Mass*	*Solid B Mass*
▲	2.0 g	7.0 g
△	6.0 g	7.0 g
◭	10.0 g	7.0 g

a) Does solid C mass affect the change in temperature of the reaction? **YES** **NO**

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

- As solid C mass increases, the temperature change _____.

b) What temperature change would you expect to calculate with the following amounts?

Solid A Mass	2.0 g
Solid B Mass	3.0 g
Solid C Mass	8.0 g

Expected Temperature Change:

_____

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

▲ △ ◭

c) What temperature change would you expect to calculate with the following amounts?

Solid A Mass	5.0 g
Solid B Mass	7.0 g
Solid C Mass	10.0 g

Expected Temperature Change:

_____

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

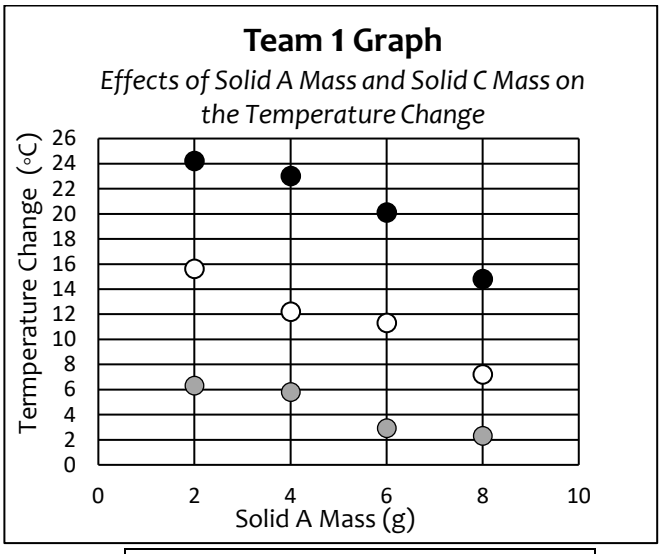
▲ △ ◭

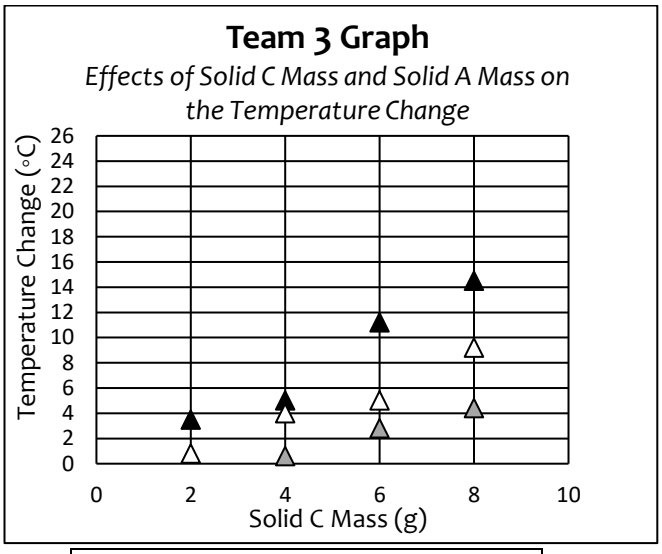
SCIENTIFIC PRACTICES

Analyzing & Interpreting Data

The lab wants to know if the trends in their data can be used to predict the temperature change for different combinations of solid A mass, and solid C mass, which have not been tested yet. Use team 1 and 3 graphs to help the lab interpret the data.

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





Controls		
Scientist Symbol	*Solid B Mass*	*Solid C Mass*
●	6.0 g	12.0 g
○	6.0 g	8.0 g
◍	6.0 g	5.0 g

Controls		
Scientist Symbol	*Solid A Mass*	*Solid B Mass*
▲	2.0 g	7.0 g
△	6.0 g	7.0 g
◬	10.0 g	7.0 g

a) Using <u>both</u> of the graphs above, what temperature change would you expect to calculate with the following amounts?

Solid A Mass	4.0 g
Solid B Mass	10.0 g
Solid C Mass	6.0 g

Team 1 Prediction: _____

Team 3 Prediction: _____

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

Team 1: ● ○ ◍

Team 3: ▲ △ ◬

<u>Expected Temperature Change:</u>

_____

Changing Variables (Independent Variable(s))

For your second experiment, decide which variable(s) (max two) 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 calculating

  _____?

Use the following constraints to select your changing variable values:

- $NaHCO_3$ masses must be between 0.0 g and 4.0g (original 2.4 g)
- $CaCl_2$ masses must be between 3.0 g and 6.0 g (original 3.9 g)
- NaCl masses must be between 0.0 g and 8.0 g (original 6.0 g)

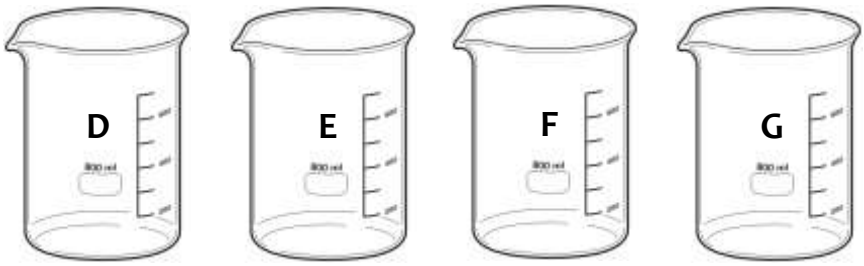
Selected changing variable values:

	D	E	F	G
1) _____ :				
2) _____ :				

SciTrek Member Approval: _____

EXPERIMENTAL SET-UP

Write your changing variable(s) (Ex: NaCl mass) and the values (Ex: 2.0 g) you will use for your trials under each beaker.



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: container type/beaker).

Class and Team Controls:	**Subgroup Control:**
Container Type / Beaker	_____ / _____
_____ / _____	
_____ / _____	
_____ / _____	

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 sodium chloride (NaCl) mass one step would be: Measure D) 2.0 g, E) 4.0 g, F) 6.0 g, and G) 8.0 g of NaCl in a weigh boat.

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. 2.1 g).

Subgroup Control: ☐ $NaHCO_3$ Mass ☐ $CaCl_2$ Mass **Subgroup Symbol:** _____

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

Variables		**Trial D**	**Trial E**	**Trial F**	**Trial G**
Container Type:		***Beaker***	→	→	→
Water Volume:					
$CaCl_2$ Mass:					
$NaHCO_3$ Mass:					
NaCl Mass:					
_____ Other Variable					
Predictions		**Trial D**	**Trial E**	**Trial F**	**Trial G**
Put an "S" in the trial that will give the smallest temperature change and an "L" in the trial that will give the largest temperature change.					
Data and Calculations		**Trial D**	**Trial E**	**Trial F**	**Trial G**
Measurements:	Initial Temperature (℃):				
	Maximum Temperature (℃):				
Observations:	Other:				
Calculations:	Temperature Change (℃): $\Delta T = T_{max} - T_{min}$				

The independent variable is the changing variable and the dependent variables are the maximum temperature and other.

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: Temperature Change (°C)).
- ☐ Label the x-axis (horizontal) with your changing variable, including units (Ex: $CaCl_2$ Mass (g)).
- ☐ 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.

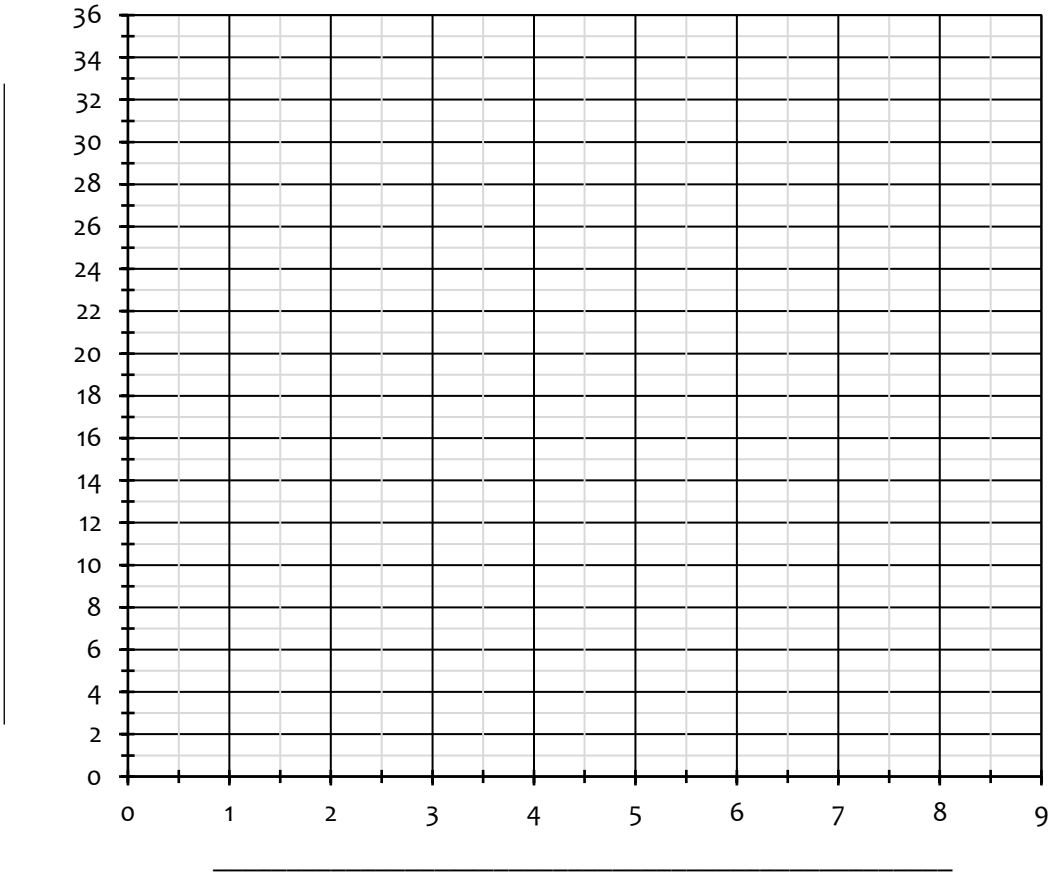
- ☐ On the x-axis, circle your 4 changing variable values. If a value is not there, write it in.
- ☐ Starting with the smallest changing variable value, determine the temperature change, and put your subgroup symbol at the appropriate level. Write the temperature change next to the point.
- ☐ Once you 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: ☐ $NaHCO_3$ Mass ☐ $CaCl_2$ Mass	
Subgroup Symbol	*Subgroup Control Value*
○	
△	

CONCLUSION

Generate a <u>claim</u> about how your changing variable affected your subgroup's results. (Ex: The greater the water volume the smaller the temperature change.)	We can conclude _____ claim _____ _____ _____ _____
What <u>data</u> do you have to support your claim? (Remember to include your measurements and/or observations, <u>not trial letters</u>.	because_____ data _____ _____ _____ _____

I acted like a scientist when _____

_____

TEAM PREDICTIONS

Use your team graph to predict the temperature change for each subgroup if you were to use 3.5 g of your changing variable. Write your predictions in the table below.

Changing Variable Mass: 3.5 g	
Subgroup Symbol	***Prediction***
○	
△	

NOTES ON PRESENTATIONS

What variables affect the temperature change of the chemical reaction?

Changing Variable: ☐ $NaHCO_3$ Mass (g) ☐ $CaCl_2$ Mass (g) ☐ NaCl Mass (g)				
Temperature Change (°C):				

Question: _____

_____

Summary: _____

_____

_____

Changing Variable: ☐ $NaHCO_3$ Mass (g) ☐ $CaCl_2$ Mass (g) ☐ NaCl Mass (g)				
Temperature Change (°C):				

Question: _____

_____

Summary: _____

_____

_____

TIE TO STANDARDS

1. Review the class findings about each substance from poster presentations.

   Does **NaCl mass** affect the temperature change? **YES** **NO**

   If YES, describe the trend: The greater the NaCl mass, the _____ the temperature change.

   Does **$NaHCO_3$ mass** affect the temperature change? **YES** **NO**

   If YES, describe the trend: The greater the $NaHCO_3$ mass, the _____ the temperature change.

   Does **$CaCl_2$ mass** affect the temperature change? **YES** **NO**

   If YES, describe the trend: The greater the $CaCl_2$ mass, the _____ the temperature change.

2. When scientists conduct experiments, they often repeat each trial in the <u>exact same way,</u> several times. Why? _____

   _____

   _____

   _____

*When running multiple trials in an experiment, scientists collect a series of different data points. Then, they use math tools called **median** and **range** to help analyze the data.*

3. Determine the median and range for the data in the table below.

Substance Masses:	**Temperature Change (°C):**	**Median:**	**Range:**
0.0 g $NaHCO_3$ 4.0 g NaCl 5.0 g $CaCl_2$	11.9, 11.7, 12.1, 14.9, 13.4		

4. What does this tell us? _____

   _____

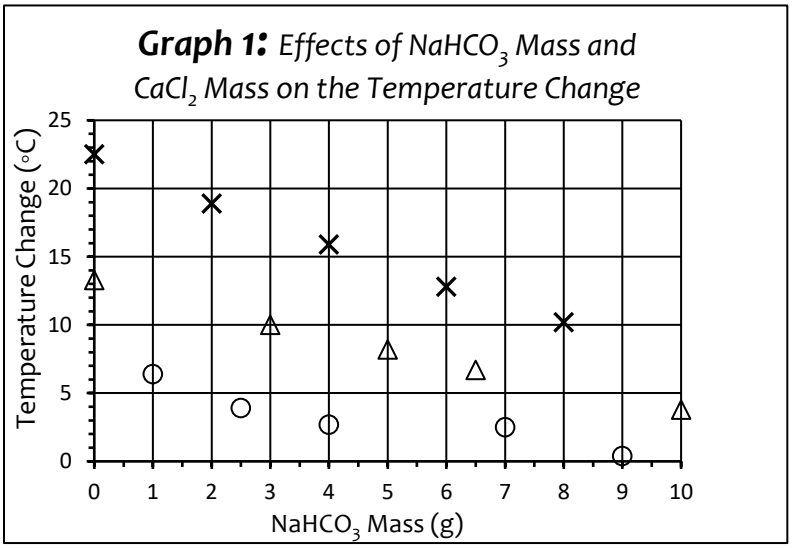
   _____

   _____

5. Annotate the graphs below, draw trend lines, label subgroup controls, and answer the questions.

Why has the graph for NaCl mass been left out? _____

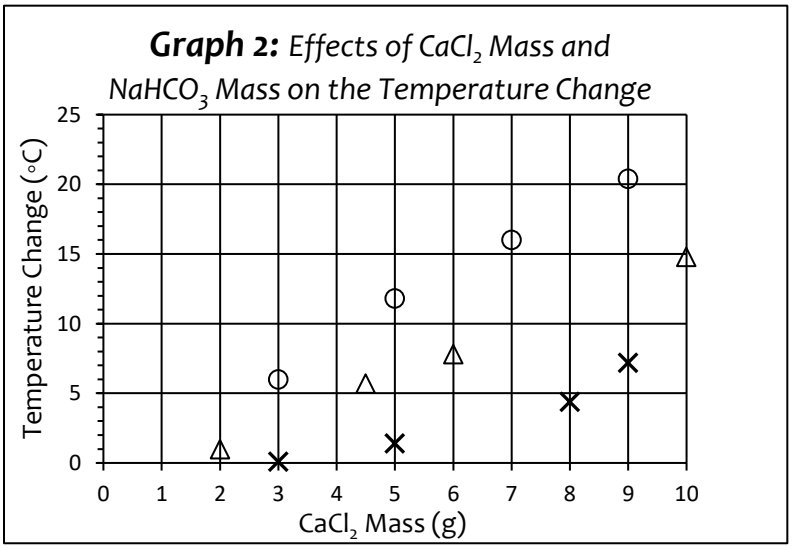
_____



Graph 1 Controls			
Experiment Symbol	*$CaCl_2$ Mass*	*NaCl Mass*	*Water Volume*
○	3.0 g	4.0 g	50 mL
△	6.0 g	4.0 g	50 mL
X	10.0 g	4.0 g	50 mL

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

YES NO



Graph 2 Controls			
Experiment Symbol	*$NaHCO_3$ Mass*	*NaCl Mass*	*Water Volume*
○	0.0 g	4.0 g	50 mL
△	4.0 g	4.0 g	50 mL
X	8.0 g	4.0 g	50 mL

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

YES NO

6. Using data from the graphs, what temperature change would you expect to measure if you mixed 4.0 g NaCl, 3.0 g $NaHCO_3$, 10.0 g $CaCl_2$, and 50 mL water?

Which experiment(s) should you look at?

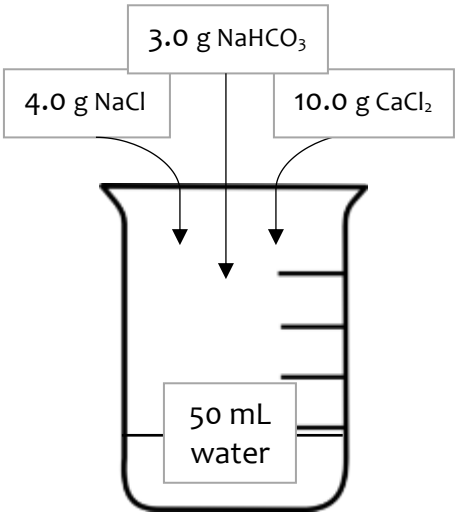
Graph 1: ○ △ **X** Prediction: _____

Graph 2: ○ △ **X** Prediction: _____

Expected Temperature Change:
(Round to the nearest tenth)

_____

7. What temperature change was measured when we mixed 4.0 g NaCl, 3.0 g $NaHCO_3$, 10.0 g $CaCl_2$, and 50 mL water?



Initial Temperature	
Maximum Temperature	
Temperature Change	

8. How far was the measured temperature change from the expected temperature change?

9. Can we consider our expected temperature change correct? YES NO

10. Is the temperature change in the reaction predictable? YES NO

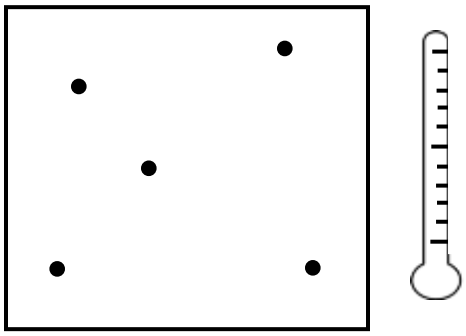
Why is the temperature change predictable?

11. **Temperature** is a measure of _____, which is

_____.

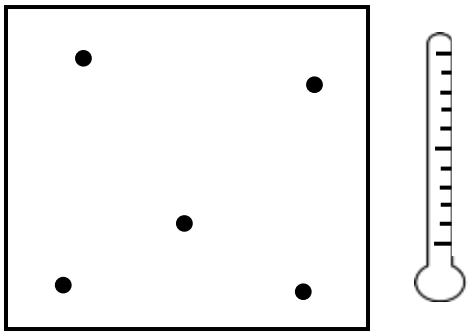
12. In the boxes below, indicate the speeds of the particles using arrows (larger arrows = faster speeds). Then, fill in the thermometers to represent their relative temperatures.

Kinetic Energy: Low



Particles are moving _____.

Kinetic Energy: High



Particles are moving _____.

13. What did we <u>start</u> with in our experiment? Fill out the table below with your observations of the starting materials.

Starting Material	Observations
NaCl	
$CaCl_2$	
$NaHCO_3$	
Water	

14. What did we <u>end</u> with? _____

_____

_____

15. Did a chemical reaction happen? YES NO

Evidence: _____

_____

16. Can energy be created or destroyed? YES NO

17. When a chemical reaction gets warmer, energy has been _____.

18. Do all substances store the same amount of energy? YES NO

Evidence: _____

_____

_____

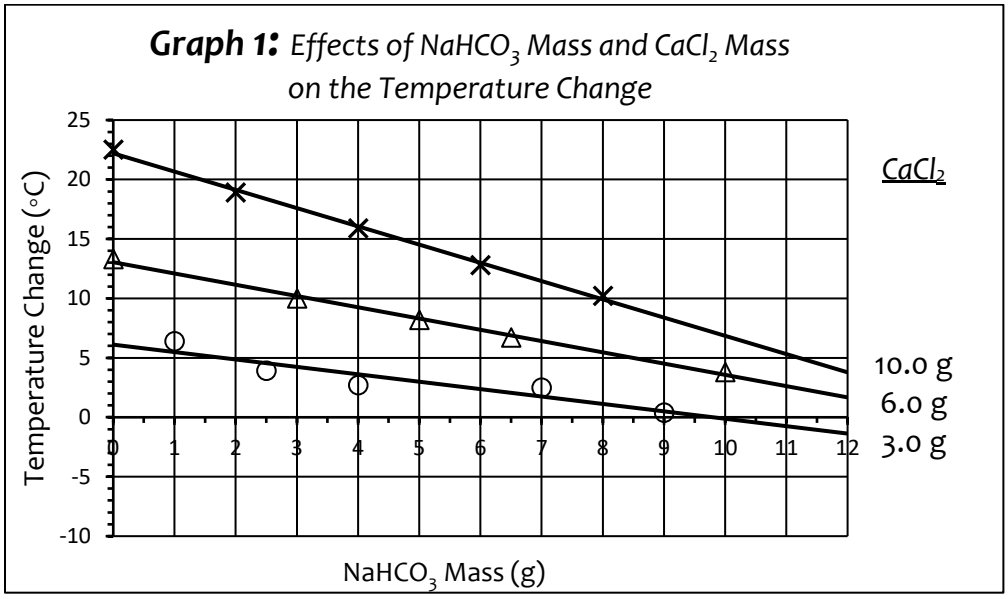
19. Summarize the effects of each substance on the temperature change and kinetic energy by circling the answer that best completes each statement.

NaCl Mass	
As NaCl mass increases, the temperature change _____.	increases decreases stays the same
If we add more NaCl to the reaction, the kinetic energy _____.	increases decreases stays the same
$CaCl_2$ Mass	
As $CaCl_2$ mass increases, the temperature change _____.	increases decreases stays the same
If we add more $CaCl_2$ to the reaction, the kinetic energy _____.	increases decreases stays the same
$NaHCO_3$ Mass	
As $NaHCO_3$ mass increases, the temperature change _____.	increases decreases stays the same
If we add more $NaHCO_3$ to the reaction, the kinetic energy _____.	increases decreases stays the same

20. What would happen if we mixed 12.0 g of $NaHCO_3$, 3.0 g of $CaCl_2$, 4.0 g of NaCl, and 50 mL of water? (Graph 1 is shown again below to help you).

_____

_____



21. When a chemical reaction gets colder, energy has been _____.

22. Chemical reactions can _____ or _____ energy.

23. The energy transferred in a chemical reaction is affected by:

_____

_____

EXTRA PRACTICE

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

1.	a.	The Mariana Trench is 10,994 m deep and the Tonga Trench is 10,880 m deep.	*Claim*	*Data*	*Opinion*
	b.	Adults eat more vegetables than children do.	*Claim*	*Data*	*Opinion*
	c.	Oceans with temperatures over 25°C have more fish than cooler oceans.	*Claim*	*Data*	*Opinion*
	d.	115 people bought Oreos and 95 people bought Chips Ahoy.	*Claim*	*Data*	*Opinion*
	e.	Writing a procedure is hard.	*Claim*	*Data*	*Opinion*
	f.	The planet Venus has been observed in full, half, and quarter phases.	*Claim*	*Data*	*Opinion*
	g.	The largest reptile is the saltwater crocodile.	*Claim*	*Data*	*Opinion*
	h.	The more dust in the air, the prettier the sunset.	*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 A	Trial B	Trial C
Solid A Mass:		4.0 g	→	→
Solid B Mass:		6.0 g	9.0 g	12.0 g
Solid C Mass:		5.0 g	→	→
Data		**Trial A**	**Trial B**	**Trial C**
Measurements/ Observations:	Temperature Change (°C):	9.3°C	8.7°C	9.1°C
	Other:	Large amount of foam	Medium amount of foam	Small amount of foam

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

c) Annotate the following possible conclusion.

Possible Conclusion: The greater the solid B mass, the less foam is made, because we observed, when the solid B mass was 6.0 g, there was a large amount of foam, and when the solid B mass was 12.0 g, there was a small amount of foam.

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
Solid A Mass:		2.0 g	4.0	8.0
Solid B Mass:		3.0 g	6.5 g	8.0 g
Solid C Mass:		5.0 g	→	→
Data		**Trial A**	**Trial B**	**Trial C**
Measurements/ Observations:	Temperature Change (°C):	10.5°C	13.3°C	16.1°C
	Other:	Small amount of foam	Medium amount of foam	Large amount of foam

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

c) Annotate the following possible conclusion.

Possible Conclusion: The greater the solid A mass, the greater the temperature change, because when the solid A mass was 2.0 g, the temperature change was 10.5°C, and when the solid A mass was 8.0 g, the temperature change was 16.1°C.

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
Solid A Mass:		7.0 g	→	→
Solid B Mass:		5.0 g	→	→
Solid C Mass:		2.5 g	5.0 g	7.5 g
Data		**Trial A**	**Trial B**	**Trial C**
Measurements/ Observations:	Temperature Change (°C):	7.2°C	10.2°C	14.4°C
	Other:	Medium amount of foam	Medium amount of foam	Small amount of foam

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

c) Annotate the following possible conclusion.

Possible Conclusion: The greater the solid C mass, the greater the temperature change, because when the solid C mass was 2.5 g, the temperature change was 14.4°C, and when the solid A mass was 7.5 g, the temperature change was 7.2°C.

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

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

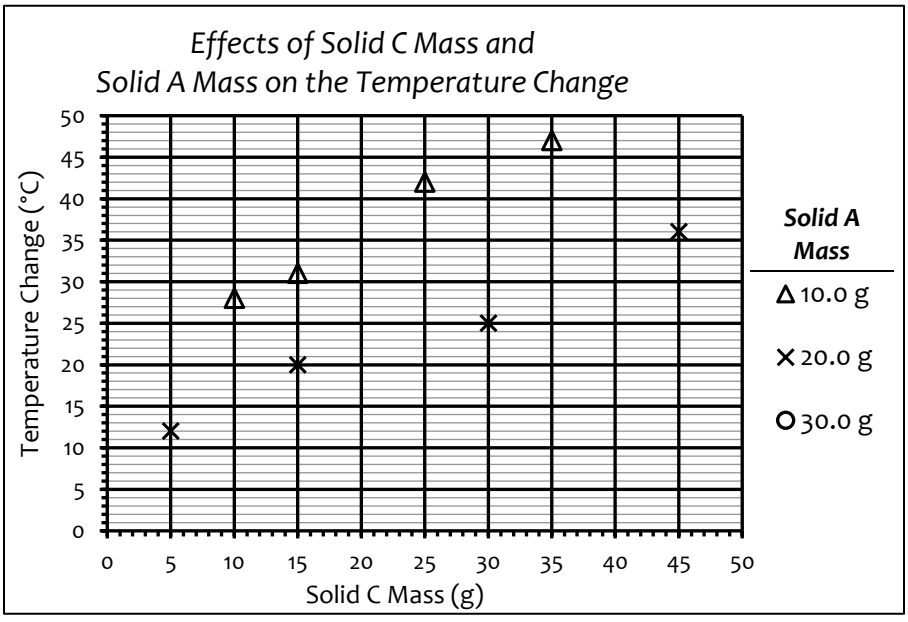
Directions: Some scientists wanted to know how changing the solid C mass would affect the temperature change of the reaction. They did three experiments, using a different solid A masses each time, and plotted most of their data on a graph. Answer question 5 using the graph below.

5. a) Annotate the graph.

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

Substance A Mass: *30.0 g*	
Substance C Mass	**Change in Temperature (°C)**
15	5
20	10
30	13
40	22

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



d) In general, for all solid A masses, what happens to the temperature, as the solid C mass increases?

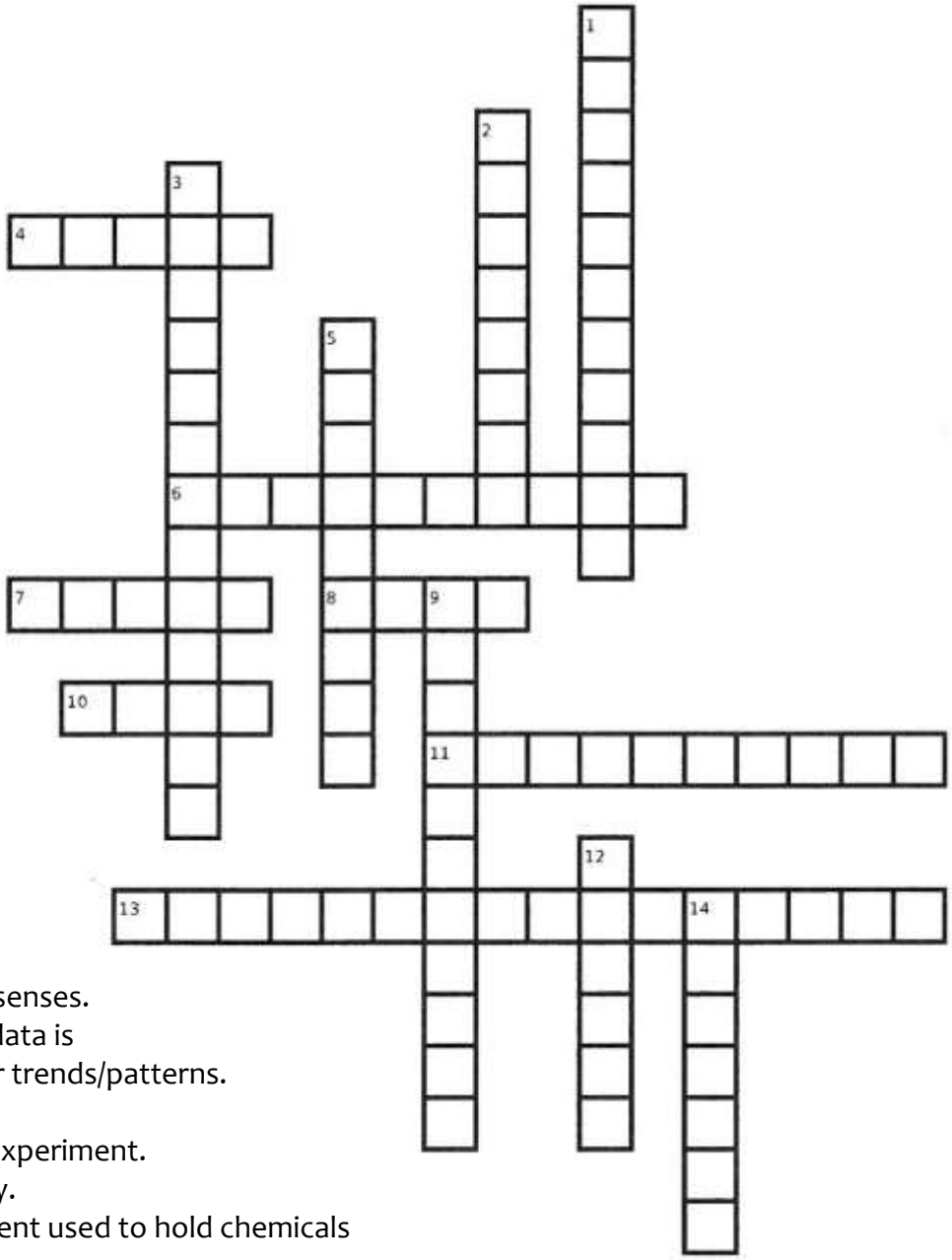
_____

e) What will the temperature change be when 10.0 g of A and 5.0 g of C are mixed? _____

f) What will the temperature change be when 15.0 g of A and 35.0 g of C are mixed? _____

CROSSWORD PUZZLE

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



Down

1. A description using your five senses.
2. A scientific practice in which data is examined critically to look for trends/patterns.
3. The energy of motion.
5. A set of steps to conduct an experiment.
9. The measure of kinetic energy.
12. A piece of laboratory equipment used to hold chemicals and conduct chemical reactions.
14. A variable that is purposely kept the same throughout an experiment.

Across

4. A statement that can be tested.
6. A claim supported by data.
7. When data changes in one general direction, there is a _____.
8. Measurements and observations are the two types of _____.
10. The button you push to "zero" a scale.
11. What you expect to happen based off of previous data.
13. A process where substances are altered into different substances.

SciTrek

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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