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FIELD TRIP

Changes in Matter

Theme
Physical and chemical changes in matter can be observed within our natural environment.

Utah State Science Core Curriculum Topic
Standard One - Students will understand that chemical and physical changes occur in matter.

Objective One: Describe that matter is neither created nor destroyed even though it may undergo change.

Objective Two: Evaluate evidence that indicates a physical change has occurred.

Objective Three: Investigate evidence for changes in matter that occur during a chemical reaction.

Field Trip Location
Island in the Sky District, Canyonlands National Park or another quiet area with spectacular views.

Times
The pre trip lesson, ozone lesson, and air quality lesson are each 30 minutes. The hike is 1 hour. The post trip is 45 minutes.

Science Language Students Should Use
Heat, substance, chemical change, dissolve, physical change, matter, product, reactants, solid, liquid, weight

Background

Matter is the "stuff" of the universe. Everything that has mass and volume, no matter how small, is considered matter. Air, water, rocks, trees, stars, and animals all consist of matter. Matter can exist as a solid, liquid, or gas and can change in many different ways. Physical changes are those in which the weight of the matter stays the same. At the end of a physical change, the substance is still essentially the same. For example, chopping up a carrot or ice melting into water are both physical changes. Dissolving dirt into water would also be considered a physical change because the weight would equal that of the water and the dirt. Chemical changes are those where one or more substances are combined to produce a new substance. Sometimes, the product weighs the same as the ingredients. Sometimes, matter is converted into energy and emitted in the form of heat, light, or sound. At the end of a chemical change, you have a fundamentally new substance. Burning a piece of paper would be a chemical change, as would baking a cake.

Clean air is a common, often under appreciated resource of the public lands of the Colorado Plateau. The Clean Air Act names 160 federal lands with pristine air quality and mandates that air quality at these sites be monitored, preserved, and enhanced. Sixteen of these sites are on the Colorado Plateau; one site is in the Island in the Sky District of Canyonlands National Park. The equipment there measures fine particulate, acid rain, and ozone levels.

Some fine particles, or particulates, are always present in the air. The number of particulates varies; high numbers result in the visible part of air pollution. Particulate sources can be natural or human-caused. They can be the

Group at Mesa Arch

result of both chemical and physical changes in matter. They can include dust and sand from roads, fields, and windstorms, smoke from burning leaves, forest fires, and wood-burning stoves, and exhaust from cars and industries. Particulates remain in the air until gravity slowly filters them out.

Ozone is an invisible gas that is a form of oxygen. High levels of it in the lower atmosphere can cause human health problems and can contribute to the greenhouse effect. Car exhaust, the result of a chemical change in fuel, is a major contributor of ozone to the lower atmosphere. However, ozone plays a positive role in the upper atmosphere. The upper atmosphere ozone layer blocks much of the UV sunlight from reaching the earth's surface. Normal quantities of UV light are good for such things as plant growth and suntans. But, the increase in UV light that would result from a damaged ozone layer would lead to increased incidences of skin and eye disease in humans and damage to some wildlife and plants.

The single largest factor in the destruction of the ozone layer is a family of chemicals called chlorofluorocarbons (CFCs). This reaction is a chemical change in the ozone molecule. CFC's were used in manufacturing hundreds of different products, including Styrofoam packaging, aerosol spray cans, and the coolants in refrigerators and air conditioners. Their use has been outlawed in the United States and many countries. Even if all countries quit using CFCs, however, they will linger in the upper atmosphere for decades. At Canyonlands National Park, ozone is monitored at ground level. UV light is also monitored, which indirectly reflects the condition of the upper atmosphere ozone layer. Scientists monitor ozone levels in order to study trends in national parks as well as global trends.

Looking for ways that matter changes in nature on the way to Mesa Arch

PRE-TRIP ACTIVITY

Matter What?

Objectives

Students will be able to:

a. Define matter.

b. Describe the difference between physical and chemical changes in matter

Materials

Apple; scale; cards showing a picture of a substance both before and after a change.

PROCEDURE

1) Ask students to define *matter* (anything that has mass and volume). Explain that matter can be large or small and that you may or may not be able to touch and see it, even with the aid of a microscope. Have students list some things that might be matter (i.e. books, desks, themselves, air, water, bugs, etc…). Tell students that matter exists in three forms, and see if they can name and define them. A *solid* is a substance that has a definite volume and shape. *Liquid* is a substance that has a definite volume but changes shape to fit its container. A *gas* is a substance that has neither shape nor definite volume. Ask students to give examples of each form. Write types and examples on the board.

2) Tell students that matter changes in two ways. Physical changes occur when an object changes form, but is still basically the same. Describe this change by discussing water. Ask students to describe what happens if you put a container of water in the freezer. Explain that although it changes form, it still is the same water. Tell the students that if they heated the ice up, it would return to the liquid water state and that there would be the same amount of water in the container. Tell students that you are going to demonstrate by using an apple. Have a student place the apple on the scale and tell the class its weight. Cut up the apple, and have another student place the apple bits on the scale and read the weight. Ask the students if the apple has changed its form. Has the apple changed what it is? Is there still the same amount of apple on the scale? Tell the students that this is a physical change.

3) Have the students eat the bits of the apple. Tell the students that they have just caused the apple to go through a chemical change. Ask them if the apple is still an apple. Would it ever be possible to reassemble it as an apple again? If we were to isolate the pieces of apple would they weight the same? Why not? What has been added or removed by your stomach? Tell the students that you have caused the apple to go through a chemical change. When a substance undergoes a chemical change, it combines with another substance or energy, such as heat or light to become a new substance.

4) Tell the students that they are going to try and figure out the way matter changes. Tell students that for this activity they will need a partner. Give everyone a change card. Have the students look at the cards and identify how the object or objects were changed. The students should then turn to their partner and share their card and conclusions. See if the partner agrees. Pass the cards to another group and repeat until time is up or cards have gone around the room.

5) Ask students if there were any examples that were easy to understand. Have students name them. Ask students if there were any examples that were difficult to figure out; discuss these. Tell the students that during the upcoming field trip, they will be looking at physical and chemical changes in matter in the real world. Have students list the things they will need to remember to bring for a winter field trip. Write the list on the board.

EXTENSION

As a class, mix the ingredients to make a large batch of cookies. As you add each ingredient, discuss what changes the ingredient has gone through, including if those changes were chemical or physical. For example, wheat changed chemically as it was growing, but only physically when it was ground into flour. Bake the cookies in the lunchroom, and discuss that adding the heat of the oven is creating a chemical change in the cookie batter. Eat the assignment.

STATION #1

Particulates and Filters

Objectives

Students will be able to:

a. Describe at least two sources of particulate matter in the air, and discuss if these particulates result from physical or chemical changes.

b. Give a basic description of how the equipment at the filtering station or transmissometer room operates.

Materials

Pictures of a city with clean and dirty air; 4 plastic funnels; paper coffee filters; water spray bottles; extra water; hand lenses.

PROCEDURE

1) Briefly discuss what makes Island in the Sky a popular place to visit. Emphasize views and clean air. Ask students if they believe there is matter in the air. Explain that there are often particles or particulate matter in the air that can obscure these views. Tell the students that since matter is constant, it has to come from somewhere. Discuss where these particulates came from (i.e. dust from dirt roads, smoke from fires, water vapor in clouds, etc…). For each type of particulate, discuss if its location in the air is the result of a chemical or a physical change. Show dual pictures of a city on a clean-air day and dirty-air day. Ask if any students have been somewhere where they could see the air, and discuss (include that city pollution is often the result of chemical changes in the fuels we use).

2) Tell the students that the air in southeastern Utah has been classified as type "A," meaning that we have some of the cleanest air in the country. At Canyonlands National Park, scientists measure the amount of matter in the air so that the national park system has baseline data of its clean air. This data would be useful if the air became "dirty" and we had to reduce point-source pollution. Explain that a telescope-like machine, the Transmissometer, sends a beam of light to a receiver at Dead Horse Point State Park, 6 miles away. Have students line up at the fence and try to throw a snowball (or a rock) as far as they can. Most of the snowballs will impact on trees. By measuring how many snowballs got through the trees, we would know how dense the forest is. The transmissometer works the same way. By measuring how much light is received at Dead Horse Point, we know how many particulates are in the air.

3) Show students the Transmissometer Room. This can be done at the beginning or end of the station, depending on the time. The group should not be in the room during the hourly monitoring time, which is between the hour and 16 minutes after the hour. Turn the dial to *ON* (but only between 16 past and the hour), and have each student take a turn looking through, being careful not to bump the gun. They may see a twinkle of light as they look through; this is the light beam hitting the receiver. The machine will chirp until you return the dial

Discussing air quality at the island in the Sky

to off. The information is sent back from the receiver into the computer on the table. Inform students that the farthest the human eye could possibly see, if the world were flat and the air perfectly clear, is 243 miles, the distance to Salt Lake City. Have them guess how far they could see today. Turn the A1 switch from *C* to *B*, but only if it isn't exactly half-past the hour, as this is when data is sent out. Then have a volunteer student use the readout number and the posted orange chart to determine the actual visibility of the moment. Compare to predictions. Do not forget to turn the switch back.

4) Go to the air quality filtering station. Show and discuss different types of filters. If the machine is not currently filtering (you'll hear it if it is running), a filter cartridge can be taken out and shown to the kids by pushing one of the red buttons until the cartridge pops off. To put it back, align the holes, seat, and push the other red button until it beeps at you. Show and explain how the equipment filters out different air particulates. Ask students why scientists might want to know what particulates are in the air. Ask students if they believe that filtering the air results in a chemical or physical change to the air. Discuss the difference between the filters that cause a physical change and chemical scrubbers that are used in factories.

5) Ask students how they think the particulates get out of the air. Ask if they think this process is a chemical or a physical change. Tell the students to look around them the answer; explain that the plants around them are holding dust (adapted from National Park Service and others 1989, 4-9). Tell the students that they will be conducting an experiment to answer this question. Have students gather closely, and pull out of your backpack a spray bottle of water, a plastic funnel, and a paper coffee filter. Demonstrate how they will use these. Explain that one student will spray water over some leaves into the funnel filter held by another student. Describe boundaries, put students in pairs, and give each pair a water bottle, funnel, and filter.

OPTIONAL

Have students find the "cleanest" and "dirtiest" plants within a designated area, including a roadside area if possible.) After students work for a few minutes, have them gather and examine the particulate content on their filters by using hand lenses. Discuss how plants filter the air and under what weather conditions (dry) and in what locations (near roads, etc.) they would expect to find the dirtiest plants. Summarize and review.

Learning how plants remove particulates from the air

STATION #2
No Zone for Ozone

Objectives
Students will be able to:
a. Explain why upper atmosphere ozone is beneficial.
b. Describe what type of reaction physical or chemical is causing ozone depletion.
c. Describe why ground level ozone is harmful to humans.

Materials
Clipboard with paper and pencil/marker; *ozone depletion* poster; map of ozone hole (Berman, 2002); ozone game tags.

PROCEDURE

1) Ask students if they can describe matter. Explain that matter can be so small you cannot see it, but it still exists. Tell the students that at this station, you will be talking about matter as individual molecules. In particular, you will be discussing the ozone molecule. Ask students to relate anything they know about ozone. On a piece of paper, draw the ozone layer as a "blanket" around the Earth. Discuss the benefit of the ozone (i.e. blocking some of the sun's ultraviolet (UV) rays).

2) Have students act out the *Ozone Depletion* poster to describe the chemical changes that CFC's are causing and explain that these chemical changes have created holes in the ozone layer. Have students pretend to be oxygen atoms and link arms to become ozone molecules. One kid will play the part of Charlie Chlorofluorocarbon. As the students act out the poster, tell a story about how each of the atoms interacts. Emphasize that in the fifty years or so that it will take Charlie to drift back to the earth's surface, he can do a lot of damage to the ozone layer. Show the students the ozone layer map, and discuss effects of the ozone hole. Explain that the hole is estimate to close by 2050. Relate the story as one of success (we are solving a huge problem), rather than one of failure (we created a huge problem.)

2) Discuss Canyonlands National Park's role as a monitoring site. Point out the equipment on the high scaffold, which includes a lens that constantly measures incoming UV rays and indirectly accesses the condition of the upper atmosphere ozone layer. (We do not take the kids up the scaffold because a shadow cast across the lens will affect the data. The machine is wired to a computer in the ozone shack, the one on the upper left as you walk in the door, where the information is processed and sent to a scientist in Athens, Georgia.)

3) Referring back to your drawing, tell students that ozone also exists in the lower atmosphere. Discuss the chemical reactions that create lower level ozone (pollution) and make it harmful to living creatures (it reacts with carbon). Ask students if anyone has ever visited a big city with bad air. Did they have a difficult time breathing?

4) Tell students that the ozone shack measures the lower level ozone. Walk over to the tower outside the shack, and lower the tower using the rope. In the underside, there are two filters. The green one has a filter that collects little to no particulate matter so as to have a clean sample. The other, wider filter takes a sample of the particulate matter to be analyzed in the lab. Discuss why it would be helpful for a scientist to know what particulates occur during times of high lower atmospheric ozone. Point out to the students that both filters are connected to tubes that run the length of the tower and into the building.

5) Review the detrimental effects of lower atmosphere ozone and that it is an invisible and odorless gas. Inform students that ozone concentrations in the lower atmosphere are affected by weather conditions, so both weather and ozone is monitored daily. Point out the nearby weather station. Ask students not to touch anything in the ozone shack, and explain that the equipment is sensitive to changes in air temperature and quality (the door needs to be opened and closed as quickly as possible). Once inside, follow the tubes as they enter the building and go to the rotometer on the wall on the right. This machine measures the amount of air flowing through the machines. The silver, floating ball measures airflow in liters per minute. Discuss why scientists would want to make sure the amount of flow is consistent.

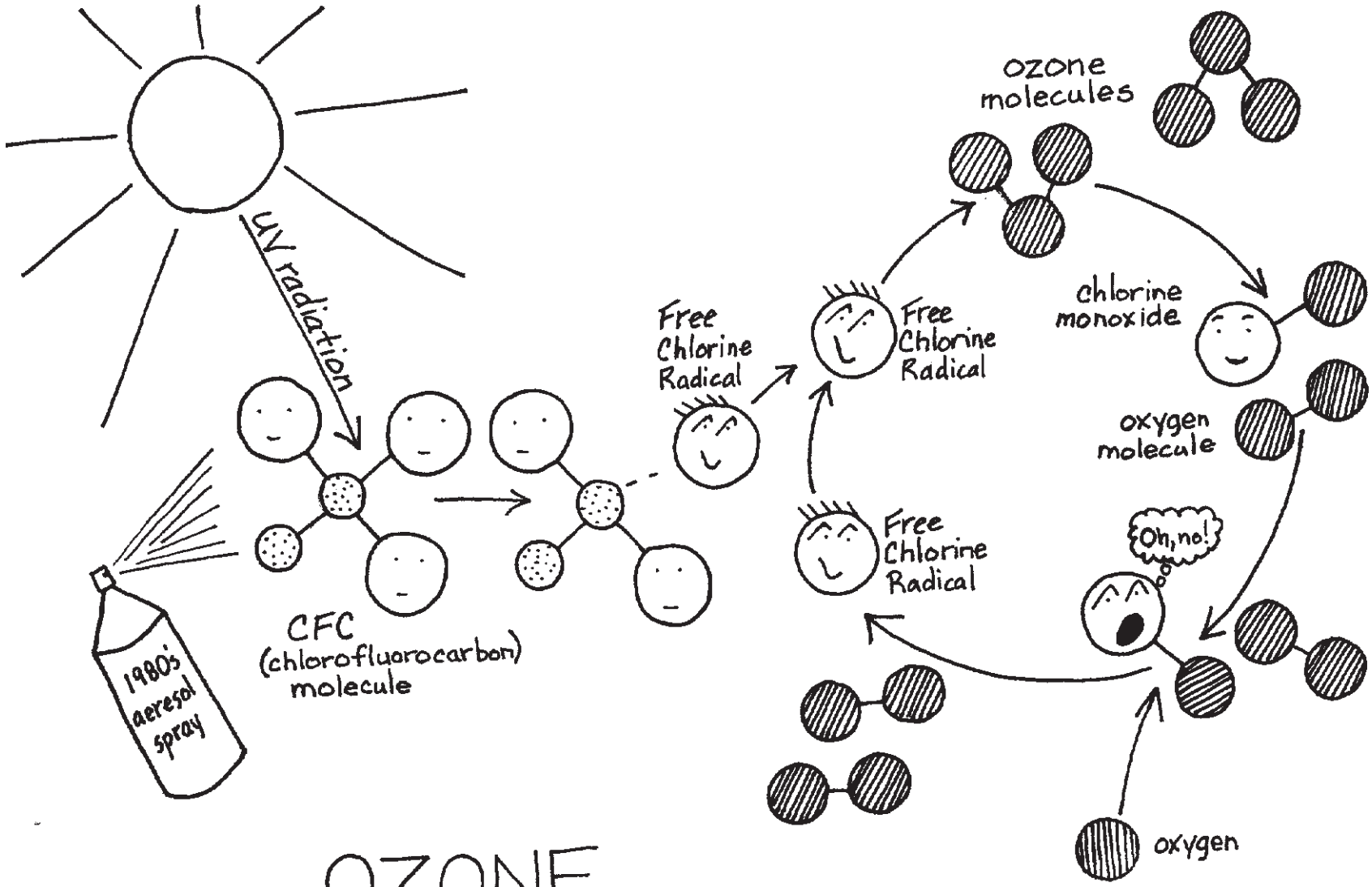
6) Have students follow the tube into a "manifold" which separates the gasses and then into the analyzer. Ask students if separating the gasses would be a physical or chemical change to the air. In the bank of computers/machines in the center of the room, the analyzer is the one on the top, closest to the wall. It displays how much ozone is in the lower atmosphere. Have the students read the number, including the decimal and PPM. Discuss PPM and how that number would be different if the machine was in a big city. (The machine just below the analyzer that looks just like it calibrates the analyzer, so the readings are exact; there is no need to discuss it much.) Point out the two computers to the left of the analyzer. Explain

that these computers compile the data and send it electronically to scientists in Fort Collins, Colorado.

7) Play Ozone Depletion Tag with as many students, teachers, and parents as you can round up. Review the beneficial properties of upper atmosphere ozone. Explain that CFCs destroy this ozone. Define boundaries, and have each participant pick and secretly look at one card to determine what type of upper atmosphere gas they will be. Have participants return their cards, and inform them that one of them is a CFC while the rest are ozone. Ask students to spread out, floating in the upper atmosphere. Instruct them that when you say, "go," the CFC should destroy ozone by tagging them. Once an ozone is tagged, it acts as a free radical chlorine and may tag other ozones. It doesn't take long until all of the ozone is gone. Play two or three rounds.

OPTIONAL ACTIVITY

Play Silent Killer to reinforce the concept of the hidden nature of ozone depletion (adapted from Fluegelman 1981, 81). Have players sit in a circle; then, distribute and recollect the cards as in the previous game. Instruct the unknown CFC to wink at an ozone when no one else is looking. Instruct any ozone that is winked at to *quietly* pause a few seconds and then say, "I've been destroyed." All live ozones should watch carefully and try to identify the CFC killer.



OZONE DEPLETION

STATION # 3

As a Matter of Fact

Objectives

Students will be able to:

a. Describe the difference between chemical and physical changes in matter.

b. Name one chemical and one physical change that can be observed at Canyonlands National Park.

Materials

Paper; pencils; field guides.

PROCEDURE

1) Take the bus with the students to the trailhead of the Mesa Arch Trail. Once on the trail, stop and explain to students that they are going to hike and look for ways that matter changes in nature. Tell them that it is important to pay attention because there will be an activity at the arch that incorporates what the group has talked about on the hike. Ask students to describe matter and to define physical and chemical changes in matter.

2) Hike to the arch. Along the way, point out examples of physical and chemical changes in matter (i.e. plants absorbing nutrients out of the ground, plants changing carbon dioxide into oxygen, photosynthesis, animals eating plants, animal scat, animal tracks, erosion of rock, creation of the canyon and arch, snow melting, and sand transportation).

3) At the arch, give students a piece of paper and have them fold it in half twice, once lengthwise and once widthwise, to make four boxes. Tell the students to draw a physical or chemical change that they have observed in each of the boxes. Each drawing should be labeled and the type of change should be included.

4) Have each student present a drawing to the group. Collect the papers to give to the teacher. Hike back to the bus.

EXTENSION

Have the students write a story from the point of view of a substance undergoing a chemical or a physical change. For example, Joe Nutrient, who is happy in a rock, gets eroded and used by a plant. Stories should be descriptive, in the first person, discuss whether a chemical or physical change is occurring, and have a title.

The trip to Mesa Arch

POST-TRIP ACTIVITY

It Does What?

Objectives

Students will be able to:

a. Describe a physical and chemical change that occurs to matter.

b. Name two indicators of a chemical change.

Materials

Five jars; balloons; poster with a list of students' choice of ingredients; milk; vinegar; baking soda; lemon juice; rock salt; Mountain Dew; dish soap; Milk of Magnesia; investigation sheets; scales; 5 thermometers.

PROCEDURE

1) Review the information students learned on the field trip. See if they can name some physical and chemical changes that they observed in nature. Tell the students that they are going to investigate changes in matter by conducting scientific experiments. Review the definitions of physical and chemical changes, and ask the students to list some indications that a chemical change has occurred. Write these on the board. The list should include: production of heat, cold, light, a gas, change to solid, and change colors.

2) Divide the class into groups of four or five. Tell students that they are going to be performing science experiments and recording the results. Hand out science investigation worksheets, and discuss the experiment's procedure with the class. Tell students that they will be able to choose two or three things from the poster to mix together. Describe the choices for the students. Ask students to designate one person from the group to fill out the investigation sheet and two people to collect materials. Have the collectors get jars, scales, thermometers, and balloons for each group. Ask each group what they would like to try and mix. Give the ingredients to the students. Have students predict the results of the experiment. Then, they should add both ingredients to the jar, quickly putting the balloon on top

3) Have students examine their results. Weigh the finished product, and observe the temperature. If the balloon changed, measure the balloon. Then, record their results. If matter seemed to disappear (chemical change), students must record where it went (i.e. converted to energy or was emitted as heat or light). In complete sentences, the group will need to record their conclusion. Their conclusion should include what they mixed together and whether a physical or chemical change occurred. They should support their conclusion with a justification of why they believe the change to be chemical or physical. Have students pour their concoctions in the sink. Allow students to repeat the experiment (filling out new investigation sheet for each mixture) as often as time allows.

4) Have groups present their experiments to the class. Students should explain what they mixed, what happened, and if it was a chemical or physical change.

MATTER INVESTIGATION

Scientists Names _____

Question: What happens when you mix _____ and _____?

Hypothesis:

_____

_____

_____

_____

Procedure:

1. Measure materials

2. Mix Materials

3. Observe results

4. Measure results

Results:

_____

_____

_____

_____

Conclusion (What type of reaction occurred? How did you know?):

_____

_____

_____

_____

References and Resources

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