Group Color: Orange

Subgroup Number: 1

Team/Subgroup Symbol: $NaHCO_3$ / O

How Science Works

Grade 6

Module 2

Class Question:

What variables affect the temperature change of the chemical reaction?

Scientist (Your Name): Example Notebook

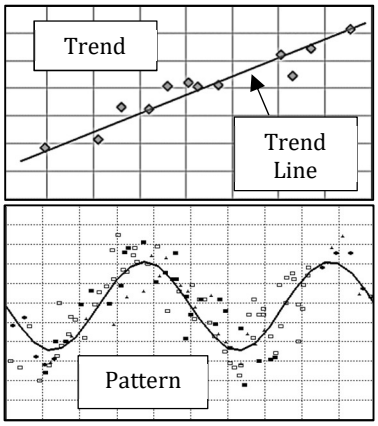
Teacher's Name: _____

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
$NaHCO_3$	Sodium hydrogen carbonate	White, powdery, solid	2.4 g
NaCl	Sodium chloride	White, grainy, solid	3.9 g
$CaCl_2$	Calcium chloride	White, ball shaped, solid	6.0 g
H_2O	water	Clear, colorless, liquid	50 mL

Other aspects of experimental set-up:

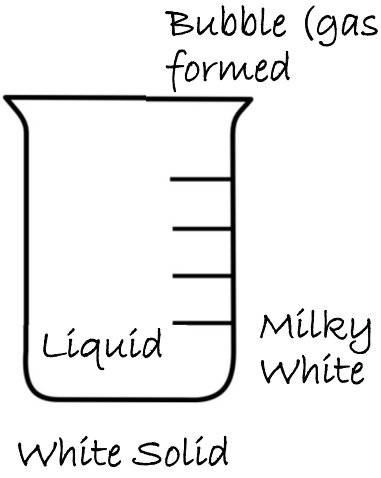
Initial Water Temperature: 19.2°C

Graduated cylinder
Beaker
Stir plate
Stir bar
Scale
Thermometer
4 weigh boats
Plastic lid

Describe what happened during the experiment.

Pour all substances together and stir
Beaker got warm and solution made a lot of bubbles
Temp Max: 29.0°C
Temp Change:

$$\begin{array}{r} {}^{1}\cancel{2}\cancel{9}.{}^{1}\cancel{0}\,^{\circ}C \\ -19.2\,^{\circ}C \\ \hline 9.8\,^{\circ}C \end{array}$$



VARIABLES

Variable	How will changing this variable affect the temperature change of the reaction?
Water Amount	The greater the water amount, the smaller the temperature change.
Water Temperature	The hotter the water, the bigger the temperature change.
NaCl Mass	The greater the NaCl mass, the bigger the temperature change.
$NaHCO_3$ Mass	The greater the $NaHCO_3$ mass, the bigger the temperature change.
Container Material	The thicker the container material, the smaller the temperature change.

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.

Changing Variable 1: CaCl2 Mass

Discuss with your subgroup how you think **changing variable 1** will affect the temperature change of the chemical reaction.

Changing Variable 2 (optional): NaCl Mass

Discuss with your subgroup how you think **changing variable 2** will affect the temperature change of the chemical reaction.

QUESTION

Question our subgroup will investigate:

- If we change the CaCl2 mass and NaCl mass
  (insert each changing variable (independent variable))

  what will happen to the temperature change of the
  (insert what you are calculating)

  reaction?

SciTrek Member Approval: SG

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)	~~NaHCO$_3$~~ Mass :	9.0 g	~~3.2 g~~	2.3 g
2)	NaCl Mass :	2.0 g	0.3 g	6.9 g

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 ~~NaHCO$_3$ Mass~~ / 4.0 g

Water Volume / 50 mL ~~NaCl Speed~~ / ~~Level~~ 2

Stir Speed / Level 2

SciTrek Member Approval: SG

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. Measure A) 0.0 g, B) 4.0 g, and C) 2.3 g of $NaHCO_3$ in a weigh boat.
2. Measure A) 2.0 g, B) 0.3 g, and C) 6.9 g of NaCl in a weigh boat.
3. Measure 6.0 g of $CaCl_2$ in a weigh boat.
4. Mix all the solids together in another weigh boat.
5. Pour 50 mL of water into a beaker, and record the initial temperature.
6. Put a stir bar in the beaker, and turn the stir speed to level 2.
7. Pour the solids into the beaker.
8. Record the max temperature, and subtract to find the temperature change.

SciTrek Member Approval: SG

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:		50 mL	→	
$CaCl_2$ Mass:		6.0 g	→	
$NaHCO_3$ Mass:		0.0 g	4.0 g	2.3 g
NaCl Mass:		2.0 g	0.3 g	6.9 g
Stir Speed (Other Variable)		Level 2	→	
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.		S		L
Data and Calculations		**Trial A**	**Trial B**	**Trial C**
Measurements:	Initial Temperature (°C):	20.0°C	19.9°C	19.8°C
	Maximum Temperature (°C):	42.5°C	35.7°C	40.7°C
Observations:	Other:	Felt hot	felt warm; lots of bubbles	felt warm; medium bubbles
Calculations:	Temperature Change (°C): $\Delta T = T_{max} - T_{min}$	42.5°C -20.0°C 22.5°C	~~35.7~~ 214 °C -19.9°C 15.8 °C	~~40.7~~ 31 °C -19.8°C 20.9°C

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:** A claim supported by data
   - **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 changing variable.
   - **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 measurements or observations.
     - Data statements also often include values of the changing variable.

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? Incorrect claim.

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? Claim and data switched.

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? More than 1 changing variable.

3. How many changing variables can you have in order to make a conclusion? 1

CONCLUSION

Making a Conclusion from Your Data

How many changing variables did you have in your experiment? 2

Can you make a conclusion from your data? ☒ YES ☒ NO

IF NO

Why? Because we had more than one changing variable.

IF YES

We can conclude The greater the calcium chloride mass, the greater the temperature change
(claim)

because When the $CaCl_2$ mass was 3.2 g, the temperature change was 3.4°C, and when the $CaCl_2$ mass was 9.0 g, the temperature change was 13.3°C.
(data (measurements/observations/calculations))

SciTrek Member Approval: SG

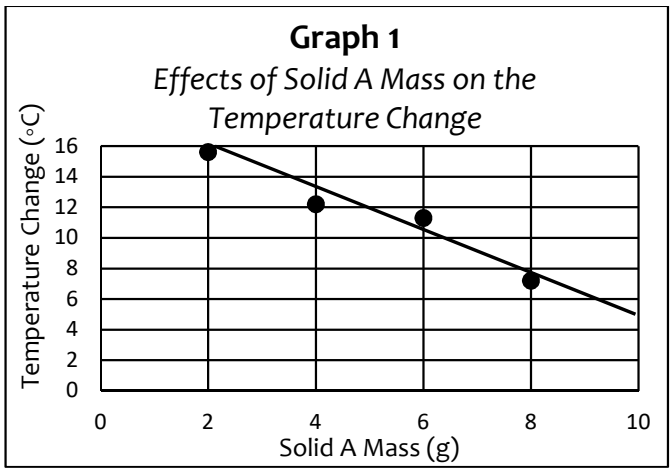
TECHNIQUE

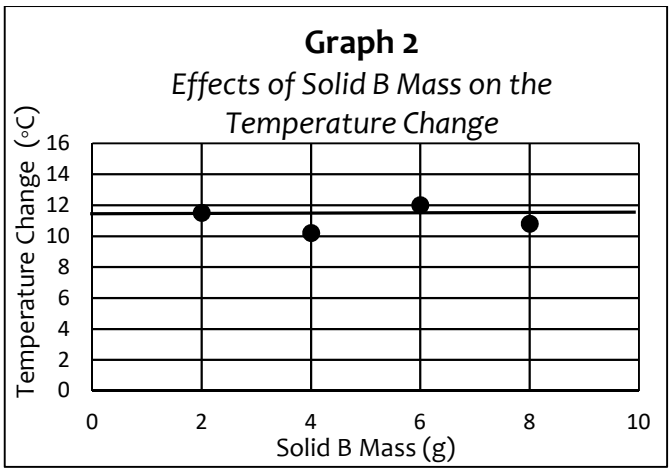
Trend Lines

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**

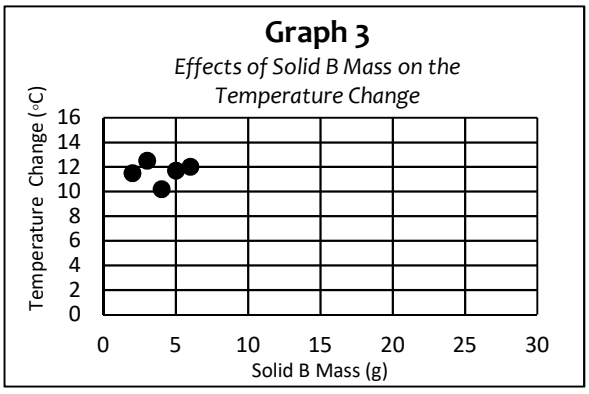
- Describe the trend by filling in the following sentence frame:

  As solid A mass increases, the temperature change decreases.

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

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

The points are too close together.

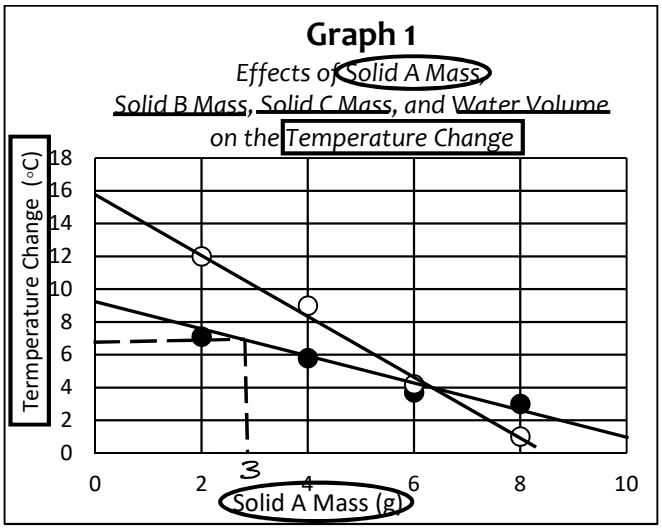


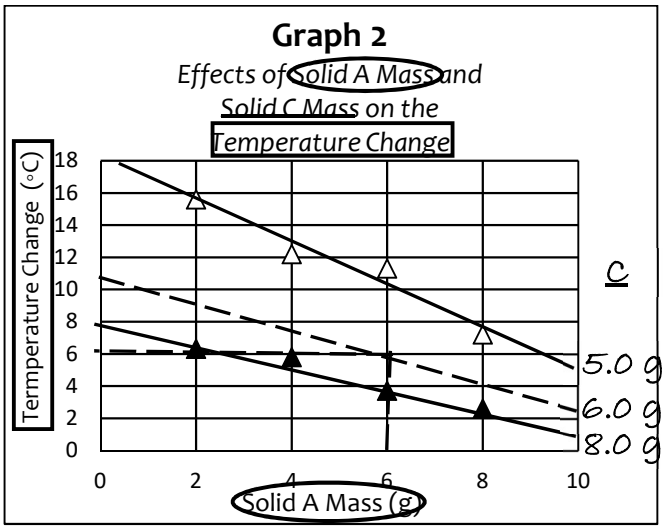
TECHNIQUE

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.*





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
	team control	subgroup control	team control

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 decreases.

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? **Expected Temperature Change:** 7°C

- Why are trend lines important? They allow us to make predictions.

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)**

Expected Temperature Change: 6°C

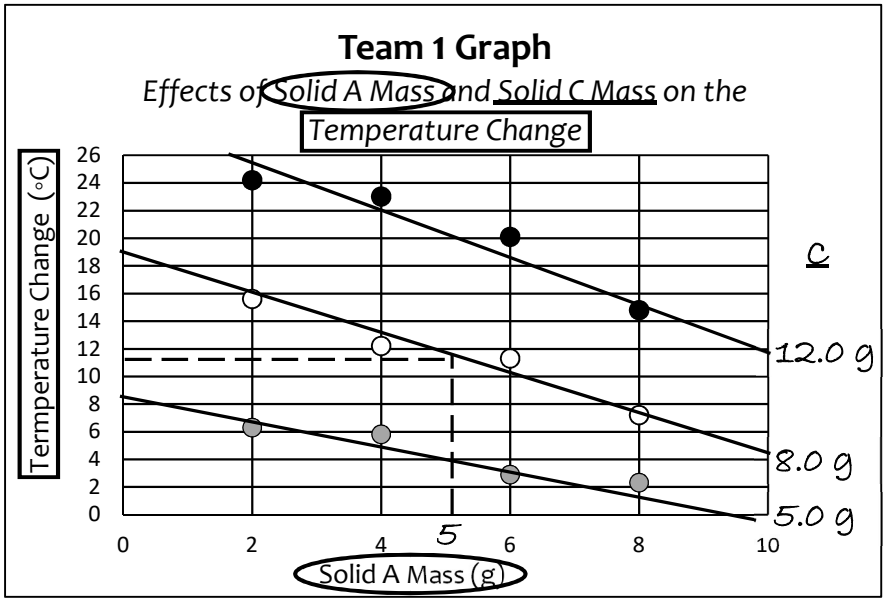
d) What does this mean for your experimental design? We should collaborate with other groups.

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 decreases.

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?

● ◎ ●

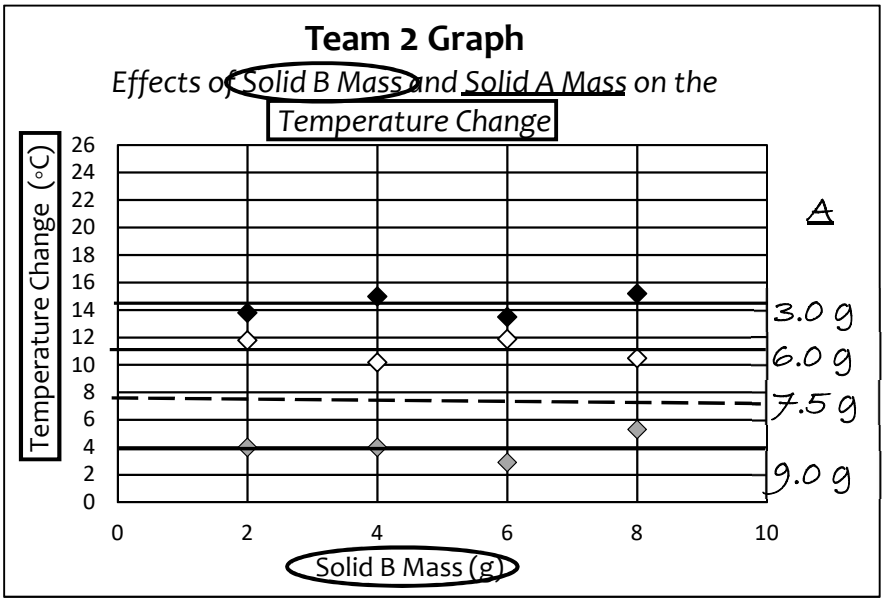
Expected Temperature Change:

11°C

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?

◆ (◇ ◆)

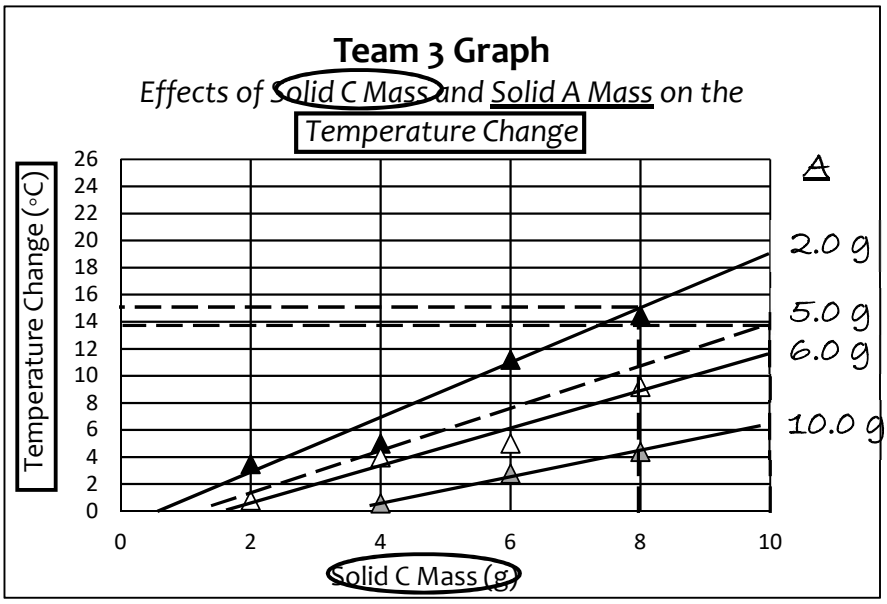
Expected Temperature Change:

7°C

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 ___increases___.

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:

___15°C___

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:

___13.5°C___

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

(▲ △) ▲

SCIENTIFIC PRACTICES

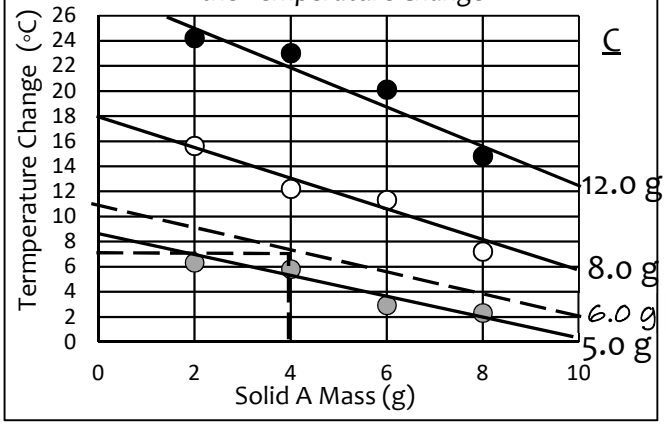
Analyzing & Interpreting Data

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 teams' 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.*

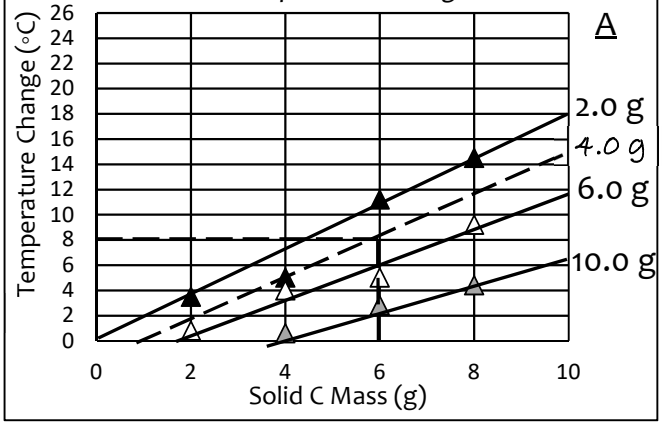
Team 1 Graph

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



Team 3 Graph

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



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: 7°C

Team 3 Prediction: 8°C

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

Team 1: ● ○ ◍

Team 3: ▲ △ ◬

<u>Expected Temperature Change:</u>

7.5°C

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

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

Changing Variable 1: $NaHCO_3$ Mass

Changing Variable 2 (optional): _____

#1 The scientists in our team are _____.

#2 **QUESTION**

Question our subgroup will investigate:

- If we change the $NaHCO_3$ mass (insert each changing variable (independent variable)),

  what will happen to the temperature change of the (insert what you are calculating)

  reaction?

Use the following constraints to select your changing variable values:

- $CaCl_2$ masses must be between 3.0 g and 9.0 g (original 6.0 g)
- $NaHCO_3$ masses must be between 0.0 g and 4.0g (original 2.4 g)
- NaCl masses must be between 0.0 g and 8.0 g (original 3.9 g)

Selected changing variable values:

	D	E	F	G
1) $NaHCO_3$ Mass:	0.0 g	4.0 g	1.8 g	3.2 g
2) :				

SciTrek Member Approval: SG

#3 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.

#4. EXPERIMENTAL SET-UP: SPECIFIC

(Once filled out, staple to notebook pg. 19)

If you are responsible for presenting your team's specific experimental set-up, fill in the following sentence frame with information from your Experimental Set-Up. This is what you will read when you present.

Our team's subgroup control is $CaCl_2$ mass. The values our team used are 9.0 g and 3.0 g. We picked these values because we wanted our trend lines to be spaced out, so we spread our $CaCl_2$ masses across the range.

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:
(same values between subgroups)

Container Type / Beaker

Water Volume / 50 mL

NaCl Mass / 5.0 g

Stir Speed / Level 2

Subgroup Control:
(different values between subgroups)

$CaCl_2$ Mass / 9.0 g

SciTrek Member Approval: SG

#6 **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) 3.0 g, E) 4.0 g, F) 6.0 g, and G) 8.0 g of NaCl in a weigh boat.

Step #

1. Measure the appropriate mass of $NaHCO_3$ in a weigh boat.
2. Measure 5.0 g of NaCl in a weigh boat.
3. 3. Measure the appropriate mass of $CaCl_2$ in a weigh
4. Mix all the solids together in another weigh boat.
5. Pour 50 mL of water into a beaker, and measure the initial temperature.
6. Put a stir bar in the beaker, and turn the stir speed to level 2.
7. Pour the solids into the beaker.
8. Record the max temperature, and subtract to find the temperature change.

SciTrek Member Approval: SG

#5a

RESULTS

Table

Check the l … able for each of … rrow through ea… t tenth (Ex. 2.1 g).

We are subgroup ___O___ (symbol). Our changing variable is ___$NaHCO_3$ mass___, and the values we use are ___0.0___ g, ___4.0___ g, ___1.8___ g, and ___3.2___ g.

Subgroup Control: ☒ $CaCl_2$ Mass ☐ $NaHCO_3$ Mass ☐ NaCl Mass **Subgroup Symbol:** ___O___

Variables	Trial D	Trial E	Trial F	Trial G
Container Type:	***Beaker***	→	→	→
Water Volume:	50 mL	→	→	→
$CaCl_2$ Mass:	9.0 g	→	→	→
$NaHCO_3$ Mass:	0.0 g	4.0 g	1.8 g	3.2 g
NaCl Mass:	5.0 g	→	→	→
Stir Speed (Other Variable)	Level 2	→	→	→
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.	L	S		
Data and Calculations	**Trial D**	**Trial E**	**Trial F**	**Trial G**
Measurements: Initial Temperature (°C):	20.2°C	19.8°C	19.8°C	19.9°C
Measurements: Maximum Temperature (°C):	40.4°C	33.1°C	37.6°C	34.9°C
Observations: Other:	Felt hot	Felt slightly warm; lots of bubbles	Small amount of bubbles	Medium amount of bubbles
Calculations: Temperature Change (°C): $\Delta T = T_{max} - T_{min}$	40.4°C -20.2°C 20.2°C	~~33~~ 212 ~~3~~ 1°C -19.8°C 13.3 °C	~~37~~ 216 ~~7~~ 1.6°C -19.8°C 17.8°C	~~34~~ 31 ~~4~~ .9°C -19.9°C 15.0°C

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

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

#8 **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.

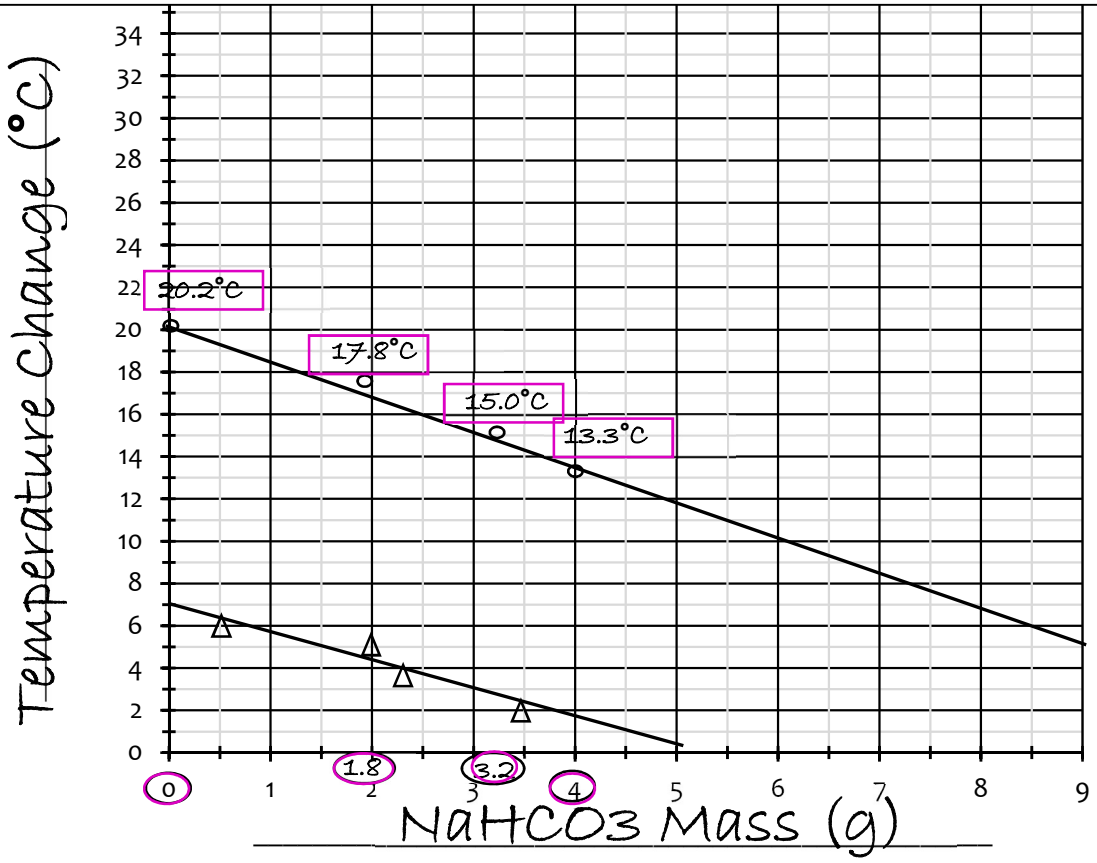
#7. GRAPH: GENERAL

(Once filled out, staple to notebook pg. 22)

If you are responsible for presenting your team's graph, fill in the following sentence frame. This is what you will read when you present.

All of our graphs showed a decreasing trend
(General trend observed)
.

We think subgroup ○ (symbol) had the most convincing data because their data points were closest to the trend line.



Legend	
Subgroup Control: ☒ $CaCl_2$ Mass ☐ $NaHCO_3$ Mass ☐ NaCl Mass	
Subgroup Symbol	*Subgroup Control Value*
○	9.0 g
△	5.0 g

#9 **CONCLUSION**

Generate a claim about how your changing variable affected your subgroup's results. (Ex: The greater the water volume the smaller the temperature change.)

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

We can conclude ~~the greater the NaHCO volume, mass the smaller the temperature change~~ the smaller the temperature change (claim) change

because ~~when the water volume was~~ when the NaHCO mass was (data) 2.1 g, the temperature change was 12.4°C (biggest), and when the NaHCO~~3~~ volume was 4.9 g, the temperature change was 13.3°C (smallest).

I acted like a scientist when I measured the maximum temperature of the reaction.

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***
○	2.0°C
△	14.5°C

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)	3.0	4.5	7.1	9.0
Temperature Change (°C):	2.8	5.9	10.8	13.4

Question: Did all subgroups on your team observe the same trend?

Summary: As $CaCl_2$ mass ↑, temperature change ↑

NaCl mass does not affect temperature change

Changing Variable: ☐ $NaHCO_3$ Mass (g) ☐ $CaCl_2$ Mass (g) ☒ NaCl Mass (g)	0.5	3.1	6.4	8.0
Temperature Change (°C):	5.7	6.2	5.1	5.6

Question: Based on the first experiment, were you able to predict how NaCl mass would affect the temperature change?

Summary: NaCl mass does not affect temperature change

As $NaHCO_3$ mass ↑, temperature change ↓

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 smaller 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 larger the temperature change.

2. When scientists conduct experiments, they often repeat each trial in the exact same way, several times. Why? Results will not always be the same numbers. Doing multiple trials tells us how much the results can vary from each other.

*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.*

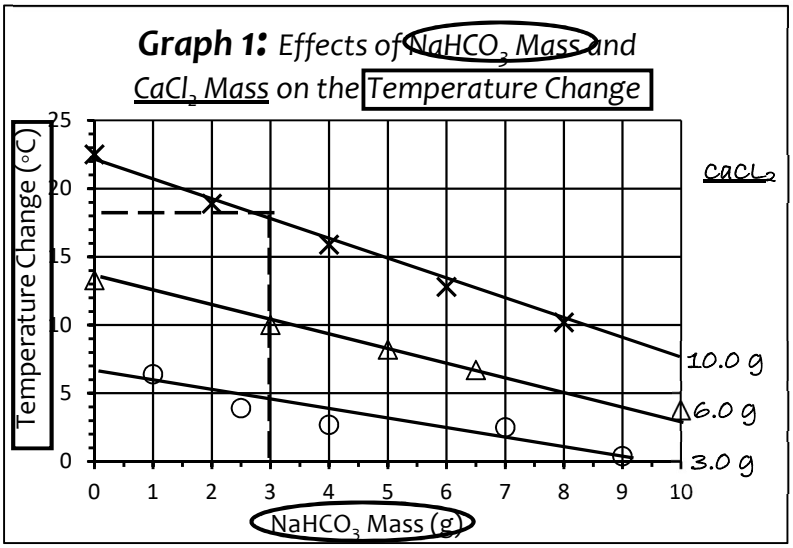
3. Determine the median and range for the data in the table below.

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 ~~11.7~~, ~~11.9~~, (12.1) ~~13.4~~, ~~14.9~~	12.1°C	14.9°C -11.7°C 3.2°C

4. What does this tell us? As long as our predictions are within 3.2°C of the actual data, we can consider them correct.

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

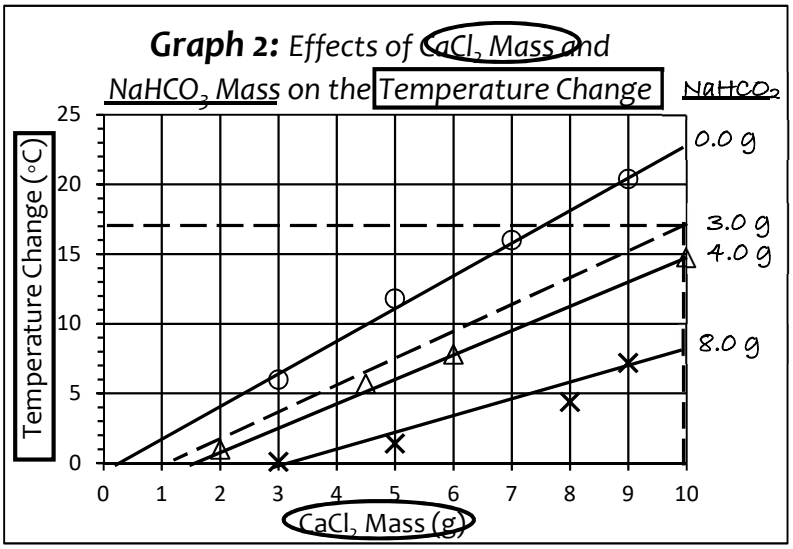
Why has the graph for NaCl mass been left out? NaCl mass does not affect the temperature change.



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?

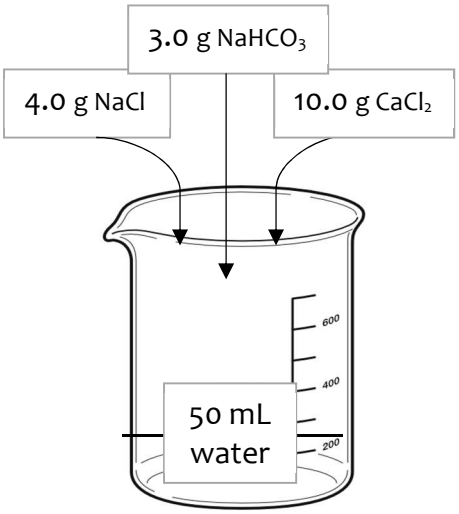
Graph 1: ○ △ (X) Prediction: 18°C

Graph 2: (○ △) **X** Prediction: 17°C

Expected Temperature Change:
(Round to the nearest tenth)

17.5°C

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	19.0°C
Maximum Temperature	35.7°C
Temperature Change	$^{2}\cancel{3}^{1}5.7°C$ $-19.0°C$ $16.7°C$

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

$$^{6}\cancel{1}^{1}7.5°C$$
$$-16.7°C$$
$$0.8°C$$

9. Can we consider our predicted temperature change correct? (YES) NO

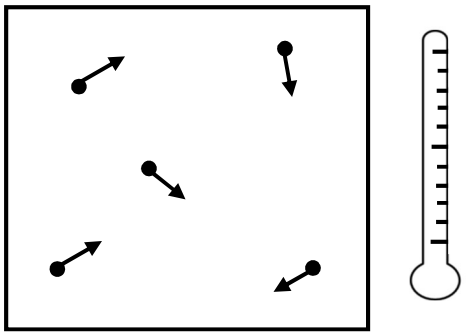
10. Is the temperature change in the reaction predictable? (YES) NO

Why is the temperature change predictable?

11. **Temperature** is a measure of kinetic energy, which is the energy of motion.

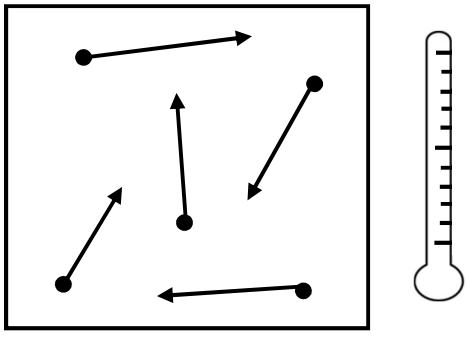
12. In the boxes below, indicate the speeds of the particles using arrows (larger arrows = faster speeds). Then, fill in the thermometers to represent their relative temperatures.

Kinetic Energy: Low



Particles are moving Slow.

Kinetic Energy: High



Particles are moving fast.

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	White, grainy, square pieces, solid
$CaCl_2$	White, small, solid balls
$NaHCO_3$	White, powdery, different size pieces, solid
Water	Clear liquid

14. What did we <u>end</u> with? Liquid turned milky white with a solid at bottom of bag. Gas was produced that puff up the bag.

15. Did a chemical reaction happen? (YES) NO

Evidence: Gas formed, temperature changed

16. Can energy be created or destroyed? YES (NO)

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

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

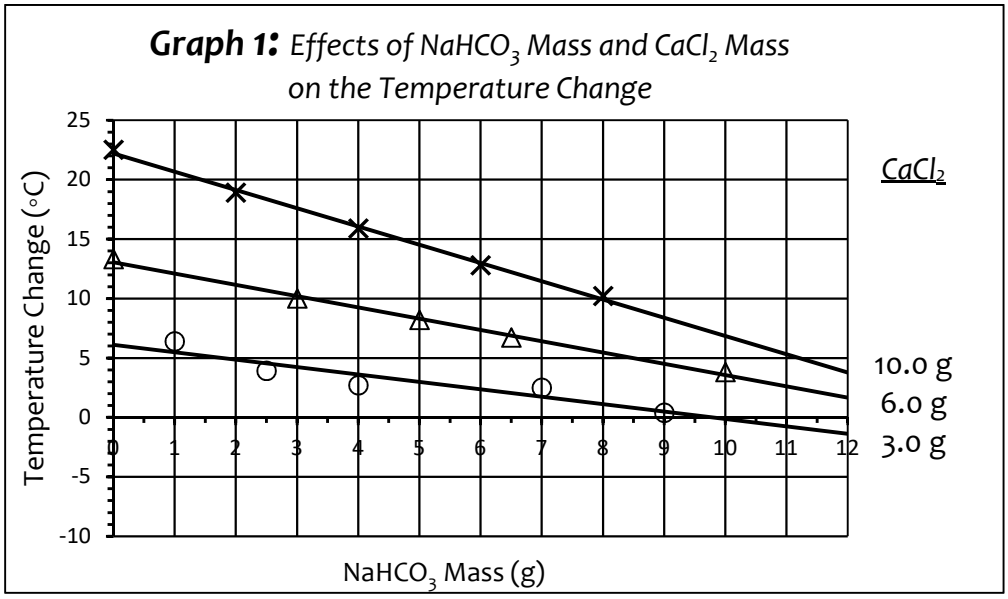
Evidence: Adding the same amounts of different substances gives a different temperature change.

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).

The reaction will feel cold, because the temperature change will be negative.



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

22. Chemical reactions can ___absorb_____ or _____release_____ energy.

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

Type of substance

Mass

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? More than 1 changing variable.

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 C 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

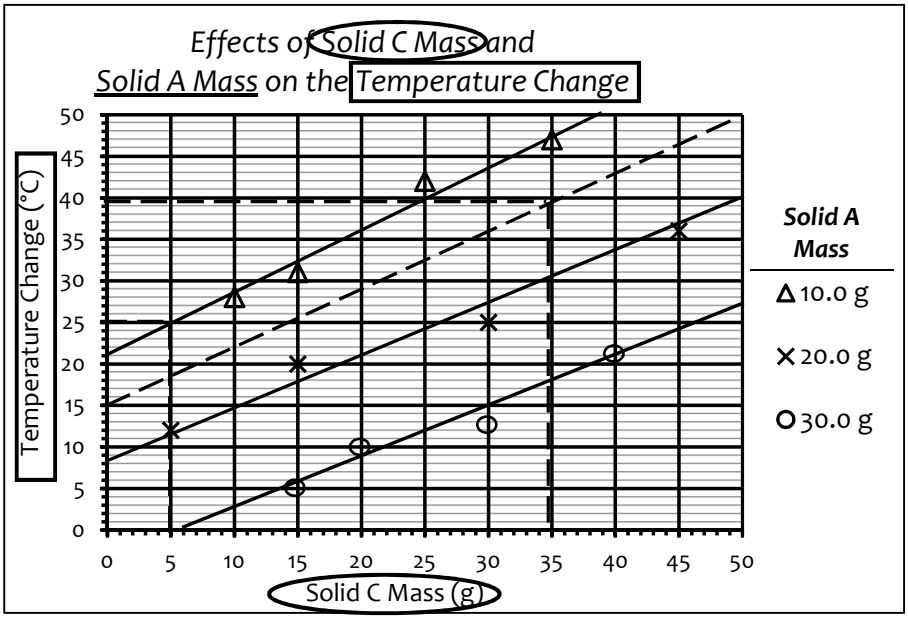
If NO, what is wrong with the conclusion? Claim and data switched.

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?

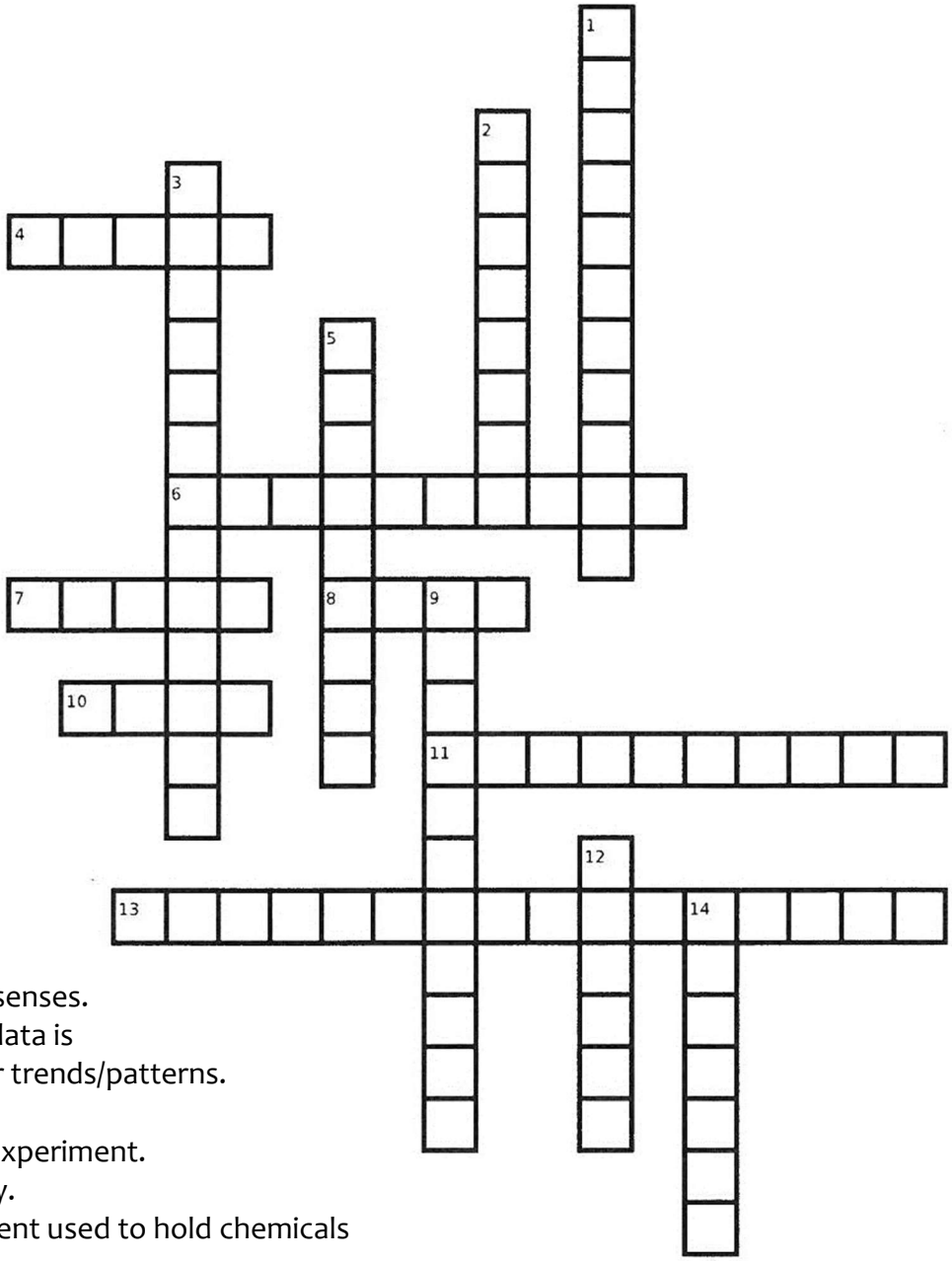
The temperature change increases.

e) What will the temperature change be when 10.0 g of A and 5.0 g of C are mixed? 25°C

f) What will the temperature change be when 15.0 g of A and 35.0 g of C are mixed? 39°C

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.

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