Lesson 4-1
What happens to these materials when they are mixed?

Lesson Overview

1. Timeframe: 2 class periods

2. Learning Performance
   Students engage in an argument that a reaction may produce a new substance when substances mix, but the matter is conserved.

   SEP *Engage in argument from evidence*: *Support an argument with evidence, data, or a model.*

   DCI *PS1.A*: *The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.*

   DCI *PS1.B*: *When two or more different substances are mixed, a new substance with different properties may be formed.*

   DCI *PS1.B*: *No matter what reaction or change in properties occurs, the total weight of the substances does not change.*

   CCC *Energy and matter - Flows, cycles, and conservation*: *Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter.*

3. Overview
   Day 1
   - Teacher introduces a new sub-question, *What happens to these materials when they are mixed?*
   - Groups complete Investigation 4-1: Rock Salt, Baking Soda, and Water.

   Day 2
   - Groups answer investigation questions and interpret investigation data.
   - Students engage in argument to answer the question, *What happens to these materials when they are mixed?*

Materials

For each student:	**For each group:**
○ 1 Science and engineering notebook (SEN)	○ 1 Quart plastic baggie ○ 1 Gallon plastic baggie

○ 1 Pencil ○ 1 Copy of Investigation 4-1: Rock Salt, Baking Soda, and Water (both days) ○ 1 Pair of plastic gloves ○ 1 Pair of safety goggles	○ 1 Plastic spoon ○ 1 Syringe (any size, approx. 10 mL) ○ 1, 4 oz cup with lid ○ 2 Clear plastic cups (any size, approx. 10 oz) ○ 1 Electronic scale

For the class:

- Access to water
- Rock salt in a container with spoon (students measure one spoonful of rock salt)
- Baking soda in a container with spoon (students measure one spoonful of baking soda)
- PowerPoint Lesson 4-1

Preparation

- Provide water access.
- Set out substances in a location for easy access.

Safety

- Students wear plastic gloves during investigations.
- Students wear safety glasses on Day 1.
- In Investigation 4-1: Rock Salt, Baking Soda, and Water, when the substances mix, the inside baggie will get very hot and may pop. Be prepared, but do not tell students in advance, as it will give away the investigation results.

Introducing the Lesson

Reviewing What We Figured Out and Connecting to DQ

Review the DQ, *What happens to our garbage?*, and the results of the landfill bottle investigations. *In our investigation to answer our DQ, we observed that materials changed in the landfill bottle and that a gas (smell) was produced. How did we know that the materials changed?* (The properties of materials changed.) *We also argued that matter was conserved. How did we know that matter was conserved?* (We measured the weight before and after, and it was the same in the closed system. In the open system, we could not tell because matter could enter or leave the system, so the landfill bottle's weight changed even when matter was conserved.)

CLASS CHECK! Conservation of Matter Extension Task Follow-Up

Return Exit Slip 3-3 to students. Based on their responses, review conservation of matter, as needed. Guide students to make connections between matter changing form in the landfill bottle system (i.e., the solid food becomes the smell as a gas), the ice cream example (i.e., the

solid ice cream becomes the liquid ice cream), and the puddle of water example (i.e., the liquid water becomes water vapor as a gas).

We observed the changes in the properties in the food materials, and we still have questions about that. What other investigations have we done where the properties of materials changed, but matter was conserved? (The sugar and water investigation.)

Write the following questions on the board and ask students to discuss the answers in groups:

1. *What happened to the properties when we mixed sugar and water?* (The properties of the liquid [taste] changed.)
2. *What happened to the weight of the sugar and water before and after mixing?* (The weight stayed the same.)
3. *What did we figure out from the investigation?* (We figured out that matter is conserved. The matter did not disappear.)

Last class we wondered about what causes the smell coming from the landfill bottles. To help us figure out what's going on in the landfill bottles, we are going to investigate mixing other materials to answer the question, What happens to these materials when they are mixed?

Carrying Out the Lesson

Teacher Background: Mixing Substances

 Because in the NGSS in grade 5 students do not identify particles within matter at the atomic and molecular level, we, like scientists, do not emphasize a traditional distinction between physical changes (dissolved sugar in water) and chemical changes (the investigations in this lesson).

As far as the students are concerned, the water with dissolved sugar has changed a property (taste) and thus is a new substance (sugar water). In this lesson, we mix rock salt, baking soda, and water to make a new liquid and a gas with different properties.

The DCI, *When two or more different substances are mixed, a new substance with different properties may be formed*, emphasizes the question "How do we know a new substance has been formed?" This lesson includes several indicators of the formation of a new substance:

1. appearance of a new gas
2. change in visible properties, such as color
3. change in temperature

Investigation: Rock Salt and Baking Soda

Describe the investigation. *Our purpose is to investigate what happens when we mix different materials, or substances. Substance is another word like material, meaning a particular type of matter. Today, in our investigation, we are mixing a liquid substance, water, with two different solid substances, rock salt and baking soda. We will measure properties of materials and track the weight of the materials before and after mixing. Our investigation question is, What happens to these materials when they are mixed?*

Display PowerPoint Lesson 4-1: Properties.

Ask, *What are the substances we are mixing?* (Rock Salt, Baking Soda, and Water). *What are the properties of those substances that we are measuring?* (Color, Texture, Clarity, Form of Matter) *What else are we measuring?* (Weight) *Are there additional properties we could observe or measure?* Students may add additional properties.

Substance	**Property**			
	Color	**Clarity** (Transparent or Opaque)	**Solid, Liquid, or Gas**	_____
Rock Salt				
Baking Soda				
Water				
Mixed Substances: _____ _____				

	Weight (grams)
Total amount of all substances **before** mixing	
Total amount of all substances **after** mixing	

Direct students to take out Investigation 4-1: Rock Salt, Baking Soda, and Water and guide students to think of the purpose of the investigation. Ask, *What is the purpose of our investigation?* (Our purpose is to investigate what happens when we mix different materials, or substances.)

- Review procedures for operating the electronic scale as needed.
- Guide the class through the procedures in Investigation 4-1: Rock Salt, Baking Soda, and Water. Do not give away the final results.
- Tell students to feel the temperature of the baggie before, during, and after mixing.
- Give students time to complete Investigation 4-1: Rock Salt, Baking Soda, and Water.

Give students time to share their observations. *Wow! What happened in the investigation?* (The bag inflated; the bag blew up; the bag was filled with gas; the bag was hot). *This investigation had some interesting property changes. Scientists call that a reaction.*

Break – end of class period 1

Resume during the next class period:

Interpreting the Rock Salt and Baking Soda Investigation Data

Allow students time to complete investigation questions 1-3 in groups.

SMALL GROUP CHECK! Mixing Substances
As students work, circulate among the groups.

Possible teacher prompts to guide student thinking:
- *Was a new substance formed when the substances were mixed?* (Yes, I know this because the properties changed. For example, the water was transparent before mixing, but the final liquid is opaque. Also, a gas was produced.)
- *What do the weight measurements tell you?* (The amount of matter is the same before and after mixing, even though new substances were formed.)

Possible teacher prompts to EXTEND student thinking:
- *In another investigation, you mix two different substances.*
  - *How will you know whether a new substance is formed?*
  - *How will you know whether the same amount of matter is still there after mixing?*

Call on students to share observations of the investigation with the whole class. As students describe the changes in properties, remind them to refer to the changes as a reaction of the substances.

Engaging in Argument About Claim 1 as a Class

Inform the class, *We are going to continue our discussion on what we have found out.*

Remind students that they investigated the question, *What happens to these materials when they are mixed?* Elicit claims from the class that answer this question.

Summarize student claims by writing two claims on the board (see below) and tell students they will be making two arguments, one for each claim. First, they will write an argument for Claim 1 as a class. Then, they will write an argument for Claim 2 in groups.

1. Make the claims.
   Claim 1. When we mixed rock salt, baking soda, and water, new substances were formed.
   Claim 2. When we mixed rock salt, baking soda, and water, the total amount of matter stayed the same.

   Direct students to write Claim 1 in the first graphic organizer in Investigation 4-1: Rock Salt, Baking Soda, and Water. Tell students they can copy the claims on the board if they agree. If they disagree or want to add something, they can write their own claims.

Display PowerPoint Lesson 4-1: Engaging in Argument.

2. Identify the evidence in groups.
   Remind the class, *To support a claim in science, we use evidence based on our data. The data are the observations or measurements. Work in groups to decide: What evidence supports Claim 1?*

   Give groups time to write the evidence that supports the claims.

   Elicit evidence from groups and fill in the evidence section of the graphic organizer in PowerPoint Lesson 4-1: Engaging in Argument.

3. Work through the reasoning for Claim 1 as a class.
   Describe to the class, *The argument must connect our evidence to our claim. This is called reasoning. Reasoning tells why we think that evidence supports the claim. Our argument must give both the evidence and reasoning to support the claim.*

   Guide the class to come up with reasoning by asking, *Why did you include these data as evidence to support your claim?*

   As students respond, fill in the reasoning section of the graphic organizer on the board.

4. Final argument: claim, evidence, and reasoning.

Sample argument for Claim 1:

Arguing from Evidence

Question: What happens to these materials when they are mixed?	
Claim: When we mixed rock salt, baking soda, and water, new substances were formed.	
Evidence:	**Why did you include these data?**
When the materials were mixed, a gas was formed because the baggie expanded.	These data show that the properties changed.
A new liquid was formed because the water was clear before mixing, but the new liquid was white and opaque after mixing.	These data show that the properties changed.
Reasoning: These changes in the properties of the materials indicate that new substances (a gas and a liquid) were formed after mixing.	

Engaging in Argument About Claim 2 Individually

INDIVIDUAL CHECK! Arguing About the Amount of Matter When Substances are Mixed

Tell students they will now write an argument for Claim 2 individually. Direct students to complete the second graphic organizer in Investigation 4-1: Rock Salt, Baking Soda, and Water. By this point in the unit, some students may no longer require the graphic organizer as support for engaging in the practice of argument. Allow these students to write their arguments in the SEN.

Collect the graphic organizer. Use the criteria outlined in Teacher Rubric 4-1 to provide specific comments to students on the feedback form at the bottom of the graphic organizer. For students who wrote the argument in their SEN, provide the same type of feedback.

Sample argument for Claim 2:

Question: What happens to these materials when they are mixed?	
Claim: When we mixed rock salt, baking soda, and water, the amount of matter stayed the same.	
Evidence:	**Why did you include these data?**
The total weight before mixing was the same as after mixing (40 g).	These data show the weight did not change.
Reasoning: If the weight stayed the same before and after mixing, that means that the same amount of matter was present before and after mixing, even if the properties changed.	

Closing the Lesson

Connecting to the Next Question

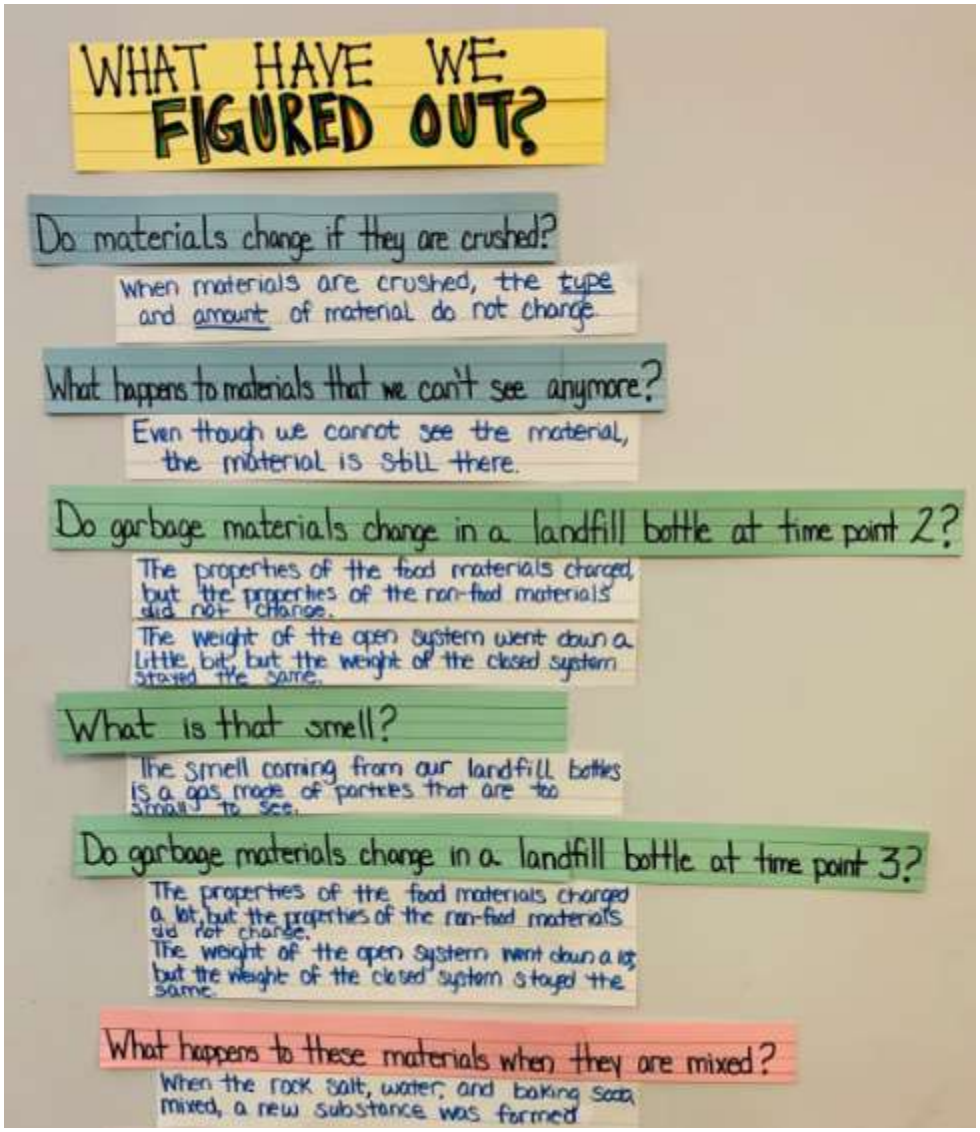
Summarize the arguments by saying, *Many of us agree that mixing substances can produce a new substance. We observed that the final substances produced included a gas. So we have figured out that reactions can produce gases.*

Tell the class, *In the landfill bottles, you observed changes in the properties of the materials. Smell as a gas was produced, and the orange appeared to vanish. We also observed a fuzzy material on the food that grew larger over time. What does that make you wonder about?*

Point to the DQ Board question, *What causes changes in landfill bottles?* Add this question and other new questions to the DQ Board.

Tracking What We Figured Out (optional)

Guide students to think about the sub-question of the lesson and what they have figured out so far. Create the class visual display using their responses. In addition to the class visual display, students may complete the individual graphic organizers (located in Lesson 2-2). Students can add to their graphic organizers after each lesson.



Evidence Statement Lesson 4-1

LP4-1 ES

- Students measure the properties of the substances and measure the final properties of the substances after the reaction as a process. Students argue that a new substance is produced as a result of mixing the substances because the properties have changed.
- Students measure the weight of initial substances and compare those data to the weight of the new substances. They argue that weight stays the same and matter is conserved during the reaction as the new substances are formed.

Connections to Targeted 5th Grade NGSS Performance Expectations

5-PS1-2 Measure and graph quantities to provide evidence that, regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Building Progressions

SEP *Engage in argument from evidence*: *Support an argument with evidence, data, or a model.*

K-2: Construct an argument with evidence to support a claim.

3-5: *Support an argument with evidence, data, or a model.*

Middle School: Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.

DCI *PS1.A*: *The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.*

K-2: Different kinds of matter exist and many of them can be either solid or liquid, depending on the temperature. Matter can be described and classified by its observable properties. Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces.

3-5: *The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.*

Middle School: Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to

thousands of atoms. Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

DCI *PS1.B*: *When two or more different substances are mixed, a new substance with different properties may be formed. No matter what reaction or change in properties occurs, the total weight of the substances does not change.*

K-2: Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.

3-5: *When two or more different substances are mixed, a new substance with different properties may be formed. No matter what reaction or change in properties occurs, the total weight of the substances does not change.*

Middle School: Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substance are regrouped into different molecules that have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change.

CCC *Energy and matter - Flows, cycles, and conservation*: *Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter.*

K-2: Objects may break into smaller pieces and be put together into larger pieces, or change shape.

3-5: *Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter.*

Middle School: Matter is conserved because atoms are conserved in physical and chemical processes. Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. The transfer of energy can be tracked as energy flows through a designed or natural system.

Connections to CCSS for English Language Arts-Literacy

W.5.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

W.5.2.E: Provide a concluding statement or section related to the information or explanation presented.

SL.5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher- led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

SL.5.1.C: Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

L.5.6: Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g., however, although, nevertheless, similarly, moreover, in addition).

Connection to CCSS for Mathematics

5.NBT.3.B: Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.

MP1: Make sense of problems and persevere in solving them.

MP2: Reason abstractly and quantitatively.

Name _____ Date _____

Investigation 4-1: Rock Salt, Baking Soda, and Water

Investigation plan		✓
1	Gather supplies for the group: ☐ 1 Quart plastic baggie ☐ 1 Gallon plastic baggie ☐ 1 Plastic spoon ☐ Class supply of rock salt ☐ Class supply of baking soda ☐ Class supply of water ☐ 1 Syringe (any size, approx. 10 mL) ☐ 1, 4 oz cup with lid (for water) ☐ 2 Clear plastic cups (any size; approx. 10 oz) ☐ 1 Electronic scale ☐ Safety goggles (1 pair per student) ☐ Plastic gloves (1 pair per student)	
2	Put on plastic gloves and safety glasses.	
3	Prepare the rock salt cup: ☐ Pour a spoonful of rock salt into the 10 oz cup. ☐ Record the properties of rock salt in the investigation table.	
4	Prepare the baking soda cup: ☐ Pour a spoonful of baking soda into the second 10 oz. cup. ☐ Record the properties of baking soda in the investigation table.	
5	Prepare the 4 oz water cup: ☐ Use the syringe to measure 10 mL of water out of the class supply and carefully squirt it into the water cup (with the lid). ☐ **Seal the lid tightly.** ☐ Record the properties of water in the investigation table. 	

6	Prepare the quart baggie: • Pour the rock salt and the baking soda from the plastic cups into the quart baggie. • Carefully place the sealed water cup into the quart baggie. • **Seal the quart baggie.** 	
7	Prepare the gallon baggie: • Place the quart baggie into the gallon baggie. • **Seal the gallon baggie.** • Record the weight of the gallon baggie in the investigation table. ○ When weighing the gallon baggie, make sure it is all on the scale, and not falling off. 	
8	Combine the substances: • Remove the gallon baggie from the scale. • Pop the lid off the water cup while it is still in the gallon baggie. • Allow the water to mix with the rock salt and baking soda. • Weigh the gallon baggie immediately after the water mixes with the rock salt and baking soda. Record the weight in the investigation table. • Record the properties of the mixed substance in the investigation table. 	
9	Complete the investigation questions.	

Investigation Table:

Substance	Property			
	Color	**Clarity** (Transparent or Opaque)	**Solid, Liquid or Gas**	_____
Rock Salt				
Baking Soda				
Water				
Mixed Substances: _____ _____				

	Weight (grams)
Total amount of all substances **before** mixing	
Total amount of all substances **after** mixing	

Investigation Questions:

1. Describe the **properties** of the substances before and after mixing. What did you figure out?

_____

_____

_____

_____

_____

2. Compare the **weight** of the substances before and after mixing. What did you figure out?

_____

_____

_____

_____

_____

3. Compare similarities and difference between the results of this investigation and the results of the investigation mixing sugar and water.

_____

_____

_____

_____

_____

Write your arguments for Claims 1 and 2. Your claims should answer the investigation question: *What happens to these materials when they are mixed?*

Arguing from Evidence

Question: _____	
Claim: _____	
Evidence:	**Why did you use these data?**
Reasoning: _____	

Arguing from Evidence

Question: _____

_____

Claim: _____

_____

Evidence:	**Why did you use these data?**
_____ _____ _____	_____ _____ _____
_____ _____ _____	_____ _____ _____
_____ _____ _____	_____ _____ _____

Reasoning: _____

_____

_____

_____

Teacher Feedback:

	Comments
Claim	
Evidence	
Reasoning	

Investigation 4-1 ANSWER KEY

1. Describe the **properties** of the substances before and after mixing. What did you figure out? *Before mixing, the rock salt and baking soda were both white, rough and opaque solids. The water was a transparent liquid. When the substances were mixed, new substances were formed because the properties were different. After mixing, a gas filled the baggie and the liquid became white and opaque.*

2. Compare the **weight** of the substances before and after mixing. What did you figure out? *Before mixing, the weight was 40 g. After mixing, the weight was still 40 g. The weight did not change. This tells me that matter is conserved. Even though new substances are produced, the weight does not change.*

3. Write your arguments for Claims 1 and 2.

Question: What happens to these materials when they are mixed?	
Claim: When we mixed rock salt, baking soda, and water, new substances were formed.	
Evidence:	**Why did you include these data?**
When the materials were mixed, a gas was formed because the baggie expanded.	These data show that the properties changed.
A new liquid was formed because the water was clear before mixing, but the new liquid was white and opaque after mixing.	These data show that the properties changed.
Reasoning: These changes in the properties of the materials indicate that new substances (a gas and a liquid) were formed after mixing.	

Question: What happens to these materials when they are mixed?	
Claim: When we mixed rock salt, baking soda, and water, the amount of matter stayed the same.	
Evidence:	**Why did you include these data?**
The total weight before mixing was the same as after mixing (40 g).	These data show the weight did not change.
Reasoning: If the weight stayed the same before and after mixing, that means that the same amount of matter was present before and after mixing, even if the properties changed.	

Lesson 4-1 Teacher Rubric
Arguing About the Amount of Matter When Substances Are Mixed

	Claim	Evidence	Reasoning
0	Claim is incorrect, irrelevant, or missing. Examples: • *(None)* • *When we mixed rock salt, baking soda, and water, there was a reaction.*	Evidence is incorrect, irrelevant, or missing. Examples: • *(None)* • *The bag inflated and was very hot.* • *The total weight of the materials decreased after mixing.*	Reasoning is incorrect, irrelevant, or missing. Examples: • *(None)* • *The total weight of the materials was the same, but some of the properties changed.*
1	Claim is correct and answers the investigation question. Example: • *When we mixed rock salt, baking soda, and water, the amount of matter stayed the same.*	Evidence supports claim but does not compare weight data before and after mixing or provides vague evidence. Examples: • *The total weight of the materials before mixing was 40 g.* • *The total weight of the materials after mixing was 40 g.* • *It was all still there, just in a different form.*	Reasoning is correct and links evidence to claim. Examples: • *Since the total weight of the materials was the same before and after mixing, the amount of matter must be the same, even if some of the properties changed.*
2		Evidence supports claim by comparing weight data before and after mixing. Example: • *The total weight of the materials before and after mixing was 40 g.*	

TOTAL: _____ out of 4