Last Revised: 12/12/2024

Lead Information Packet

Module 2: Thermal Transfer
6th Grade

This document is not intended to give you all of the information you need to lead the module. It is only intended to be a reference during the module. You can find the complete instructions at scitrek.chem.ucsb.edu/module as well as the notebook and picture packet used during the module.

Important Things to Remember During the Module

1. You are responsible for keeping track of time in the classroom and making sure **all** activities run smoothly. There will be a time card in the lead box with suggested times to start/stop each activity.
2. You are responsible for keeping mentors and students on track.
3. Walk around during times mentors are working with students and help struggling groups/subgroups/teams.

Types of Documents:

Notebook:
One given to every student and is filled out by the student. The lead will use a notebook to write in as an example for students. The notebook the lead uses is referred to as the class notebook in these instructions.
Notepad:
One given to every group and is filled out by the mentor. In these instructions, the examples are narrower and taller than the notebook pages.
Picture Packet:
One per class that, if needed, the lead fills out. In these instructions, the examples are the same size as the notebook pages but are labeled.

In these instructions, all other example documents are labeled.

Day 1: Analysis Assessment/Observations/Variables

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

Introduction (SciTrek Lead) – 2 minutes
Analysis Assessment (SciTrek Lead) – 15 minutes
Observation Discussion (SciTrek Lead) – 5 minutes
Observations (SciTrek Mentors) – 19 minutes
Variable Discussion (SciTrek Lead) – 5 minutes
Variables (SciTrek Mentors) – 12 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. Make sure mentors are writing their name and group color on the whiteboard.
2. Make sure mentors are passing out nametags.
3. Make sure mentors are setting up for the initial observation.
4. Set up the document camera for the analysis assessment and class question (notebook, front cover).
5. Set up the following out: scale, weigh boat, stir plate, stir bar, and thermometer to show during the observation discussion.

6. Pass out the analysis assessments.

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

- Allow mentors to introduce themselves.
- Introduce the module.

Analysis Assessment: *(15 minutes – Full Class – SciTrek Lead)*

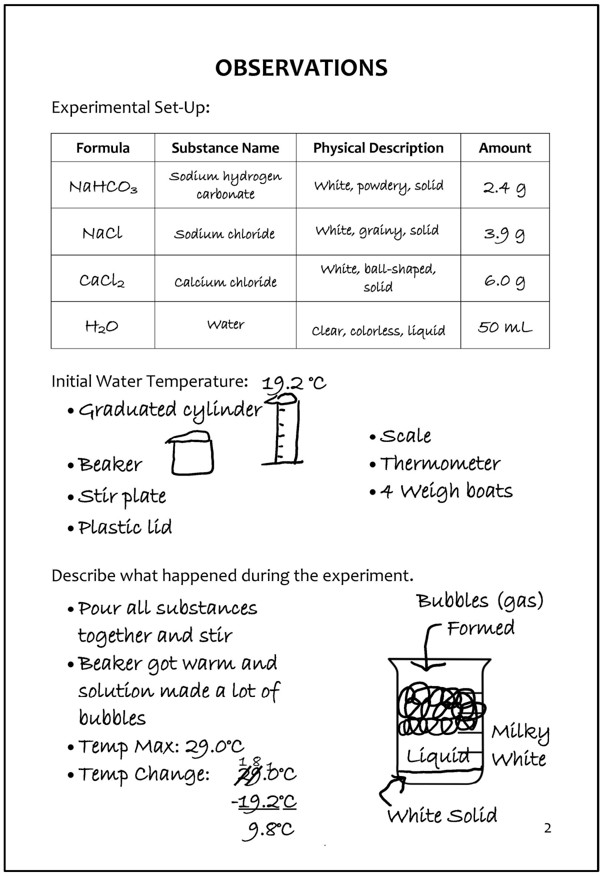
- Questions *1-3*: Have students annotate (underline controls, circle changing variable(s), and box information about data collection) and answer questions about the results table and possible conclusion.
- Pass out clear rulers to students.
- Question *4*: Have students annotate (underline controls, circle the changing variable, and box information about data collection) the graph.
- Have students answer questions *4b-4f*.
- Collect assessments and rulers.

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

- Have mentors pass out notebooks.
- Have students fill out the front cover of their notebooks.
    - They will not fill out their subgroup number, team/subgroup symbol, or class question.
- Review the definition of an observation (description using your five senses).
- Ask students, "What is a chemical reaction?"
    - A process in which one or more substances are altered into one or more different substances.
- Ask students, "How might you know if a chemical reaction has happened?"
    - Temperature change, formation of a gas, color change, etc.
- Introduce class question: "What variables affect the temperature change of the reaction?"
    - Write the class question on the front cover of the class notebook, and have students copy the question onto their notebooks.
- Demonstrate the equipment use in this module:
    - Show how to tare the scale, using a weigh boat.
    - Show how to use the stir plate and stir bar.
    - Show how to use the thermometer.
        - Discuss the max/min function.
- Have students move to their groups.
    - If a student does not have a nametag, identify the group color with the least number of students in it and write the student's name on one of the extra nametags in the lead box using that color of marker.

Observations: *(19 minutes – Groups – SciTrek Mentors)*

- **Make sure mentors are not telling students the common names of the substances**
    - We will **not** call them salt or baking soda—only sodium chloride and sodium hydrogen carbonate, respectively.
- Walk around and help groups who are struggling.
- Make sure groups are moving along and only spending ~7 minutes on the experimental set-up.



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

Initial Water Temperature: 19.2 °C

- Graduated cylinder
- Beaker
- Stir plate
- Plastic lid
- Scale
- Thermometer
- 4 Weigh boats

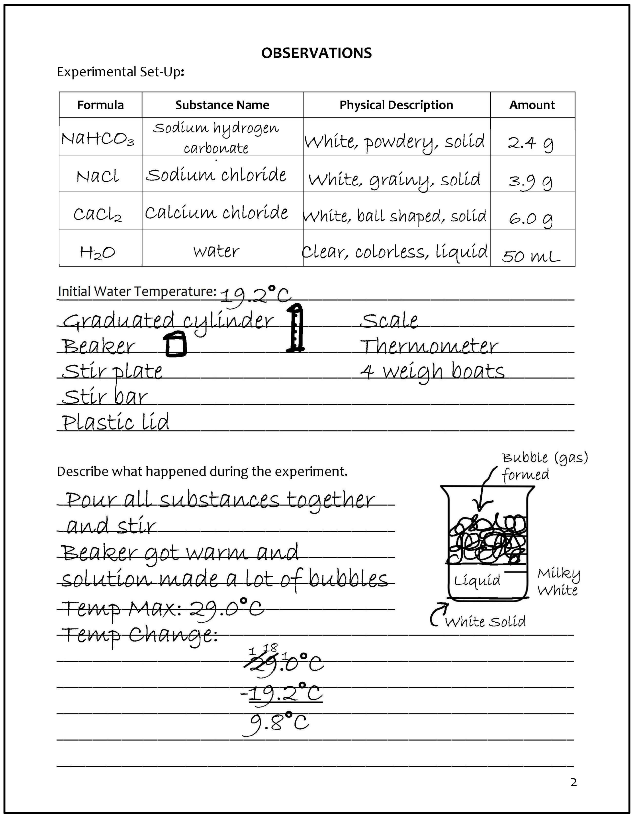
Describe what happened during the experiment.

- Pour all substances together and stir
- Beaker got warm and solution made a lot of bubbles
- Temp Max: 29.0°C
- Temp Change: $\overset{1\,8}{\cancel{29}}.0^\circ C$

$-19.2^\circ C$

$9.8^\circ C$

2



OBSERVATIONS

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H_2O	water	Clear, colorless, liquid	50 mL

Initial Water Temperature: 19.2°C

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

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:

$\overset{1\,18}{\cancel{29}}.0^\circ C$

$-19.2^\circ C$

$9.8^\circ C$

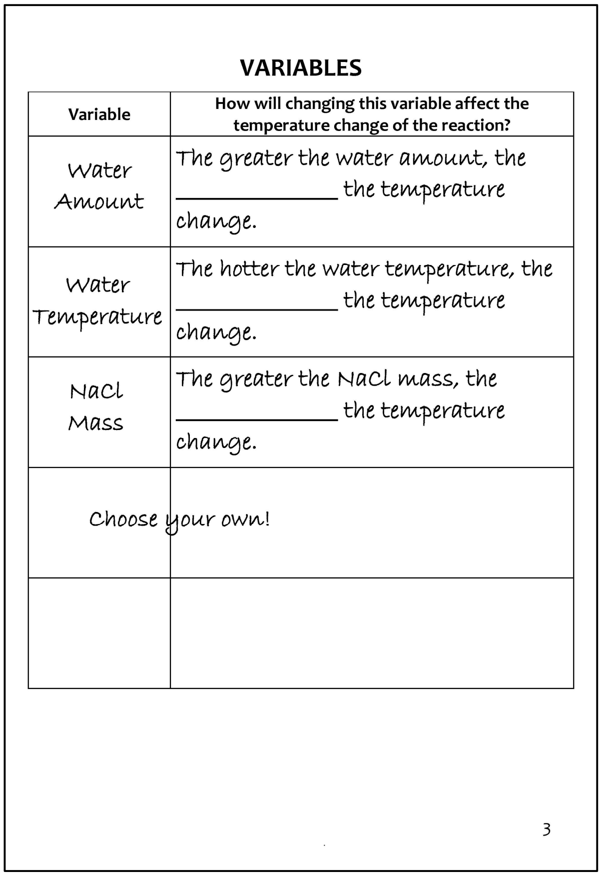
2

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

- Have groups share what they did and learned.
  - They pour three different solids into water. Bubbles were produced and the solution got warmer. Using the initial temperature and max temperature they were able to calculate the temperature change of the reaction.
- Have students discuss how they know a chemical reaction occurred.
- Review the class question: What variables affect the temperature change of the chemical reaction?
- Review the definition of a variable (something in an experiment that can be changed).
- Explore one possible changing variable with the class and have students share how and why they believe this variable might affect the temperature change of the reaction.
  - The only variable they should not generate is adding additional substances. This would change the chemical reaction and we are studying this particular reaction.

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

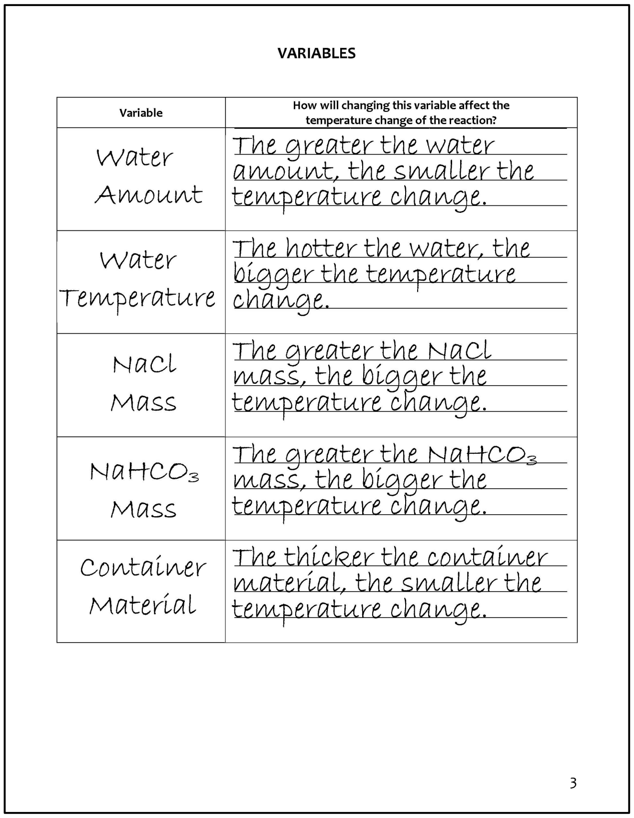
- Walk around and help groups who are struggling.
- Make sure mentors are having their group come up with three possible variables, as well as how and why they believe these variables might affect the temperature change of the reaction.
- Make sure students are generating at least one additional variable by themselves.



VARIABLES

Variable	How will changing this variable affect the temperature change of the reaction?
Water Amount	The greater the water amount, the ______ the temperature change.
Water Temperature	The hotter the water temperature, the ______ the temperature change.
NaCl Mass	The greater the NaCl mass, the ______ the temperature change.
Choose your own!	

3



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.

3

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

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

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

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

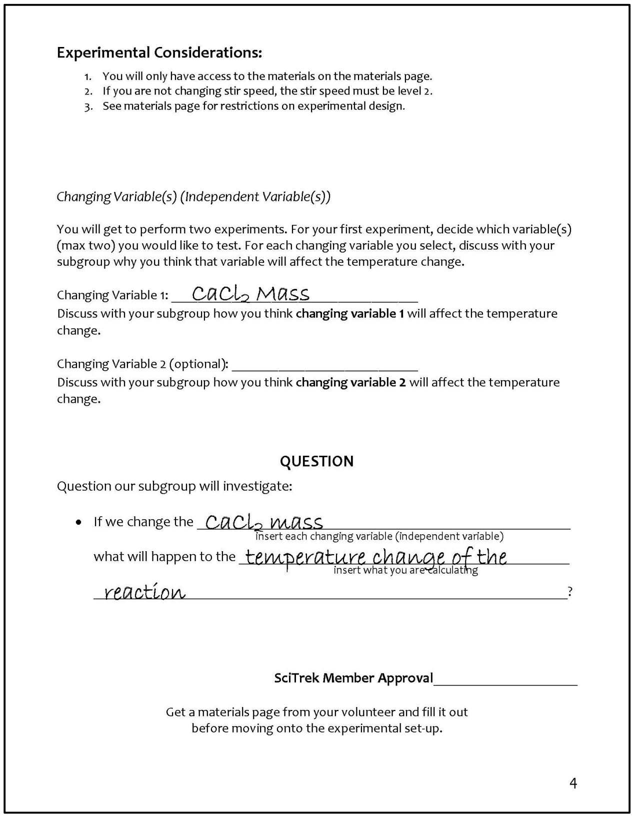
Introduction (SciTrek Lead) – 12 minutes
Question (SciTrek Mentors) – 9 minutes
Materials Page (SciTrek Mentors) – 7 minutes
Experimental Set-Up (SciTrek Mentors) – 8 minutes
Procedure (SciTrek Mentors) – 18 minutes
Results Table (SciTrek Mentors) – 3 minutes
Wrap-Up (SciTrek Lead) – 3 minutes
*If there is extra time, do the claim, data, and opinion extra practice (notebook, page 31).

Preparation:

1. Make sure mentors are setting out notebooks in such a way that allows students within the same subgroup to work together.
2. Set up the document camera for the Introduction (notebook, page 4-6; materials page; picture packet, page 1).

Introduction: *(12 minutes – Full Class – SciTrek Lead)*

- Review the class question, as well as what students did and learned last session.
- Review experimental considerations with the class (notebook, page 4, top):
    - *You will only have access to the materials on the materials page.*
    - *If you are not changing stir speed, the stir speed must be level 2.*
    - *See materials page for restrictions on experimental design.*
- Design an example experiment with the class.
    - For the changing variable, pick one variable (Ex: $CaCl_2$ mass; notebook, page 4).
    - Show students how to write the question.
        - If we change the <u>$CaCl_2$ mass,</u> what will happen to the <u>temperature change of the reaction</u>?
    - Fill out the materials page for the example experiment (lead box).
        - Read step 1 and have students tell you what to do for each bolded word (underline controls and circle changing variables).
        - Go through the list of general materials, and check them off.
            - Show students a scoopula and tell them what the tool is used for.
        - Read steps *2* and *3*. You should choose the control values, but let students choose the three changing variable values.
            - Remind students to pick changing variable values that are spread out.
            - Write trial letters underneath the changing variable values.



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: $CaCl_2$ Mass

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

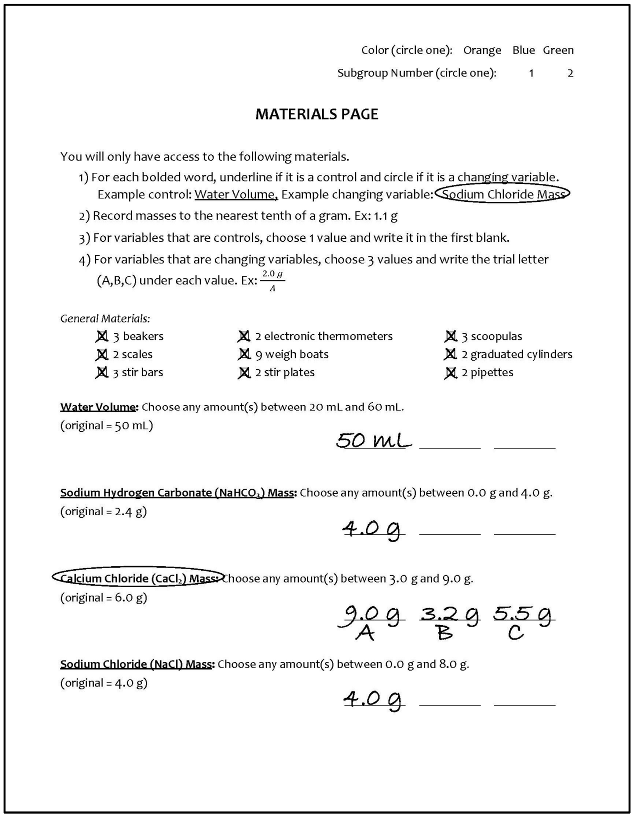
Question our subgroup will investigate:

- If we change the $CaCl_2$ 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____________________

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

4



Color (circle one): Orange Blue Green

Subgroup Number (circle one): 1 2

MATERIALS PAGE

You will only have access to the following materials.

1) For each bolded word, underline if it is a control and circle if it is a changing variable.
   Example control: <u>Water Volume,</u> Example changing variable: Sodium Chloride Mass
2) Record masses to the nearest tenth of a gram. Ex: 1.1 g
3) For variables that are controls, choose 1 value and write it in the first blank.
4) For variables that are changing variables, choose 3 values and write the trial letter (A,B,C) under each value. Ex: $\frac{2.0\ g}{A}$

General Materials:

☒ 3 beakers
☒ 2 scales
☒ 3 stir bars
☒ 2 electronic thermometers
☒ 9 weigh boats
☒ 2 stir plates
☒ 3 scoopulas
☒ 2 graduated cylinders
☒ 2 pipettes

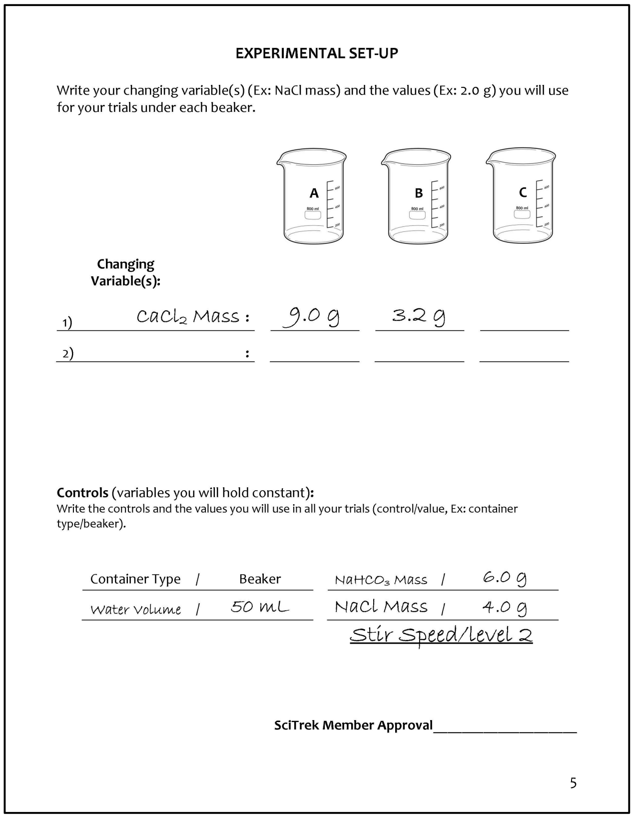
<u>Water Volume</u>: Choose any amount(s) between 20 mL and 60 mL.
(original = 50 mL)
50 mL ______ ______

<u>Sodium Hydrogen Carbonate ($NaHCO_3$) Mass</u>: Choose any amount(s) between 0.0 g and 4.0 g.
(original = 2.4 g)
4.0 g ______ ______

Calcium Chloride ($CaCl_2$) Mass: Choose any amount(s) between 3.0 g and 9.0 g.
(original = 6.0 g)
$\frac{9.0\ g}{A}$ $\frac{3.2\ g}{B}$ $\frac{5.5\ g}{C}$

<u>Sodium Chloride (NaCl) Mass</u>: Choose any amount(s) between 0.0 g and 8.0 g.
(original = 4.0 g)
4.0 g ______ ______

- Fill out the experimental set-up for the example experiment (only *Trials A* and *B* for the changing variable; notebook, page 5).
    - Draw an additional line under the controls list for another control and its value.
    - If students choose to change two variables, there will be one additional blank for controls. Lead students to come up with “stir speed/level 2.”
- Read the example procedure step that includes the changing variable (notebook, page 6, top).
- Show students the filled-out results table (picture packet, page 1) and explain how they will fill out their results tables and make predictions.



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) $CaCl_2$ Mass : 9.0 g 3.2 g ________

2) ________ : ________ ________ ________

Controls (variables you will hold constant)**:**
Write the controls and the values you will use in all your trials (control/value, Ex: container type/beaker).

Container Type / Beaker

$NaHCO_3$ Mass / 6.0 g

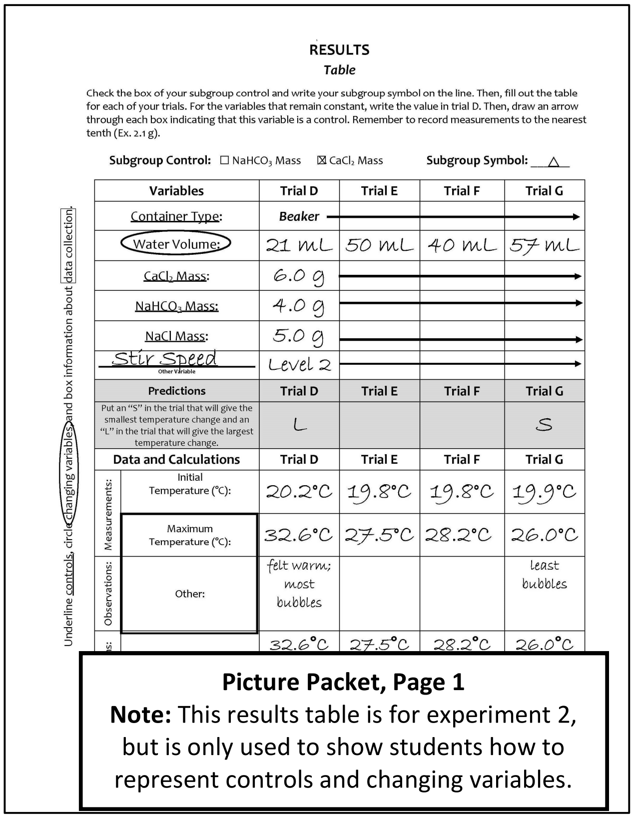
Water Volume / 50 mL

NaCl Mass / 4.0 g

Stir Speed/level 2

SciTrek Member Approval____________________

5



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 that this 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:	21 mL	50 mL	40 mL	57 mL
	$CaCl_2$ Mass:	6.0 g	→	→	→
	$NaHCO_3$ Mass:	4.0 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 (℃):	20.2°C	19.8°C	19.8°C	19.9°C
	Maximum Temperature (℃):	32.6°C	27.5°C	28.2°C	26.0°C
Observations:	Other:	felt warm; most bubbles			least bubbles
		32.6°C	27.5°C	28.2°C	26.0°C

Picture Packet, Page 1
Note: This results table is for experiment 2, but is only used to show students how to represent controls and changing variables.

Question: (9 minutes – Subgroups – SciTrek Mentors)

- Walk around and help subgroups who are struggling.
- Encourage subgroups to pick different changing variables.
- **Make sure mentors are not giving advice on how many changing variables to use.**
- Make sure, for the second part of the question (what you are calculating), students are specific (they should write, "the temperature change of the reaction," and not just "the temperature change").

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

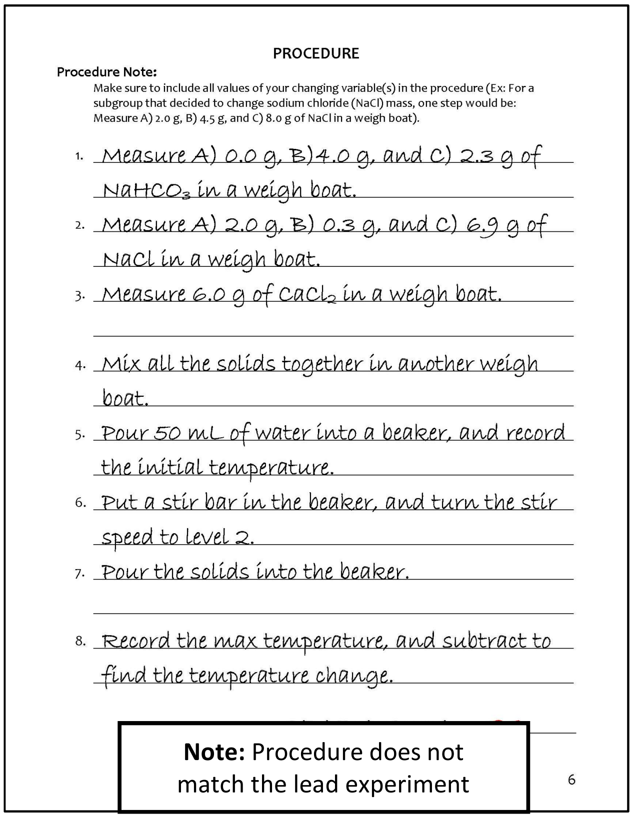
- Walk around and help subgroups who are struggling.
- Make sure subgroups are underlining their controls and circling their changing variable(s).
- Make sure subgroups are filling out the materials page correctly and completely.

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

- Walk around and help subgroups who are struggling.
- Make sure, within one subgroup, all students have the same order for their changing variable(s) values.
- Make sure all control blanks are filled out.

Procedure: *(18 minutes – Subgroups – SciTrek Mentors)*

- Walk around and help subgroups who are struggling.
- Make sure procedures are concise, but still include all values of the controls and changing variable(s), as well as the data that will be collected and the calculation that will be performed.
    - Students within each subgroup can vary the wording in their procedures, as long as the steps are in the same order and correct values are included.



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).

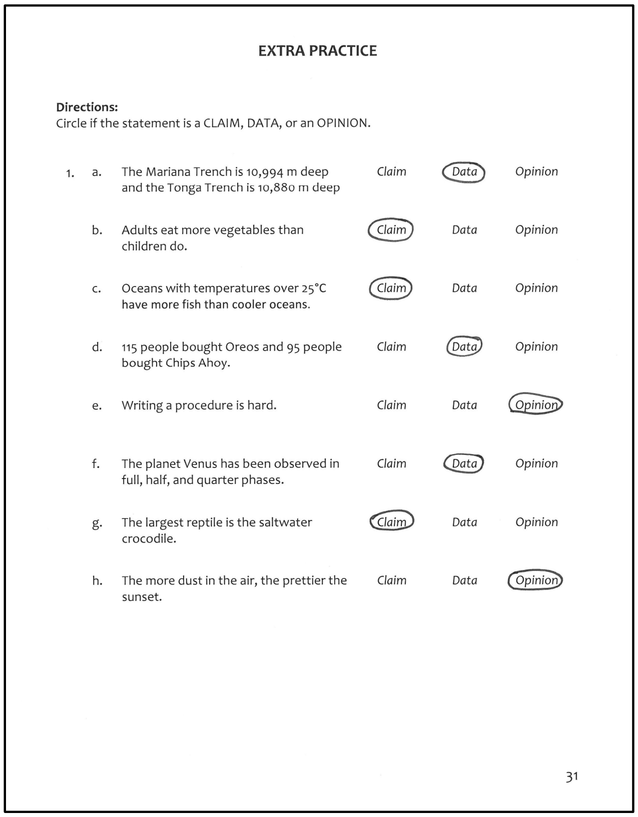
1. Measure A) 0.0 g, B)4.0 g, and C) 2.3 g of $NaHCO_3$ in a weigh boat.
2. Measure A) 2.0 g, B) 0.3 g, and C) 6.9 g of NaCl in a weigh boat.
3. Measure 6.0 g of $CaCl_2$ in a weigh boat.
4. Mix all the solids together in another weigh boat.
5. Pour 50 mL of water into a beaker, and record the initial 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.

6

Note: Procedure does not match the lead experiment

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

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



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*]

31

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

- Go over what students will do next session.

Extra Time:

- On this day there is often extra time. If so, go over page 31 in the notebook, which gives students practice on distinguishing between claim and data statements. Do not do any more than page 31 of the extra practice.

Day 3: Experiment/Analysis Activity

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

Introduction (SciTrek Lead) – 2 minutes
Experiment (SciTrek Mentors) – 28 minutes
Analysis Activity (SciTrek Lead) – 28 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

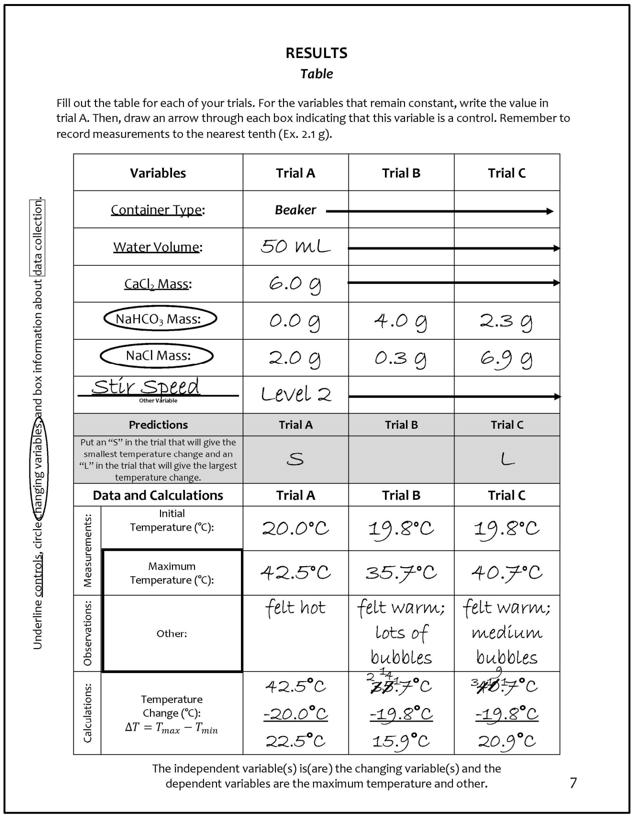
1. Make sure mentors are setting out notebooks.
2. Make sure mentors are setting up for the experiment.
3. Set up the document camera for the analysis activity (notebook, pages 8-10).
4. Have a thermometer to show students during the Introduction.

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

- Review the class question.
- Remind students of the following things about their experiment:
    - To tare the scale.
    - The scoopulas should only be used in the substance they are marked for.
    - Wipe thermometer between trials.
    - Close the thermometer after each trial, to reset the “Max/Min” function.
    - Keep the lid on the calcium chloride, as much as possible.

Experiment: *(28 minutes – Subgroups – SciTrek Mentors)*

- Walk around and help subgroups who are struggling.
- Make sure students are:
    - closing the $CaCl_2$ lid, when not in use
    - closing and wiping off, the thermometer, in between trials
    - recording the maximum temperature, with units, and subtracting to find the temperature change
- Remove beakers, weigh boats, etc., as soon as students are done with them.
    - Put beakers, stir bars, $CaCl_2$ weigh boats, mix weigh boats, and any liquid, in the bucket.
    - Put graduated cylinders, back into their box.
    - Put water bottles, back into their box.
    - Put the stir plates, back into their box.
    - All other materials go into the group boxes.
- Put water on a white rag, in the lead box, then wipe down tables to ensure no chemicals are left on them.



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 that this variable is a control. Remember to record measurements to the nearest tenth (Ex. 2.1 g).

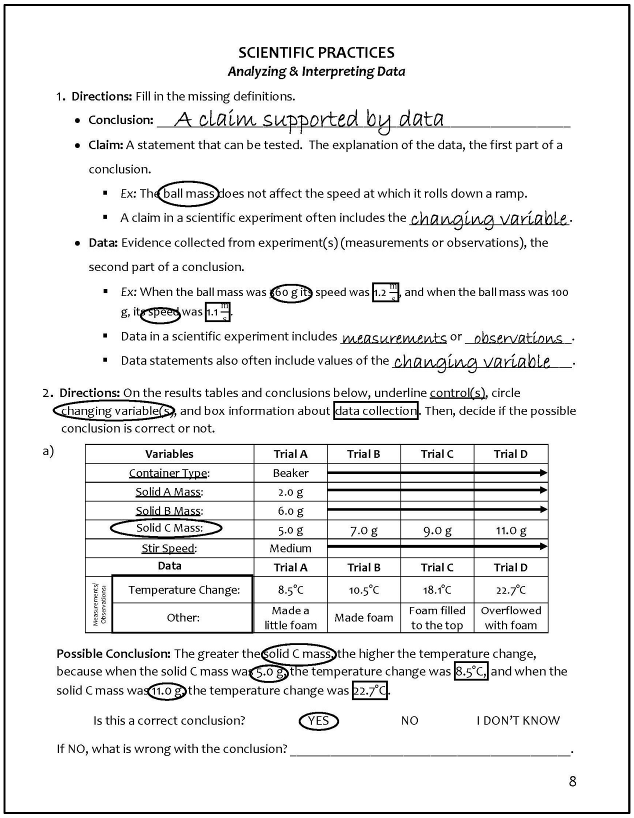
Underline controls, circle changing variables, and box information about data collection.

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 (℃):	20.0°C	19.8°C	19.8°C
Measurements: Maximum Temperature (℃):	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 (℃): $\Delta T = T_{max} - T_{min}$	42.5°C -20.0°C 22.5°C	^{2}~~3~~^{14}~~5~~.^{1}7°C -19.8°C 15.9°C	^{3}~~4~~$^{\cancel{10}\,9}$~~0~~.^{1}7°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. 7

Analysis Activity: *(28 minutes – Full Class – SciTrek Lead)*

- **Make sure to start the analysis activity at least 25 minutes before the end of the session.**
- Question *1*: Review the definition of a conclusion (claim supported by data; notebook, page 8).
- Review the definition of a claim (statement that can be tested).
- Read the example claim and have students tell you the changing variable (ball mass), then circle it.
    - Discuss and fill in what claims include (changing variable).
- Review the definition of data (evidence collected from experiments).
- Read the example data statement and have students tell you the changing variable values (360 g and 100 g), then circle them as well as the data values (1.2 $\frac{m}{s}$ and 1.1 $\frac{m}{s}$), then box them.
    - Discuss and fill in types of data (measurements and observations).
    - Discuss and fill in what is also in data statements (changing variable).



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 $\boxed{1.2 \frac{m}{s}}$, and when the ball mass was 100 g, its speed was $\boxed{1.1 \frac{m}{s}}$.
        - 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? ________________.

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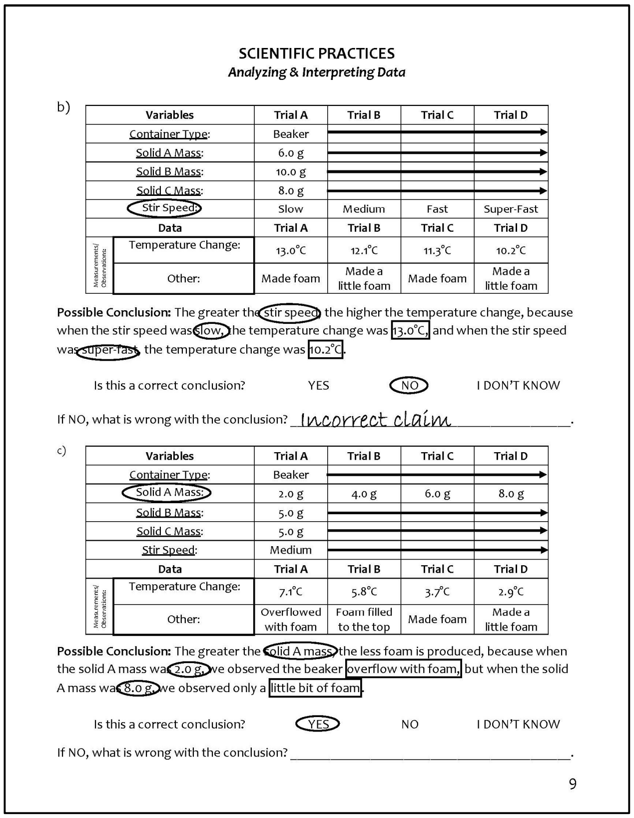
- Question *2*: Read the directions aloud to the class.
    - Annotate the results table and possible conclusion by underlining controls, circling changing variables, and boxing information about data collection.
        - Annotate sections *a* and *b* as a class, then, have students try *c*-*e* on their own, while you do them off to the side of the document camera.
    - Help students decide whether the conclusion is correct or incorrect by using the following questions:
        - What type of statement is before the 'because,' and how do you know?
            - If the statement is *data* (contains measurements or observations)
                - Is this a correct conclusion? (No)
                - What is wrong with the conclusion? (Claim and data switched)
                - Move onto next conclusion
            - If the statement is a *claim* (can be tested)
                - What is the changing variable in this claim?
                - Is this a changing variable in this experiment? (Yes)
                - Is the claim consistent with the results table?
                    - If No
                        - Is this a correct conclusion? (No)
                        - What is wrong with the conclusion? (Incorrect claim)
                        - Move onto next conclusion
                    - If Yes and *one changing variable*
                        - What type of statement is after the 'because,' and how do you know? (Data, because it contains measurements or observations.)
                        - Is the data consistent with the results table? (Yes)
                        - Is this a correct conclusion? (Yes)
                        - Move onto next conclusion.
                    - If Yes and *two changing variables*

  - What type of statement is after the ‘because,’ and how do you know? (Data, because it contains measurements or observations.)
  - Is the data consistent with the results table? (Yes)
  - Is this a fair conclusion? (No, because the change could be due to the other changing variable.)
  - Is this a correct conclusion? (No)
  - What is wrong with the conclusion? (More than one changing variable)

- For question *3*, make sure students understand, they can only have one changing variable in order to make a conclusion, and write *1* on the line.



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)

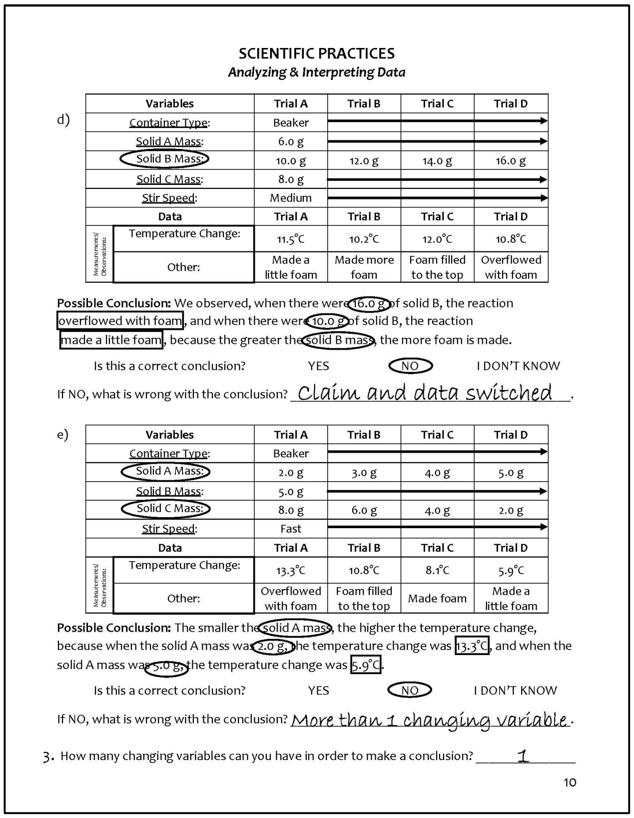
Variables	Trial A	Trial B	Trial C	Trial D
Container Type:	Beaker	→	→	→
Solid A Mass:	2.0 g	4.0 g	6.0 g	8.0 g
Solid B Mass:	5.0 g	→	→	→
Solid C Mass:	5.0 g	→	→	→
Stir Speed:	Medium	→	→	→
Data	**Trial A**	**Trial B**	**Trial C**	**Trial D**
Measurements/ Observations: Temperature Change:	7.1°C	5.8°C	3.7°C	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 when the solid A mass was 2.0 g, we observed the beaker overflow with foam, but when the solid A mass was 8.0 g, we observed 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? ______.

9



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

10

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

- Go over what students will do next session.

Day 4: Conclusion/Technique/Analysis Activity

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

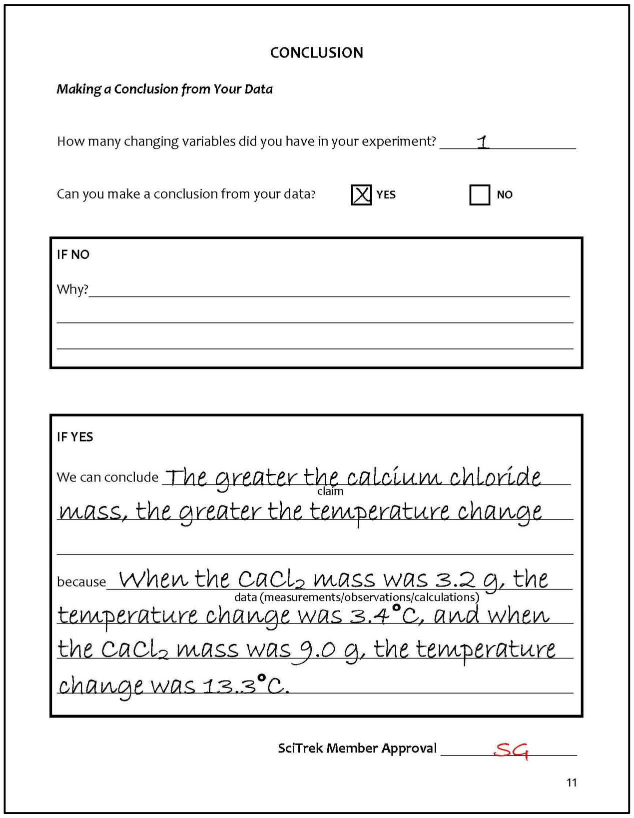
Introduction (SciTrek Lead) – 3 minutes
Conclusion (SciTrek Mentors) – 10 minutes
Findings Discussion (SciTrek Lead) – 10 minutes
Technique (SciTrek Lead) – 15 minutes
Analysis Activity (SciTrek Lead) – 20 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. Make sure mentors are setting out notebooks.
2. Set up the document camera for the findings discussion (picture packet, page 2), technique activities (notebook, pages 12-13), and analysis activity (notebook, pages 14-16).
3. Make sure mentors know they have copies of the notebook pages for the technique and analysis activities in their boxes and they know to fill them out with the class. Mentors should sit next to students that might need extra help.

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

- Review the class question, as well as what students did and learned last session.
- Review what they learned about conclusions.
    - What is a conclusion?
        - Claim supported by data
    - What is a claim and what does it usually include?
        - Statement that can be tested, which includes the changing variable
    - What type of information can be used for data?
        - Measurements, observations, or calculations
    - What else do we often see in a data statement?
        - Values of the changing variable
    - Can the claim and data statements be in any order for a conclusion?
        - No, the claim must come first, followed by the data that supports it.
    - How many changing variables can we have, in order to make a conclusion, and why?
        - One, if we test more than one changing variable at the same time, there is no way of telling which variable affected the data.



CONCLUSION

Making a Conclusion from Your Data

How many changing variables did you have in your experiment? 1

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

IF NO

Why?

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

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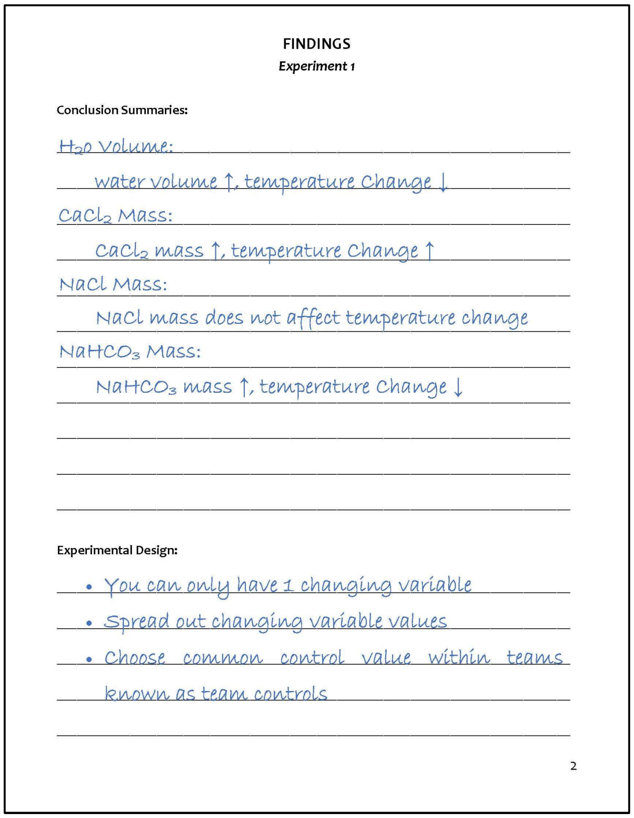
Conclusion: *(10 minutes – Subgroups – SciTrek Mentors)*

- Walk around and help subgroups who are struggling.
- Subgroups who can make a conclusion will need more help than those who cannot.
    - If a subgroup can make a conclusion, make sure they are making a claim, and using specific data to support that claim.

Findings Discussion: *(10 minutes – Full Class – SciTrek Lead)*

- Put the *Findings* (picture packet, page 2) under the document camera.



FINDINGS

Experiment 1

Conclusion Summaries:

H_2O Volume:
water volume ↑, temperature Change ↓
$CaCl_2$ Mass:
$CaCl_2$ mass ↑, temperature Change ↑
NaCl Mass:
NaCl mass does not affect temperature change
$NaHCO_3$ Mass:
$NaHCO_3$ mass ↑, temperature Change ↓

Experimental Design:

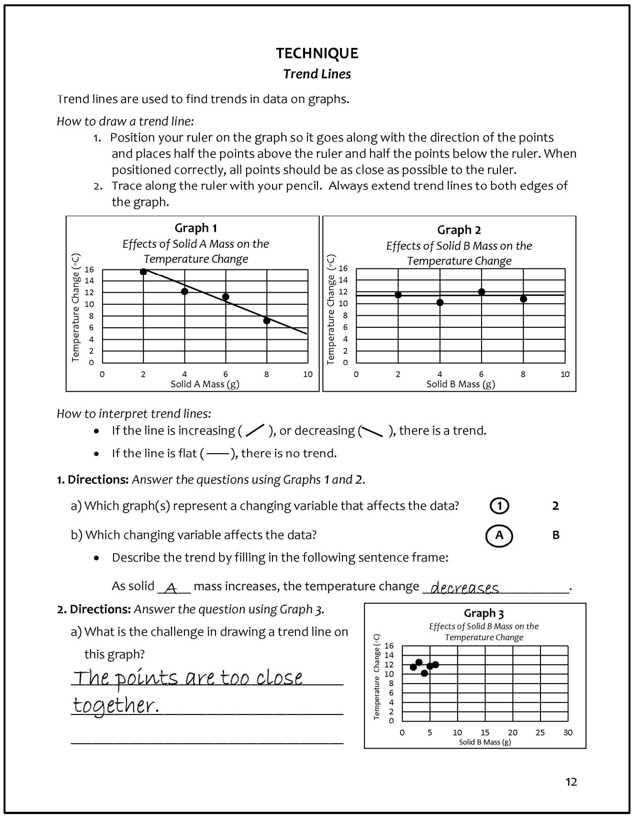
- You can only have 1 changing variable
- Spread out changing variable values
- Choose common control value within teams known as team controls

2

- Have subgroups share out what they learned from their first experiment, and record it.
    - Make sure to record “you can only have one change variable” under *Experimental Design*.

Picture Packet, Page 2

Technique: *(15 minutes – Full Class – SciTrek Lead)*



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.

Graph 1
Effects of Solid A Mass on the Temperature Change

Graph 2
Effects of Solid B Mass on the Temperature Change

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.*

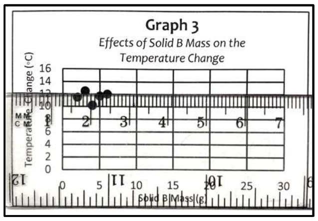
a) What is the challenge in drawing a trend line on this graph?

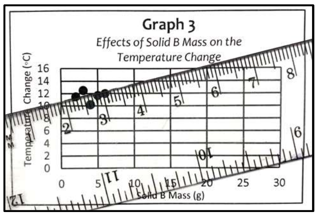
The points are too close together.

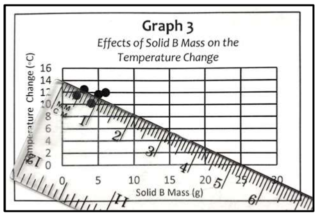
Graph 3
Effects of Solid B Mass on the Temperature Change

12

- Have mentors pass out clear rulers then get their extra copies of notebook pages 12 through 17 and sit next to a student that might need extra help and fill them out alongside of them.
- Go through the instructions for how to draw trend lines; draw trend lines for both graphs with students.
- Read, and discuss, the directions for how to interpret trend lines, and then fill in the lines under the graph.
    - Make sure to use the word ‘flat,’ rather than ‘straight,’ when describing trend lines that show no trend, because all lines are straight.
- Answer question *1* as a class.
- Show students the challenge with drawing a trend line on graph 3.
    - Put the ruler along with the points in three different ways (showing three potentially correct trend lines) and ask students, “Which placement is correct?” (see examples right)
    - Lead students to understand it is impossible to tell which way is correct because <u>the points are too close together</u> (answer question *2*).

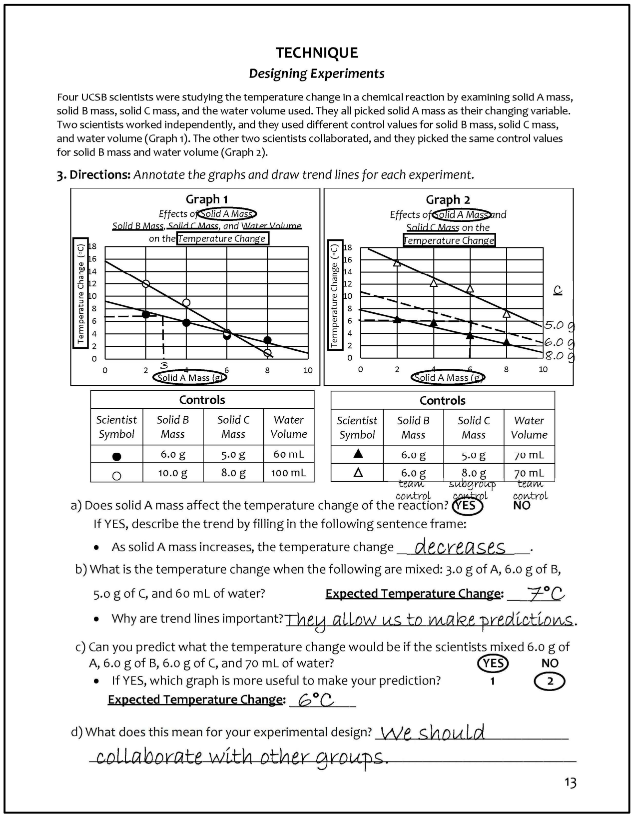






- Add “spread out changing variable values” to the *Findings* (picture packet, page 2) under *Experimental Design*.
- Turn to page 13 in the notebook and read the scenario aloud to the students.
- Show students how to annotate the graph titles.
    - Do not underline solid B mass, solid C mass, or water volume, yet.
- Have students draw trend lines for graphs 1 and 2, independently, while you do the same off to the side of the document camera. Let them check their work after approximately 1 minute.
- Lead students to identify and underline the three controls in the title of graph 1 and the one control in the title of graph 2.
- Discuss with students that these graph titles are different because the scientists in graph 1 all picked different control values, while the scientists in graph 2 collaborated to choose two of the control values.
    - Introduce vocabulary:
        - **Class Control:** A control that everyone in the class has the same value for.
            - For this example, there is no class control.
        - **Team Control:** A control that everyone in a team has the same value for, but values vary for different teams within a class.
            - Graph 2: solid B mass and water volume
        - **Subgroup Control:** A control that everyone in a subgroup has the same value for, but values vary for different subgroups within a team

        - Graph 1: solid B mass, solid C mass, and water volume
        - Graph 2: solid C mass
    - Label the controls under graph 2 as either "subgroup control," or "team control."
    - Label the trend lines on graph 2 with their subgroup control values.
- Answer question *a* as a class.
- Discuss with students which trend line they should use to answer question *b* and why.
    - Walk students through using the black circle trend line to determine the expected temperature change. You should predict approximately 7°C. Tell students, "Your prediction should be within 2°C of the class's prediction."
    - Discuss that trend lines allow us to make predictions from our graphs, making them an important tool. Write this for question *b*.
- Discuss which graph is more useful for making predictions and answer question *c*.
    - Walk students through using graph 2 to determine the expected temperature change (~6°C).
    - Make sure students understand their predicted trend line should fall closer to the 5.0 g trend line, than to the 8.0 g trend line.
- Ask students, "What did the scientists do, that made graph 2 more useful in making predictions?" Add "choose common control values within teams known as team controls" to the *Findings* (picture packet, page 2) under *Experimental Design* and use this to answer question *d* on page 13 of the notebook.



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]

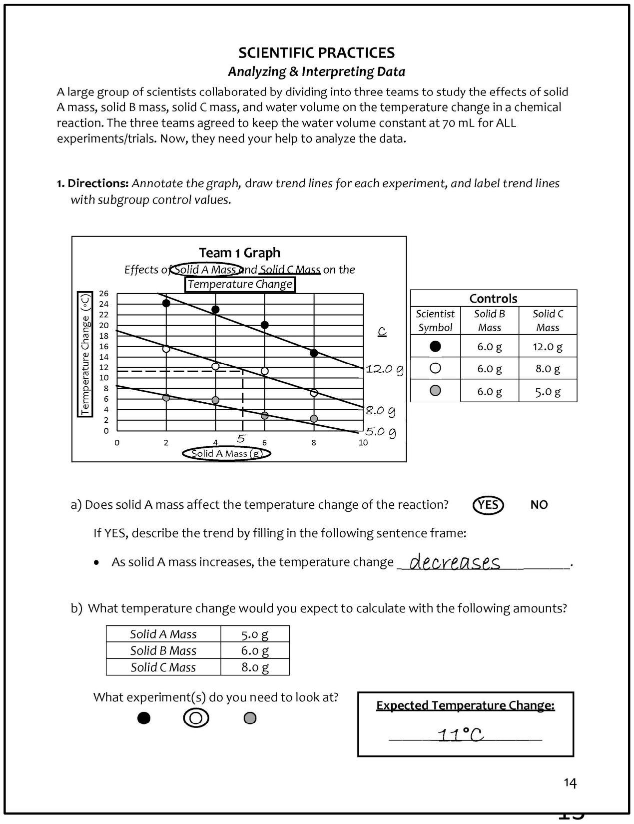
Expected Temperature Change: 6°C

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

13

Analysis Activity: *(18 minutes – Full Class – SciTrek Lead)*

- Make sure, on this day, you get through at least page 16, but continue onward if you have more time.
- Read the scenario at the top of page 14 of the notebook aloud, and point out that the scientists collaborated by making water volume a class control.
- On their own, have students annotate and draw/label trend lines on the team 1 graph. Give them approximately 1 minute, while you do the same off to the side of the document camera, then let them check their work.
- Fill out question *1a* as a class.
- As a class, complete question *1b*, which allows students to make a prediction using one trend line.
    - Help students identify the trend line they are interested in is the white circles.
    - Then have them find the changing variable value they are interested in (5.0 g) and label it if it is not already on the x-axis. Then, use a ruler to draw a dashed vertical line up to the trend



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:

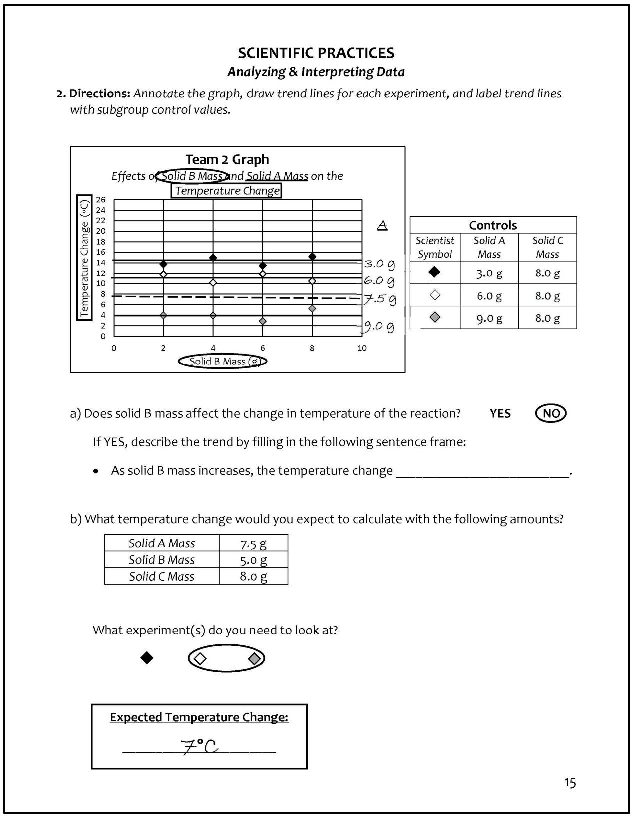
11°C

14

    line of interest. Rotate the ruler by 90° and use it to draw a horizontal dashed line over to the y-axis to determine the expected temperature change.
    - Students' predictions can be off from the value in the class notebook by up to 2° and still be considered correct This is true for all predictions within the scientific practice activity.
- Repeat this process for question *2* (notebook, page 15).
    - Make sure students understand, that solid B mass does not affect the temperature change, and this is a valid and important finding (not a mistake).
    - This time you will need to draw in a predicted trend line between the white and gray diamonds, using a dashed line.
        - Do this by drawing two dots, one dot on each vertical axis, halfway between the white and grey trend lines, then use a ruler to connect them with a dotted line and label the line 7.5 g.
    - Because mass B does not affect the temperature change, **do not** draw a dashed line up from the changing variable value of interest. Just identify where the predicted trend line crosses the y-axis.
- Repeat this process for question 3 (notebook, page 16).
    - Show students they can cross out solid B mass, since it does not affect the temperature change.
    - On their own, have students work on question *3b*. Give them approximately 3 minutes, while you do the same off to the side of the document camera, then let them check their work.
    - Repeat the same process for question *3c*.
        - This time the predicted trend line will not be directly in the middle of the white and black triangles, instead it will be closer to the 6.0 g line.
- If you still have time, go onto page 17.

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

- Go over what students will do next session.



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

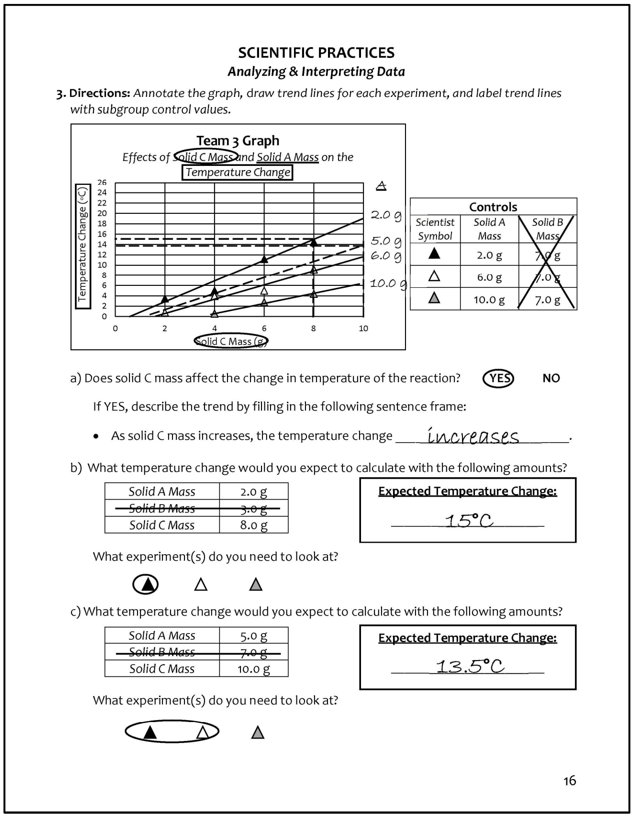
What experiment(s) do you need to look at?

◆ [✓ ◇ ◈]

Expected Temperature Change:

7°C

15



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?

[✓ ▲ △] ◮

16

Day 5: Analysis Activity/Discussion/Question/Experimental Set-Up/Procedure/Results Table

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

Introduction (SciTrek Lead) – 2 minutes
Analysis Activity (SciTrek Lead) – 10 minutes
Class Plan Discussion (SciTrek Lead/Mentors) – 10 minutes
Team Plan Discussion (SciTrek Mentors) – 7 minutes
Question (SciTrek Mentors) – 5 minutes
Experimental Set-Up (SciTrek Mentors) – 5 minutes
Procedure (SciTrek Mentors) – 14 minutes
Results Table (SciTrek Mentors) – 5 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

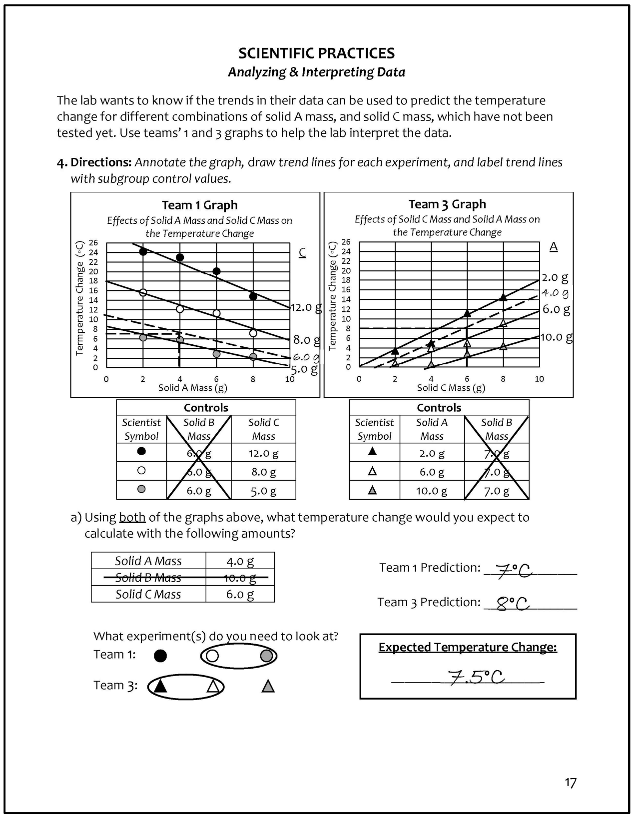
1. Make sure mentors know what team they will work with once students form teams.
2. Make sure mentors are passing out notebooks and rulers.
3. Set up the document camera for the analysis activity (notebook, page 17), and class plan discussion (picture packet, page 3).
4. Make sure mentors know they have copies of the notebook pages for the analysis activities in their boxes and they know to fill them out with the class. Mentors should sit next to students that might need extra help.

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

- Review the class question.
- Remind students they were learning about trend lines and review what we know so far about solid A, solid B, and solid C masses (notebook, page 14-16).
    - As the solid A mass goes up, the temperature change goes down.
    - The solid B mass does not affect the temperature change.
    - As solid C mass goes up, the temperature change goes up.

Analysis Activity: *(10 minutes – Full Class – SciTrek Lead)*

- Turn to page 17 of the notebook and tell students, "We will now put all of the teams' data together to make a prediction."
    - Do not have students annotate the graphs because they have already done this on the previous pages.
    - Ask students, "Why has team 2's graph been left out?" Possible student response: solid B mass does not affect the temperature change.
        - Cross off solid B mass in both control charts.



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.*

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

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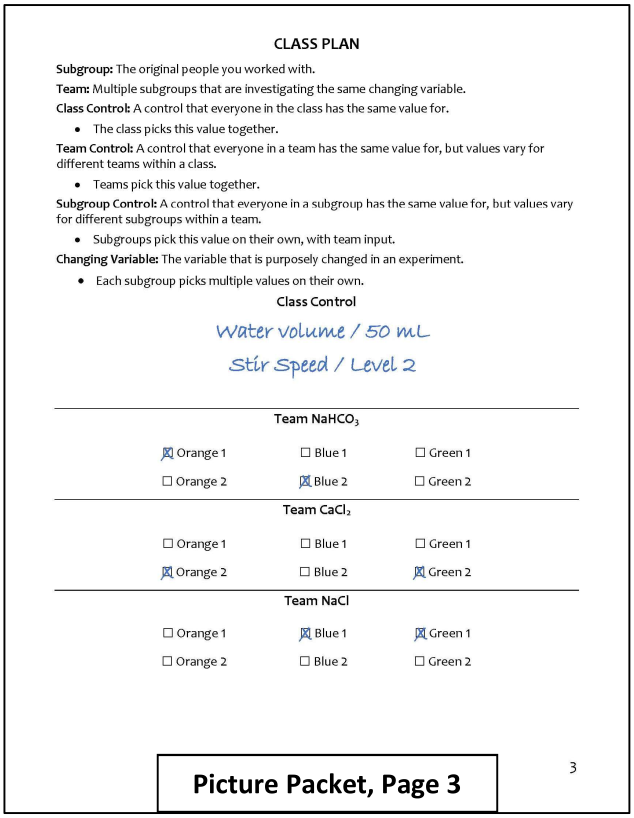
  - As a class, find the estimated temperature change from team 1’s graph.
    - Identify the trend lines that will use (white and grey circle).
    - Put dots on both vertical axes approximately where 6.0 g would be (close to the grey circles, 5.0 g, that the white circles, 8.0 g)
    - Use a ruler to connect the two dots with a dashed line.
    - Find 4.0 g on the x-axis.
    - Using a ruler make a vertical dashed line up to the estimated trend line.
    - Turn the ruler 90° and make a horizontal dashed line from the estimated trend line to the y-axis.
    - Determine the estimated temperature change.
  - On their own, have students determine the predicted temperature change from team 2’s graph. Give them approximately 3 minutes, while you do the same off to the side of the document camera, then let them check their work.
- Show students how to average their two predictions to find the final expected temperature change (for the class notebook, this value should be 7.5°C).

Class Plan Discussion: *(10 minutes – Full Class – SciTrek Lead)*

- Review the *Finding, Experimental Design* (picture packet, page 2) and what this means for the next experiment that subgroups design.
- Tell students, “We are going to break into teams to investigate each changing variable.”
- Have students identify the changing variable that will be investigated ($NaHCO_3$ mass, $CaCl_2$ mass, or NaCl mass) as well as the class controls (water volume and stir speed).
- Record class controls and their values (Water Volume/anything between 20 – 60 ml but between 40-50 ml is best and stir speed/level 2) on the *Class Plan* (picture packet, page 3).
- Have subgroups rank their top 3 choices for their changing variable. Use the subgroup fair sticks (lead box) to allow them to select their team. Record these on the *Class Plan*. **<u>Make sure to have two subgroups per team</u>**.



CLASS PLAN

Subgroup: The original people you worked with.

Team: Multiple subgroups that are investigating the same changing variable.

Class Control: A control that everyone in the class has the same value for.

- The class picks this value together.

Team Control: A control that everyone in a team has the same value for, but values vary for different teams within a class.

- Teams pick this value together.

Subgroup Control: A control that everyone in a subgroup has the same value for, but values vary for different subgroups within a team.

- Subgroups pick this value on their own, with team input.

Changing Variable: The variable that is purposely changed in an experiment.

- Each subgroup picks multiple values on their own.

Class Control

Water volume / 50 mL

Stir Speed / Level 2

Team $NaHCO_3$

☒ Orange 1 ☐ Blue 1 ☐ Green 1

☐ Orange 2 ☒ Blue 2 ☐ Green 2

Team $CaCl_2$

☐ Orange 1 ☐ Blue 1 ☐ Green 1

☒ Orange 2 ☐ Blue 2 ☒ Green 2

Team NaCl

☐ Orange 1 ☒ Blue 1 ☒ Green 1

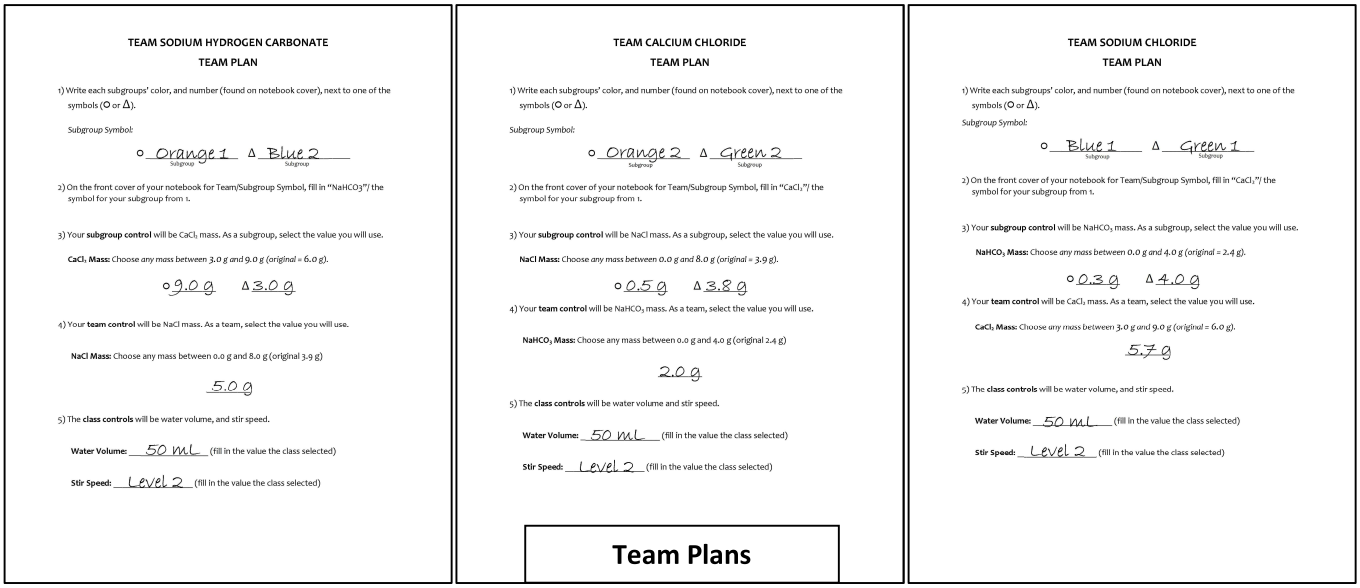
☐ Orange 2 ☐ Blue 2 ☐ Green 2

3

Picture Packet, Page 3

Team Plan Discussion: *(7 minutes – Teams – SciTrek Mentors)*

- Walk around and help teams who are struggling.
- Make sure mentors have students write their team and subgroup symbol on the front covers of their notebooks.
- Make sure mentors fill out the team plan correctly and have students pick subgroup control values that are spread out.
- Make sure students are following the restrictions for each substance and choosing values to the nearest tenth of a gram.



TEAM SODIUM HYDROGEN CARBONATE
TEAM PLAN

1) Write each subgroups' color, and number (found on notebook cover), next to one of the symbols (○ or Δ).

Subgroup Symbol:

○ Orange 1 (Subgroup) Δ Blue 2 (Subgroup)

2) On the front cover of your notebook for Team/Subgroup Symbol, fill in "NaHCO3"/ the symbol for your subgroup from 1.

3) Your **subgroup control** will be $CaCl_2$ mass. As a subgroup, select the value you will use.

$CaCl_2$ Mass: Choose *any mass between 3.0 g and 9.0 g (original = 6.0 g).*

○ 9.0 g Δ 3.0 g

4) Your **team control** will be NaCl mass. As a team, select the value you will use.

NaCl Mass: Choose any mass between 0.0 g and 8.0 g (original 3.9 g)

5.0 g

5) The **class controls** will be water volume, and stir speed.

Water Volume: 50 mL (fill in the value the class selected)

Stir Speed: Level 2 (fill in the value the class selected)

TEAM CALCIUM CHLORIDE
TEAM PLAN

1) Write each subgroups' color, and number (found on notebook cover), next to one of the symbols (○ or Δ).

Subgroup Symbol:

○ Orange 2 (Subgroup) Δ Green 2 (Subgroup)

2) On the front cover of your notebook for Team/Subgroup Symbol, fill in "$CaCl_2$"/ the symbol for your subgroup from 1.

3) Your **subgroup control** will be NaCl mass. As a subgroup, select the value you will use.

NaCl Mass: Choose *any mass between 0.0 g and 8.0 g (original = 3.9 g).*

○ 0.5 g Δ 3.8 g

4) Your **team control** will be $NaHCO_3$ mass. As a team, select the value you will use.

$NaHCO_3$ Mass: Choose any mass between 0.0 g and 4.0 g (original 2.4 g)

2.0 g

5) The **class controls** will be water volume and stir speed.

Water Volume: 50 mL (fill in the value the class selected)

Stir Speed: Level 2 (fill in the value the class selected)

TEAM SODIUM CHLORIDE
TEAM PLAN

1) Write each subgroups' color, and number (found on notebook cover), next to one of the symbols (○ or Δ).

Subgroup Symbol:

○ Blue 1 (Subgroup) Δ Green 1 (Subgroup)

2) On the front cover of your notebook for Team/Subgroup Symbol, fill in "$CaCl_2$"/ the symbol for your subgroup from 1.

3) Your **subgroup control** will be $NaHCO_3$ mass. As a subgroup, select the value you will use.

$NaHCO_3$ Mass: Choose *any mass between 0.0 g and 4.0 g (original = 2.4 g).*

○ 0.3 g Δ 4.0 g

4) Your **team control** will be $CaCl_2$ mass. As a team, select the value you will use.

$CaCl_2$ Mass: Choose *any mass between 3.0 g and 9.0 g (original = 6.0 g).*

5.7 g

5) The **class controls** will be water volume, and stir speed.

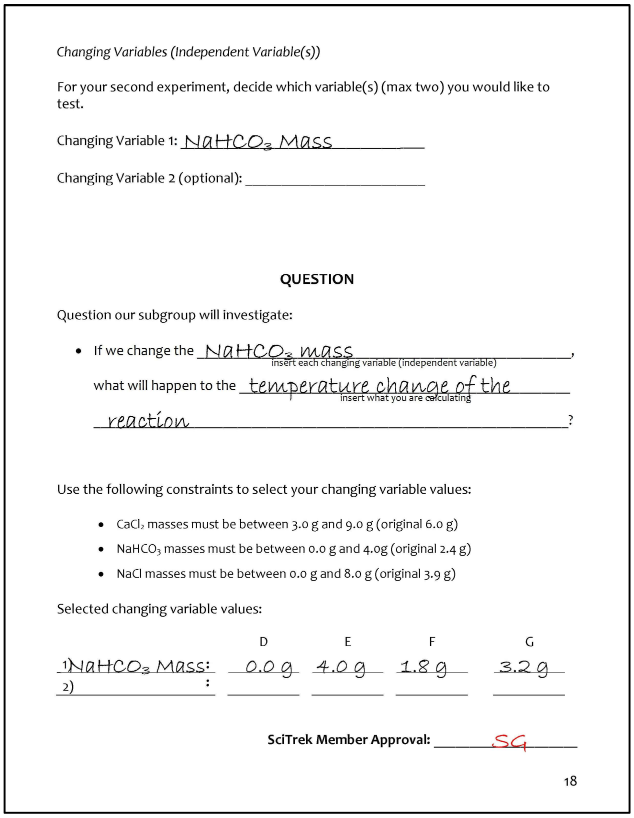
Water Volume: 50 mL (fill in the value the class selected)

Stir Speed: Level 2 (fill in the value the class selected)

Team Plans

Question: *(5 minutes – Teams – SciTrek Mentors)*

- Walk around and help subgroups who are struggling.
- Make sure for the second part of the question (what you are calculating) students are specific (they should write, "the temperature change of the reaction," and not just "the temperature change").



Changing Variables (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): ______

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 reaction (insert what you are calculating)?

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

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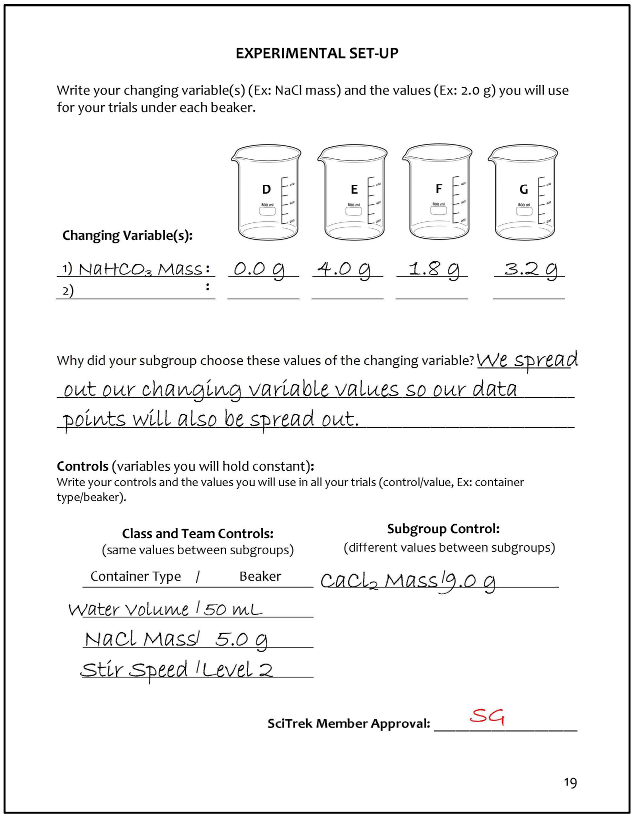

EXPERIMENTAL SET-UP

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

Why did your subgroup choose these values of the changing variable? We spread out our changing variable values so our data points will also be spread out.

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)	**Subgroup Control:** (different values between subgroups)
Container Type / Beaker	$CaCl_2$ Mass / 9.0 g
Water Volume / 50 mL	
NaCl Mass / 5.0 g	
Stir Speed / Level 2	

SciTrek Member Approval: SG

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Experimental Set-Up: *(5 minutes – Teams – SciTrek Mentors)*

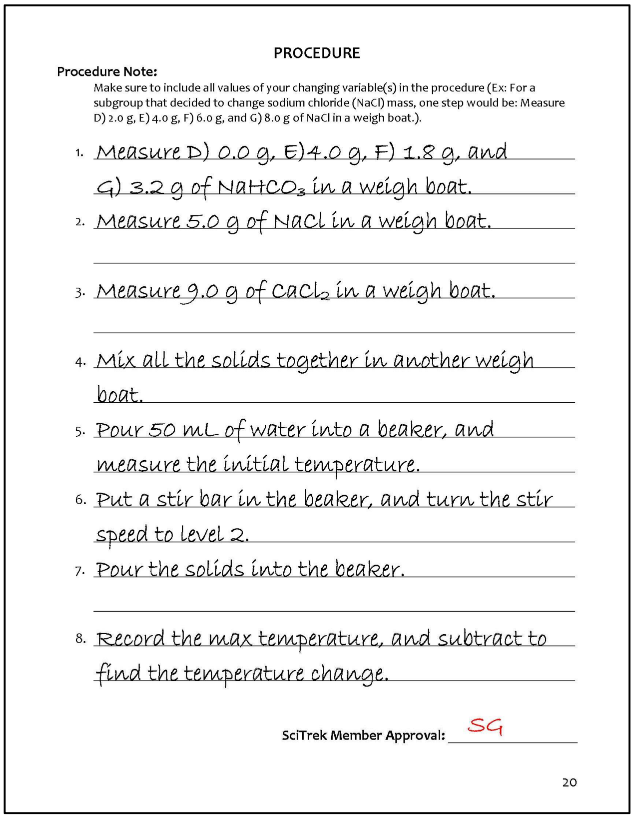
- Walk around and help subgroups who are struggling.
- Make sure within one subgroup all students have the same order for their changing variable values.
- Make sure all control blanks are filled out.

***Procedure:** (14 minutes – Teams – SciTrek Mentors)*

- Walk around and help subgroups who are struggling.
- Make sure procedures are concise, but still include all values of the controls and changing variable, as well as the data that will be collected and the calculation that will be performed.
    - Students within each subgroup can vary the wording in their procedures, as long as the steps are in the same order and correct values are included.

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

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



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. Measure D) 0.0 g, E)4.0 g, F) 1.8 g, and G) 3.2 g of $NaHCO_3$ in a weigh boat.
2. Measure 5.0 g of NaCl in a weigh boat.
3. Measure 9.0 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 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

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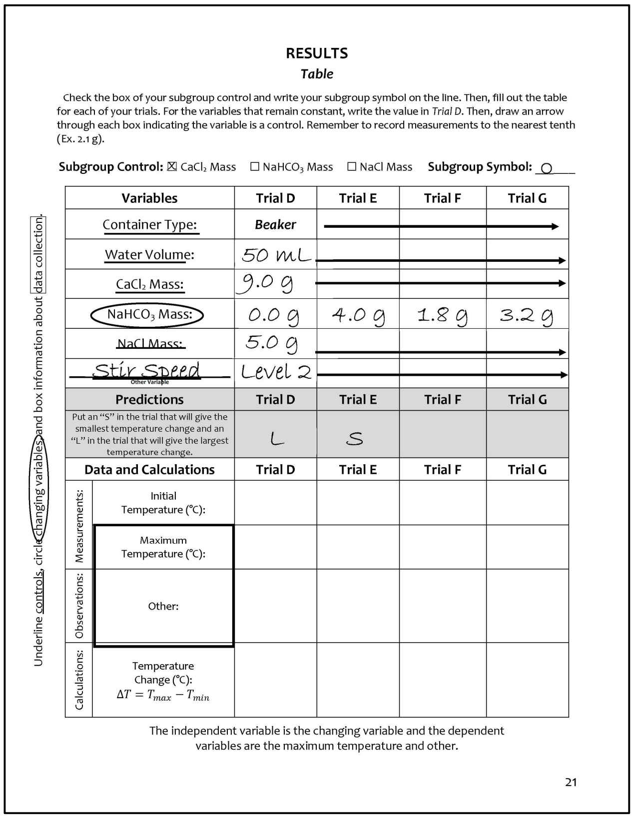

RESULTS

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: ☒ $CaCl_2$ Mass ☐ $NaHCO_3$ Mass ☐ NaCl 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:	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 (℃):				
Measurements: 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.

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

- Go over what students will do next session.

Day 6: Experiment/Graph/Conclusion

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

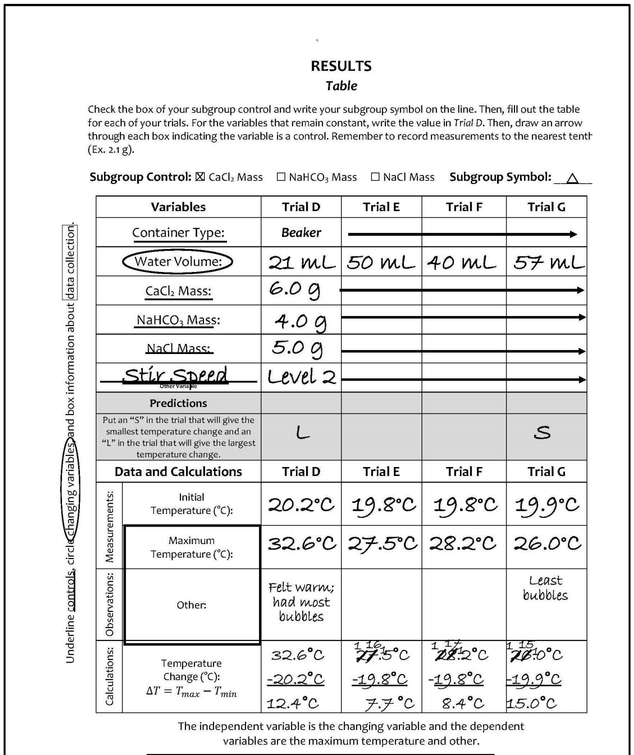
Introduction (SciTrek Lead) – 8 minutes
Experiment (SciTrek Mentors) – 24 minutes
Graph (SciTrek Mentors) – 18 minutes
Conclusion (SciTrek Mentors) – 8 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. Make sure mentors are setting out notebooks.
2. Make sure mentors are setting up for the experiment.
3. Set up the document camera for the Introduction (picture packet, pages 1, 4, and 5; notebook, page 23).

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

- Review the class question, as well as what students did and learned last session.
- Use the checklist (picture packet, page 4, top) to go over how to graph results.
    - The filled-out results table used to make the graph is on page 1 of the picture packet.
    - Talk students through the process of completing their graphs (picture packet, page 4).
    - Show what the completed team graph should look like (picture packet, page 5).



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: ☒ $CaCl_2$ Mass ☐ $NaHCO_3$ Mass ☐ NaCl Mass **Subgroup Symbol:** △

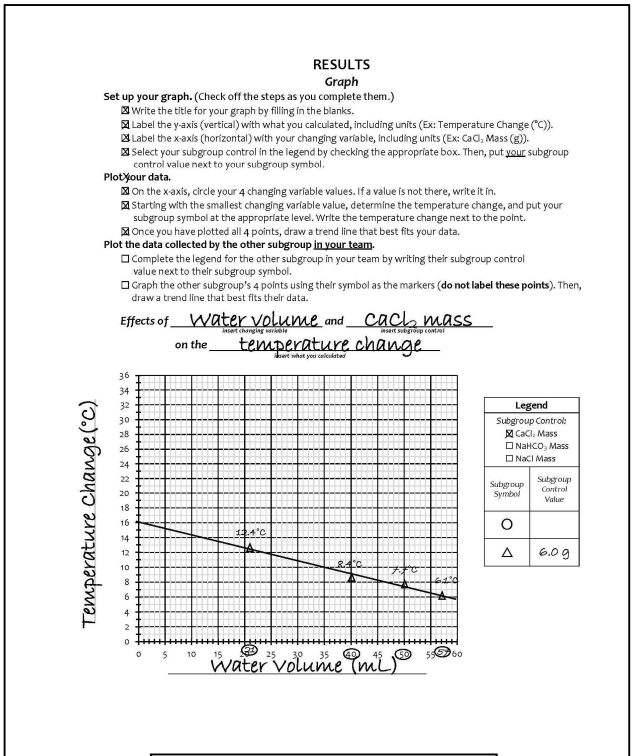
Underline controls, circle changing variables, and box information about data collection.

	Variables	**Trial D**	**Trial E**	**Trial F**	**Trial G**
	Container Type:	***Beaker***	→	→	→
	Water Volume:	21 mL	50 mL	40 mL	57 mL
	$CaCl_2$ Mass:	6.0 g	→	→	→
	$NaHCO_3$ Mass:	4.0 g	→	→	→
	NaCl Mass:	5.0 g	→	→	→
	Stir Speed Other Variable	Level 2	→	→	→
	Predictions				
	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
	Maximum Temperature (°C):	32.6°C	27.5°C	28.2°C	26.0°C
Observations:	Other:	Felt warm; had most bubbles			Least bubbles
Calculations:	Temperature Change (°C): $\Delta T = T_{max} - T_{min}$	32.6°C -20.2°C 12.4°C	1 16 ~~27~~.5°C -19.8°C 7.7 °C	1 17 ~~28~~.2°C -19.8°C 8.4°C	1 15 ~~26~~.0°C -19.9°C 15.0°C

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

1

Picture Packet, Page 1



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 your 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.

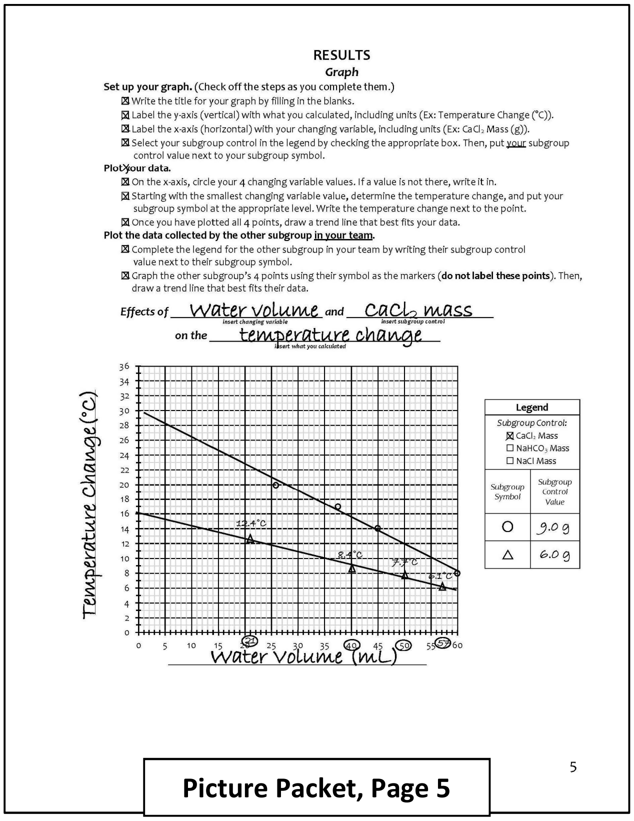
Plot the data collected by the other subgroup in your team.
- ☐ Complete the legend for the other subgroup in your team by writing their subgroup control value next to their subgroup symbol.
- ☐ Graph the other subgroup’s 4 points using their symbol as the markers (**do not label these points**). Then,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

Effects of Water volume (*insert changing variable*) *and* $CaCl_2$ mass (*insert subgroup control*)
on the temperature change (*insert what you calculated*)

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

4

Picture Packet, Page 4



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 Water volume ***and*** $CaCl_2$ mass

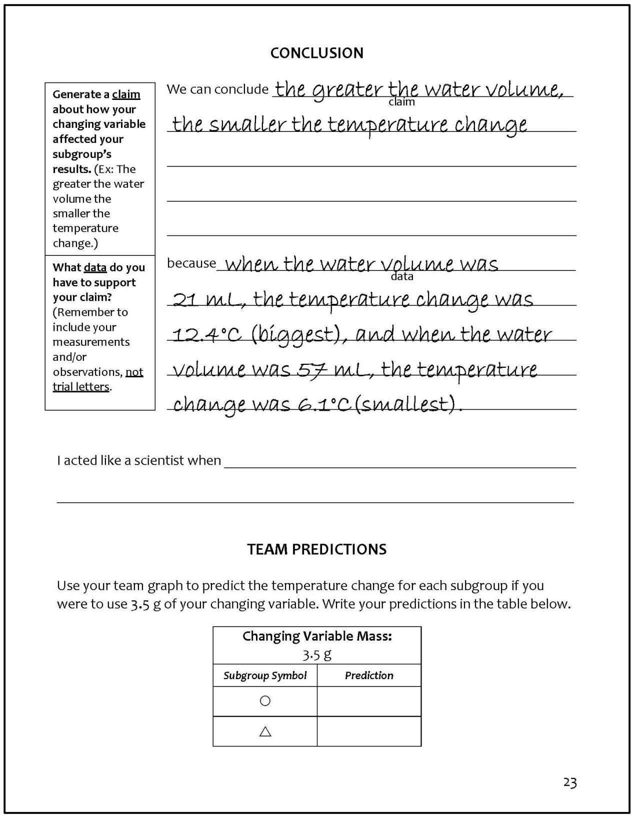
insert changing variable *insert subgroup control*

on the temperature change

insert what you calculated

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

Picture Packet, Page 5



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 the greater the water volume, the smaller the temperature change 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 when the water volume was 21 mL, the temperature change was 12.4°C (biggest), and when the water volume was 57 mL, the temperature change was 6.1°C (smallest). 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***
○	
△	

23

- Review the definition of a conclusion (a claim supported by data).
- Have students generate a conclusion from the data, using subgroup (Δ) data (picture packet, page 5).
  - We can conclude the greater the water volume, the smaller the temperature change because when the water volume was 21 mL, the temperature change was 12.4°C (biggest) and when the water volume was 57 mL, the temperature change was 6.1°C (smallest).
  - Tell students, "When you make your conclusions, you will use your entire team's graph to come up with a claim, but you will use two specific data points, from your own subgroup data, to support the claim."
- Remind students of the following things before allowing them to start doing their experiment
  - To tare scale.
  - The scoopulas should only be used in the substance they are marked for.
  - Wipe thermometers between trials.
  - Close thermometers after each trial, to reset the "Max/Min" function.
  - Keep the lid on the calcium chloride, as much as possible.

Experiment: *(24 minutes – Subgroups – SciTrek Mentors)*

- Walk around and help subgroups who are struggling.
- Make sure students are:
  - closing the $CaCl_2$ lid, when not in use
  - closing and wiping off, the thermometer, in between trials
  - recording the maximum temperature, with units, and subtracting to find the temperature change
- Remove beakers, weigh boats, etc., as soon as students are done with them.
  - Put beakers, stir bars, $CaCl_2$ weigh boats, mix weigh boats, and any liquid, in the buckets.
  - Put graduated cylinders, back into their box.
  - Put water bottles, back into their box.
  - Put the stir plates, back into their box.
  - All other materials go into the group boxes.

- Put water on a white rag, in the lead box, then wipe down tables to insure no chemicals are left on them.

Graph: *(18 minutes – Subgroups – SciTrek Mentors)*

- Walk around and help subgroups who are struggling.
- Make sure students are writing the numerical value of the temperature change above the points for their own subgroup's data.
- If one subgroup finishes before the other subgroup on the team have the mentor use their phone to take a picture of the other subgroups data for the fished subgroup to start their graph.
- Make sure students are graphing the data for the other subgroup in their team (**do not let them label these points**).
- Make sure students are drawing trend lines for each set of points.

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

- Walk around and help subgroups who are struggling.
- Make sure subgroups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and use two specific data points to support it.
    - Subgroups will be using calculations as their data; make sure they are including numerical values in their data statements.
    - Do not let subgroups reference trial letters in their conclusions.
- Mentors struggle with conclusions, so you should check at least one conclusion from each team.
- Make sure students fill out the sentence frame (notebook, page 23), *I acted like a scientist when*.
- If there is time, students should use their team graphs to fill out the *Team Predictions* (notebook, page 23).

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

- Ask students the following questions:
    - How did you act like a scientist during this project?
    - What did you do, that scientists do?

Day 7: Poster Making/Poster Presentations

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

Introduction (SciTrek Lead) – 2 minutes
Poster Making (SciTrek Mentors) – 25 minutes
Practice Posters (SciTrek Mentors) – 5 minutes
Poster Presentations (SciTrek Mentors/SciTrek Lead) – 26 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Note: Timing is tight on this day. It is possible the class will only get through two of the three presentations during the allotted time. In this case, the teacher will need to lead the third poster presentation, outside of SciTrek time, before the next SciTrek session.

Preparation:

1. Make sure notebooks have been highlighted, stickered, and numbered. If not, use the poster diagram page to have mentors do this before starting SciTrek.

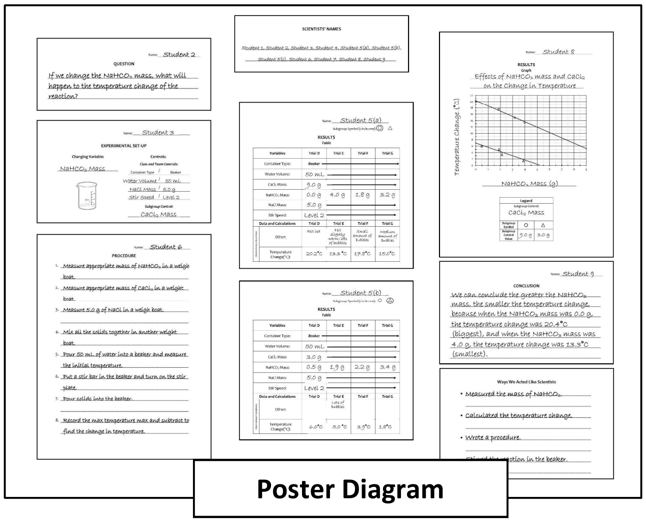
2. Make sure mentors are setting out notebooks.
3. Set up the document camera for the *Notes on Presentations* (picture packet, page 6).

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

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

Poster Making: *(25 minutes – Subgroups – SciTrek Mentors)*

- Notebooks will have already been highlighted, numbered, and stickered. If a student is absent have the mentor give that student's notebook to another student to fill out the part. During the presentation the presenting student will have two notebooks to read out of.
- Make sure students on each team who are presenting the *Experimental Set-Up: Specific* and *Graph: General*, have fill out the sheet stapled in their notebooks.
- Make sure the student presenting the *Results Graph: Specific* knows how to orally fill in the sentence frame with their data points.
- The *Ways we Acted Like Scientists* poster part can be filled out by one or multiple, student(s), as long as they have finished their assigned poster part first.
- Help mentors glue poster pieces onto the posters. When gluing, make sure **you** or the **mentors** (not the students) are gluing the poster in the **exact** order that is shown on the diagram and the poster has a landscape orientation.

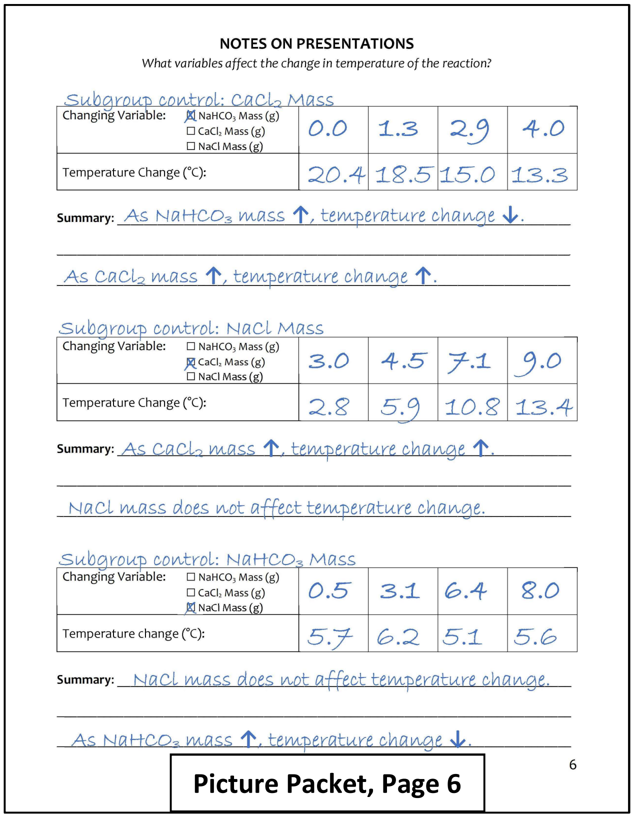


Poster Diagram

Practice Posters: *(5 minutes – Subgroups – SciTrek Mentors)*

- **Do not give students more than 5 minutes to practice or you will run out of time for presentations.**
- Organize posters so they are presented from easiest to understand, to hardest to understand (**suggested order: $NaHCO_3$ mass, $CaCl_2$ mass, NaCl mass**).
- Make sure students are reading from their notebooks and practicing the poster in order: 1) scientists' names, 2) question, 3) experimental set-up: general, 4) experimental set-up: specific (staple sheet), 5a) results table ○ (sticker), 5b) results table Δ (sticker), 6) procedure (staple sheet), 7) graph: general (staple sheet), 8) graph: specific (sticker), and 9) conclusion. They will **not** read the *Ways we Acted Like Scientists* from their posters.

Poster Presentations: *(31 minutes – Full Class – SciTrek Mentors/SciTrek Lead)*



NOTES ON PRESENTATIONS

What variables affect the change in temperature of the reaction?

Subgroup control: $CaCl_2$ Mass

Changing Variable: ☒ $NaHCO_3$ Mass (g) ☐ $CaCl_2$ Mass (g) ☐ NaCl Mass (g)	0.0	1.3	2.9	4.0
Temperature Change (°C):	20.4	18.5	15.0	13.3

Summary: As $NaHCO_3$ mass ↑, temperature change ↓.

As $CaCl_2$ mass ↑, temperature change ↑.

Subgroup control: NaCl Mass

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

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

NaCl mass does not affect temperature change.

Subgroup control: $NaHCO_3$ Mass

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

Summary: NaCl mass does not affect temperature change.

As $NaHCO_3$ mass ↑, temperature change ↓.

6

Picture Packet, Page 6

- Have students present their posters.
- While posters are being presented, record the following (picture packet, page 6), while students do the same (notebook, page 24) on their notebooks.
    - After a team reads their question, stop the presentation and have the class identify the changing variable. Then, record it in the picture packet while students do the same in their notebooks.
    - After the team presents their *Experiment Set Up Specific,* stop the presentation and have the class identify the subgroup control. Then, record it in the picture packet. Students do not have to record this if they do not want to.
    - After the first team's presentation, stop the presentations after the team has read their procedure, then have the class predict what trend they think the team saw both withing their trendlines and between trend lines, if possible
    - When a team reads their *Results Graph: Specific*, record the values of the changing variable and their measurements.
- After each presentation, ask students:
    - What questions do you have for this team?
        - Have students take approximately 30 seconds to write down one scientific question to ask this team. Then allow them to ask questions.
- Once students have asked their questions (make sure each student answers a question; you should ask at least one question per presentation), have students summarize what they learned and record it (picture packet, page 6); while students also record the summary (notebook, page 24).
- Students will not record information about their own team's poster presentation.
- After all presentations are over, have students tell you the variable values they would select to cause the largest temperature change.

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

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

Day 8: Analysis Assessment/Draw a Scientist/Tie to Standards/Content Assessment

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

Analysis Assessment (SciTrek Lead) – 10 minutes
Draw a Scientist (SciTrek Lead) – 5 minutes
Tie to Standards (SciTrek Lead) – 50 minutes
Content Assessment (SciTrek Lead) – 5 minutes

Preparation:

1. If the teacher is not leading the tie to standards activity, do the following:
    a. Ask the teacher if they completed the SciTrek final survey. If not, give them the QR code from the lead box and ask them to go to the website (at a later time) and fill out the evaluation of the program.
    b. Give the teacher an extra notebook and have them fill it out with their students, to follow along during the tie to standards activity.
    c. Collect the teacher's lab coat and put it in the lead box.
2. If you are a teacher and have not completed the final survey, take the QR code from the lead box, and fill out the evaluation of the program, at a later time.
3. Pass out the analysis assessments and notebooks.
4. Set up the document camera for the tie to standards activity (notebook, pages 25-30; picture packet, pages 7-9).
5. Set up the temperature change demonstration (just like the
6. Day 1 experimental set-up).
7. Put your lab coat in the lead box at the end of the day.

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

- Question *1-2*: Have students fill in the definition of a conclusion and the number of changing variables they can have to make a conclusion.
- Questions *3-5*: Have students annotate (underline controls, circle changing variable(s), and box information about data collection) and answer questions about the result table and possible conclusion.
- Pass out clear rulers to students.
- Question *6*: Have students annotate (underline controls, circle the changing variable, and box information about data) the graph.
- Have students answer questions *6b-6f*.
- Have students answer the attitudes about science questions *7-14*.
- Collect assessments.
    - Leave clear rulers for students to use during the tie to standards activity.

Draw a Scientist: *(5 minutes – Full Class – SciTrek Lead)*

- Pass out the *Draw a Scientist* page.
- Give students exactly 4 minutes to draw a picture of a scientist.
- If the students drew a specific person, have them write who they drew on the line at the bottom of the page. Have them leave it blank if it is just a general person/picture.
- Collect assessments.

Tie to Standards: *(40 minutes – Full Class – SciTrek Lead)*

Class Findings (3 minute)

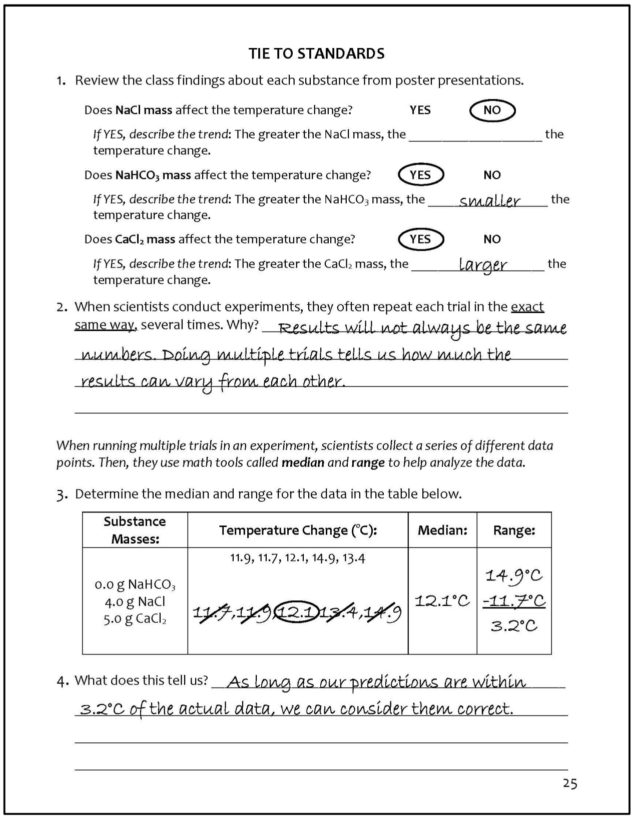
- Review the class findings, from the poster presentations from last session, and record the answer in question *1* (notebook, page 25).

Variations in Data (6 minutes)

- Discuss, with students, why scientists perform multiple trials and write the answer in question *2* (notebook, page 25).
- Introduce the median and range, as well as calculate both for the data given on question *3* (notebook, page 25).
- Tell students, "The data in the table is actual data the SciTrek lab collected after performing one trial of the class experiment five times." Discuss what this means, and record it for question *4* (notebook, page 25).

Predicting Temperature Change (10 minutes)

- Tell students, "The SciTrek lab did several experiments similar to yours, but they performed each trial three times, and graphed the median results, these graphs are shown on page 26 of your notebooks."
- Ask students, "Why has the graph for NaCl mass been left out?" and record the answer in question *5*.
- As a class, annotate graph 1, and draw/label trend lines.
- Ask students, "Is graph 1 consistent with the class findings?" and circle *YES*.
- On their own, have students annotate graph 2, and draw/label trend lines. Give them approximately 3 minutes, while you do the same off to the side of the document camera, then let them check their work.
- Ask students, "Is graph 2 consistent with the class findings?" and circle *YES*.
- As a class, use the graphs to make predictions about the temperature change of the reaction for the given amounts.
  - For graph 1, you will use the **X** trend line.
  - For graph 2, you will have to draw in a predicted trend line between the ○ and Δ trend lines.
- Show students how to find the temperature change halfway between the two predictions, and write it in the *Expected Temperature Change* box.
  - If one predicted temperature change ends in '.5' and the other ends in '.0,' the average



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.

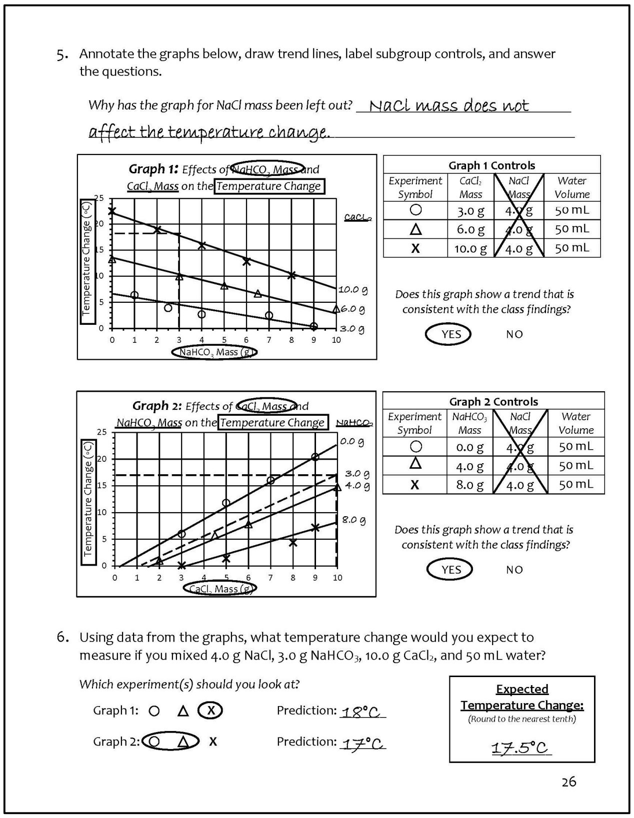
When running multiple trials in an experiment, scientists collect a series of different data points. Then, they use math tools called ***median*** *and* ***range*** *to help analyze the data.*

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.

25



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
Δ	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
Δ	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?

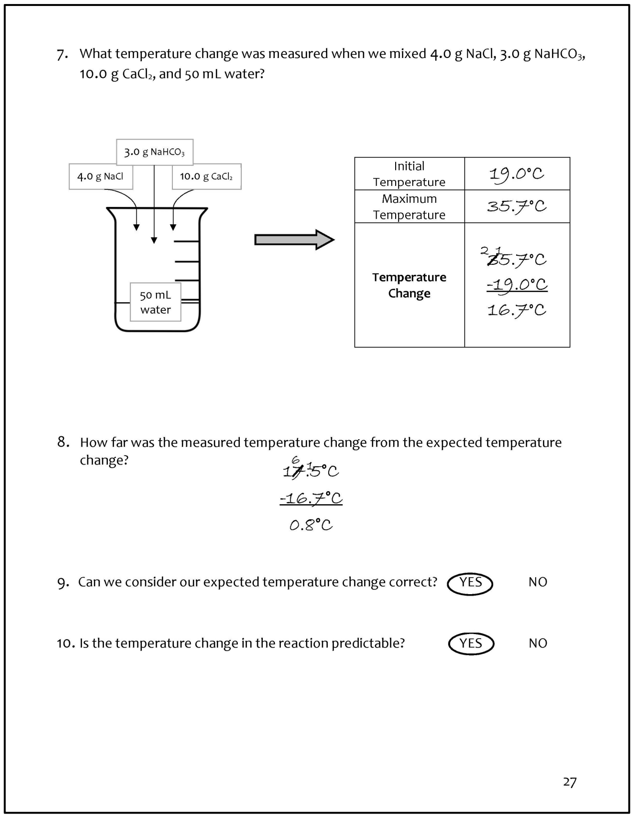
Which experiment(s) should you look at?

Graph 1: ○ Δ [✓ X] Prediction: 18°C

Graph 2: [✓ ○] [✓ Δ] X Prediction: 17°C

Expected Temperature Change:
(Round to the nearest tenth)
17.5°C

26



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?

3.0 g $NaHCO_3$
4.0 g NaCl
10.0 g $CaCl_2$
50 mL water

Initial Temperature	19.0°C
Maximum Temperature	35.7°C
Temperature Change	$\overset{2}{\cancel{3}}\overset{1}{5}$.7°C -19.0°C 16.7°C

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

$1\overset{6}{\cancel{7}}.\overset{1}{\cancel{5}}$°C
-16.7°C
0.8°C

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

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

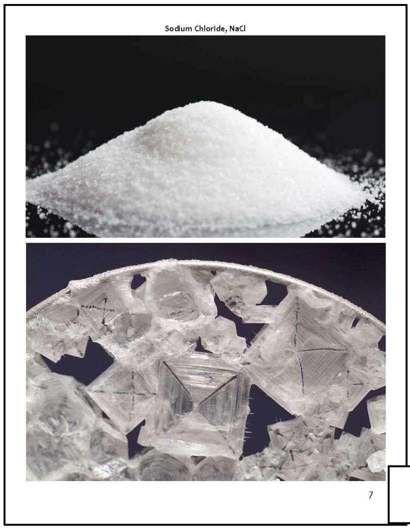
27

would technically end in '.25.' Use a money example to help students understand this, then round to '.3,' since masses are rounded to the nearest tenth.

- Perform the experiment, have students record the initial temperature and maximum temperature then do the subtraction to find the temperature change in the table on page 27.
- Answer question *8*, by subtracting the predicted, and actual, temperature changes (start with whichever temperature change was larger).
- Discuss with students whether the prediction was correct.
    - Circle *YES*, for question *9*, if the answer to question *8* is less than 3.2°C (the accepted range of variation).
- Discuss whether temperature change in a reaction is predictable, or not, and answer question *10*.

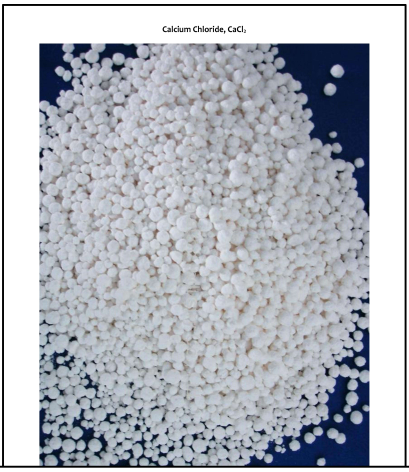
Why Temperature Changes (14 minutes)

- Have students fill out the definition of temperature, question 11 (notebook, page 28).
    - *Temperature is a measure of* kinetic energy*, which is* the energy of motion*.*
- Tell students, "If the kinetic energy is low, particles in a substance are moving slowly, and the temperature is low." Have students fill out the first diagram on question *12*.
- Have students fill out the second diagram, on their own. Give them approximately 1 minute, while you do the same off to the side of the document camera, then let them check their work.
- Show students the pictures of the substances they mixed in the reaction (picture packet, pages 7-9), then have students describe the pictures, and record their answers, for question *13*.
    - While you write observations about the substances with the students, have a mentor, or the teacher, pass out water bottles, graduated cylinders, and Experiment 1 bags, to every 2 students, and collect the clear rulers.

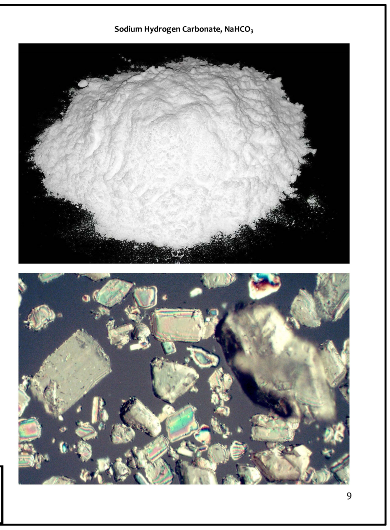


Sodium Chloride, NaCl

7



Calcium Chloride, $CaCl_2$



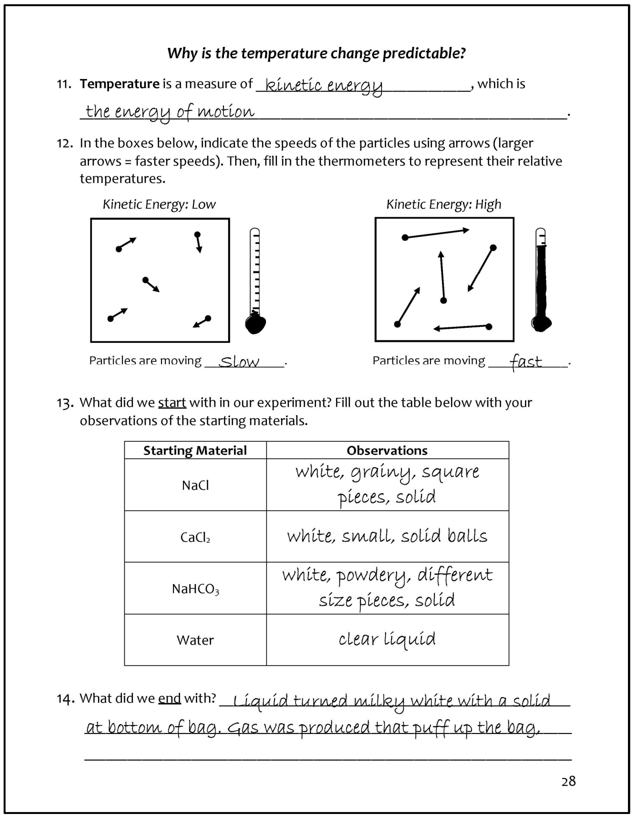
Sodium Hydrogen Carbonate, $NaHCO_3$

9

Picture Packet, Pages 7, 8, and 9

- Show students how to set up the reaction in the Experiment 1 bag.
    - Have one student in each group measure 50 mL water in the graduated cylinder.
    - Have the other student in the group tilt the bag so the solids all go in one corner, then pinch the corner and twist the bag a few times so all substances are contained in one side.

        - Make sure students do not twist the bag too many times because they will put a hole in the bag which will make a mess.
    - Have the first student pour the water into the other side of the bag, and close the zipper (have a mentor, or the teacher, do this for you).
- Once everyone is ready, count down from 3 and release the solids at the same time, shaking the bag so all substances mix together.
- Have students describe what happened during the reaction and what is left after the reaction as well as record observations on question *14*.



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

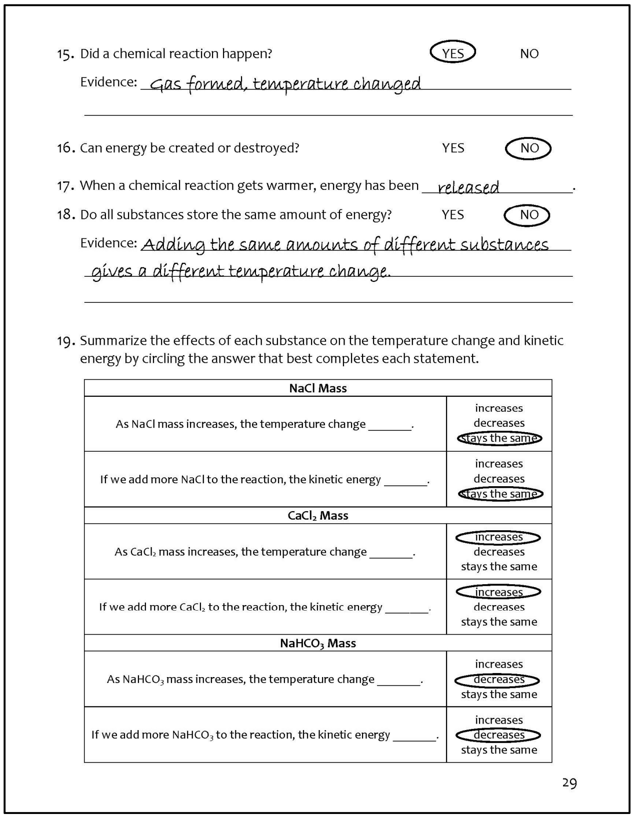
Particles are moving fast.

13. What did we start 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 end with? Liquid turned milky white with a solid at bottom of bag. Gas was produced that puff up the bag.

28



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.

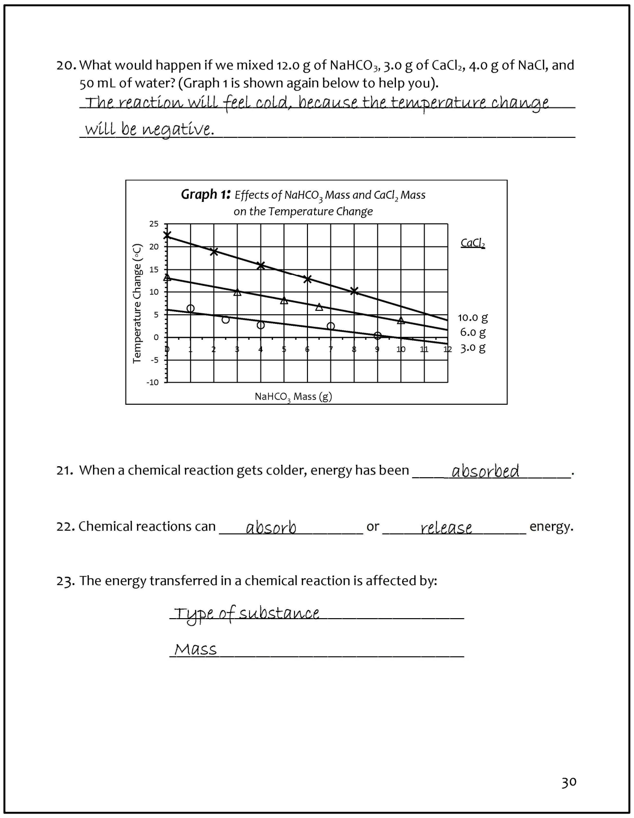
NaCl Mass	
As NaCl mass increases, the temperature change _______.	increases decreases [✓ stays the same]
If we add more NaCl to the reaction, the kinetic energy _______.	increases decreases [✓ stays the same]
$CaCl_2$ Mass	
As $CaCl_2$ mass increases, the temperature change _______.	[✓ increases] decreases 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

29

- Fill out question *15* by asking students, “Did a chemical reaction happen, and how do you know?” (notebook, page 29).
- Tell students, “Energy cannot be created or destroyed.” Circle *NO*, for question *16*.
- Ask students, “Where did the heat energy come from that made our reaction feel hot?”
    - Tell students, “Substances store energy, which can be transferred to kinetic energy during chemical reactions.”
    - *When a chemical reaction gets warm, energy has been* released (question *17*).
- Discuss if all substances store the same amount of energy and lead students to understand they do not. Then, answer question *18*.
- Discuss the trends for each substance and answer question *19*.
    - Make sure students understand that temperature and kinetic energy are directly proportional.

Cold Reactions (7 minutes)

- Discuss with students whether they think it is possible to make this same reaction feel cold (without switching out any of the substances).
    - Yes, because adding more $NaHCO_3$ makes the temperature change decrease.
- Discuss question *20*, and by the end of the conversation, make sure students understand, with these amounts, the reaction would feel cold, because the temperature change will be negative.
- Pass out Experiment 2 bags, follow the same procedure as in experiment 1, except have students switch roles.
    - Students should observe the bag gets cold.
- Discuss with students where the heat energy went.
    - *When a chemical reaction gets colder, energy has been* absorbed (question *21*).
- Discuss the two ways that chemical reactions can transfer energy (question *22*).
- Have students help you summarize what they learned about the transfer of energy in chemical reactions and record this for question *23*.



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.

Graph 1: *Effects of $NaHCO_3$ Mass and $CaCl_2$ Mass on the Temperature Change*

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

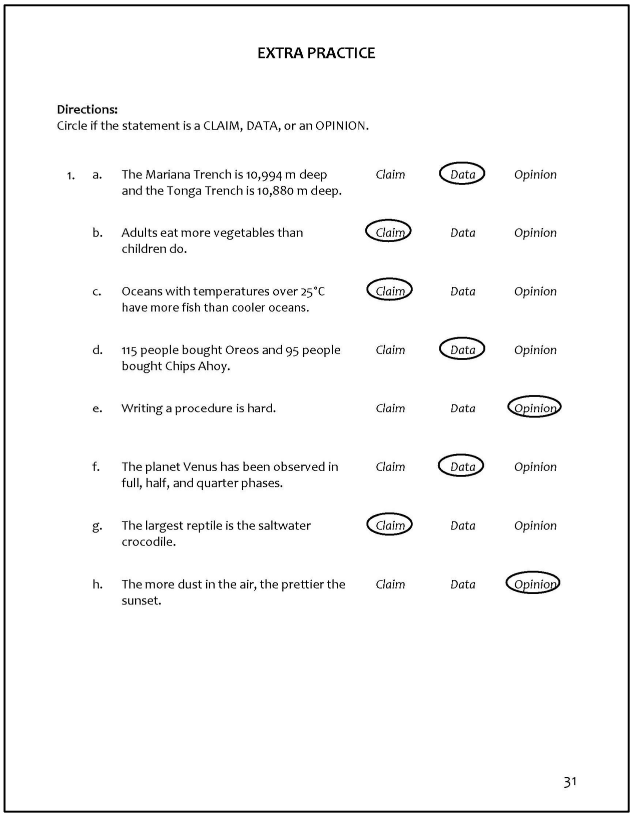
Mass

30

Content Assessment: *(5 minutes – Full Class – SciTrek Lead)*

- Pass out content assessments.
- Read each question to students.
- Collect content assessments.

Extra Practice Solutions:



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

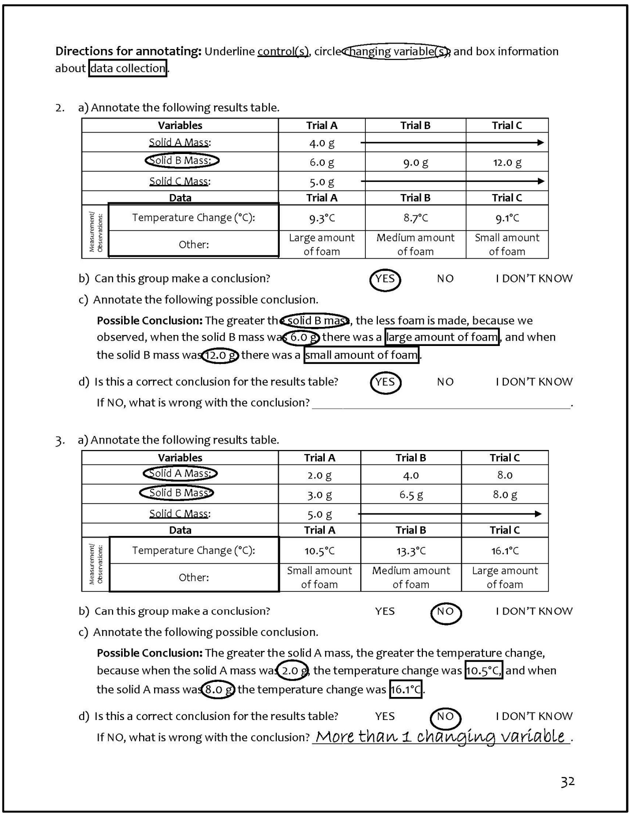
d. 115 people bought Oreos and 95 people bought Chips Ahoy. Claim [✓ Data] Opinion

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**
Measurement/ 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**
Measurement/ 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

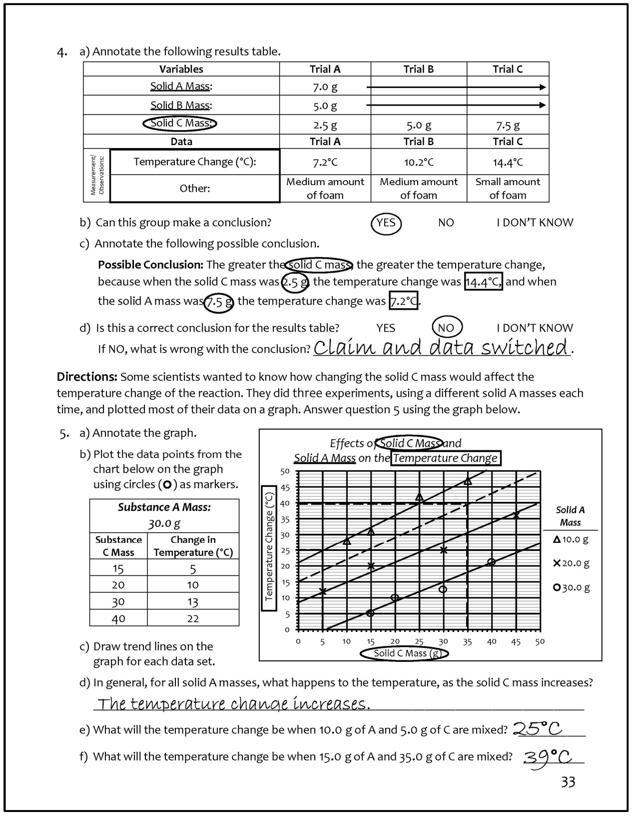
b) Can this group make a conclusion? YES [✓ NO] I DON'T KNOW

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**
Measurement/ 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? 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