Grade 8
Physical Science

Oak Meadow
Teacher Manual

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Grade 8

Table of Contents

Grade 8

2

Controlled Experiments and the Scientific Method

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Make a list of variables and how they can be controlled.
- ☐ Lab Investigation: Sink or Float?
- ☐ Complete lesson 2 test.

Learning Objectives

At the end of this lesson you will be able to:

- Identify the variable factors in an experiment.
- Design an experiment that controls all variables but one.
- Write a conclusion based on experiment results.
- Differentiate between causation and correlation.

Reading

Read the following sections (found in Reading Selections at the end of this lesson).

- Scientific Method
- Variable and Constant Factors
- Controlled Versus Uncontrolled Environments
- Using the Scientific Method
- Causation and Correlation

Look over the amount of reading before you begin, and make a plan to divide it up so you aren't trying to absorb too much information at once. If you have any questions about the reading, ask for help or do some extra research on your own.

It's important that your student has a clear understanding of the reading material. If possible, discuss the reading sections together, or ask for examples of the concepts.

Assignments

Before you begin your assignments, read through them to get a sense of what you'll be doing and how long it will take. This will help you manage your time better.

1. Take some time to make an observation around your home. Perhaps you notice that your cat naps in different places at different times of day. Or maybe you see that the temperature on one side of your house generally feels colder than on the other. Then make a list of variable factors that you might consider if you were to design an experiment. After each variable you list, explain how you might control that variable to make it a constant in your experiment.

   Some students may need help determining an observation to use for this exercise. Feel free to give some ideas if more examples are needed. Check that the list of variables is reasonably complete, and point out additional factors that may influence the behavior or phenomenon being observed. Each variable should be able to be controlled in some way. For instance, some controlled variables might include time, temperature, light, and movement. The goal is that each variable is present to the same degree each time the experiment is performed.

Lab Investigation

Complete the following lab investigation.

- **Lab Investigation: Sink or Float?**

All lab investigations are found in the lab manual, *Lab Investigations: Physical Science*. Read the instructions carefully and assemble all your materials before you begin. Use good scientific habits by taking careful observations and measurements, recording your data in an organized way, and using precise, detailed language.

Lab investigations provide students with an opportunity to develop scientific skills and practice the scientific method. Look for students to follow the procedure with care, take accurate measurements, and record their observations in an organized manner. Summaries and conclusions should include the use of scientific terminology and concepts. See the lab manual for the full description of each lab investigation.

Lab Investigation: Sink or Float?

Procedure

The procedure of each lab investigation is only included in the teacher manual if there are specific tips about supporting your student or what to look for in the student response. Often steps will

be left out if they are not relevant to the teacher manual. Check the student coursebook for the full procedure and the student's responses.

1. Write your hypothesis. This is written as a statement about what you think will happen when you test how the shape of an object influences its buoyancy. Remember, your hypothesis must be testable and written clearly to indicate which variable you will be testing.

   This is a challenging assignment, and your student may need help with the different steps. Check that the hypothesis is clearly written and focuses on what will be tested. It should be written as a statement that gives a possible (likely) answer to the question "How does the shape of an object influence its ability to sink or float?" Here is a sample hypothesis for this investigation: "Objects that are hollow or concave will float and objects that are flat or solid will sink." Check that the hypothesis is testable. If it is not, help your student revise it so that it is concise and focuses on one element as the variable.

2. Consider the variable factors that might influence whether an object floats or sinks. List all the factors you can think of.

   Answers will vary. Lists may include what an object is made of, how much it weighs, its shape, whether it is dense or porous, and whether it is solid or has holes in it. Remember, this material may be new to students and they may need help generating a list of variables that influence an object's ability to float. Having a discussion and asking questions can help your student start to see the possible influencing factors.

3. In this experiment, your variable factor is the shape of the object. How will you control all the other factors? For each factor listed above, write down how you will keep it constant during the experiment. Include exact details about where that constant will be set. The first one is done for you.

   See the lab manual; check the student's ideas for how to control variables.

4. Now you need to decide on five or more shapes that you will test. For instance, you might first test whether the ball of clay will float as is (in a ball shape). Then you might test it as a flat pancake shape, a round bowl shape, a boat shape, or any other shape. You might even test a shape with one or more holes in it! The more shapes you try, the more data you will collect. Write down a general description of the shapes you will test.

   See the lab manual for student response. If the shapes seem too similar, you may want to suggest adding a more unusual shape.

5. Now you will design your experiment, making sure to control all factors but the shape of the object. Explain in detail how you will conduct the experiment. Be as precise as you can. How much water will you use? What will the water temperature be? (Remember, it has to be held

constant.) How long will you let each shape sit in the water? Will you drop the shape from above or carefully lower it into the water? (You have to do it the same way each time to get really accurate data.) Clearly state the variables involved and how you will control all the variables except for the shape of the object. Write down the procedure you will follow, step by step.

Is the procedure written clearly enough for anyone to follow the same exact steps? If not, ask questions to get your student to clarify what information is missing. Make sure this information gets added to the procedure.

Conclusions

1. Based on the results of your experiment, form a conclusion. Was your hypothesis correct? How does your data prove (or disprove) it?

   Answers will vary. Students should directly cite their data in their response.

2. List any questions that arise from your results. What else might you test to help shed more light on this question? Are there other variables you might want to test that may affect whether an object floats or sinks?

   Hopefully, students will come up with other variables to test or questions to ask. If not, you might model this scientific inquiry skill by asking questions that expand on the experiment or its results. For instance, would objects made of other materials, such as wood or plastic, act the same way if they were in the same shapes as the clay objects? Would the results of the experiment differ if a denser liquid, such as oil or laundry detergent, was used instead of water?

3. Do you feel your experiment was successful? Why or why not? If you were to do it again, how might you do it differently?

   Your student might want to redesign the experiment after trying it. That's great! Make sure your student rewrites the procedure so that it reflects the final experiment. The conclusion should directly refer to the results of the experiment, and include notes about how the experiment might be improved or redesigned for clearer results.

Test

Answer the following questions using scientific terminology. Refer to scientific concepts to support your answer whenever possible.

1. In your own words, explain the steps of the scientific method.

   The steps of the scientific method are as follows:

Question: The problem or question is usually the result of an observation a person makes about something they have noticed that they do not know the explanation for.

Hypothesis: The hypothesis is an educated guess as to the reason or answer for the observed behavior or question.

Procedure: The procedure describes how the experiment will be conducted step-by-step.

Results: The observed results form the data collected from performing the experiment.

Conclusion: A conclusion is the interpretation of what the results indicate, including what may have influenced the results.

2. What is the difference between a variable and a constant? How many variables are normally in a scientific experiment? How many constants? Why are both part of every experiment? Give an example of each.

   A variable is an element that is changeable, and a constant is an element that is stable. In every experiment, a scientist will attempt to control and make stable all influential factors except one, which is the variable factor. There is usually only one variable while there may be many factors that are controlled or constants. Only by controlling all factors but one can the results of the experiment provide reliable data about the influence of the variable factor. For instance, in a plant growth experiment, the amount of sunlight, type of soil, and temperature might be held constant while the amount of water is varied.

3. Define controlled environment and give an example.

   A controlled environment is the space and circumstances under which an experiment is conducted where all the elements but one are controlled and identical. A laboratory is an example of a controlled environment because a scientist can set and control the light, temperature, air flow, and other factors that may influence the outcome of an experiment.

4. What does the phrase "correlation does not imply causation" mean? Make sure to define *correlation* and *causation* in your answer.

   Correlation refers to a relationship between two events, which may be incidental, and causation indicates a proven cause-and-effect relationship where one event always leads to another (A always causes B). Many events are correlated even though they do not directly influence one another or have many factors influencing them.

Learning Checklist

Use this learning checklist to keep track of how your skills are progressing. Include notes about what you need to work on. Please remember that these skills continue to develop over time.

SKILLS	Developing	Consistent	Competent	Notes
Describe the steps of the scientific method				
Write a concise, testable hypothesis				
Identify variable and constant factors				
Write a step-by-step procedure for an experiment				
Record data with accuracy				
Write a conclusion based on results				
Describe a controlled environment				
Differentiate between causation and correlation				

Grade 8

5

Mixtures and Compounds

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Give examples of mixtures.
- ☐ Identify and explain the chemical formula for common compounds.
- ☐ Illustrate and explain the process of oxidation.
- ☐ Identify the number and type of atoms in different molecules.
- ☐ Lab Investigation: Oxidation and Combustion
- ☐ Complete lesson 5 test.

Learning Objectives

At the end of this lesson you will be able to:

- Demonstrate the role of oxygen in combustion.
- Differentiate between mixtures and compounds.
- Illustrate and explain the process of oxidation.
- Interpret a chemical formula.

Reading

Read the following sections (found in Reading Selections at the end of this lesson).

- Mixtures
- Compounds
- Chemical Composition of Molecules
- Oxidation
- Chemical Reactions in Photosynthesis

If you find a section of the reading to be challenging or confusing, take the time to read it a second time. Look at one sentence at a time and make sure it makes sense to you before moving on. If you are still having trouble, ask for help.

Assignments

Take a look at all the assignments before you begin working.

1. Go on a hunt for mixtures. How many mixtures can you find around your house or outdoors? Make a list, and identify what each is made of.

   A mixture is two or more materials that are blended but not combined chemically. Mixtures can be separated into their component parts again. Examples given in the reading include mud (dirt and water), fruit salad (assorted fruits), seltzer (water and carbon dioxide), and salad dressing (vinegar and oil). Students should be able to come up with their own examples.

2. Choose two of the following common compounds. Give the chemical formula for each and explain what the chemical formula shows. Write a brief description of the process that formed the compound and what the compound is used for.

   - methane

     Chemical formula: CH_4

     Components: one atom of carbon, four atoms of hydrogen

     Properties: main component of natural gas; highly combustible; found below ground and under the ocean floor.

   - ammonia

     Chemical formula: NH_3

     Components: one atom of nitrogen and three atoms of hydrogen

     Properties: commonly found in nature; used by plants; in concentrated form, used in many cleaning products.

   - hydrochloric acid

     Chemical formula: HCl

     Components: one atom of hydrogen, one atom of chlorine

     Properties: highly corrosive acid; used in plastics, cleaning products, and in leather processing.

- isopropyl alcohol (rubbing alcohol)

  Chemical formula: C_3H_8O

  Components: three atoms of carbon, eight atoms of hydrogen, and one atom of oxygen

  Properties: flammable; used in many industrial and household disinfectants and detergents.

3. Illustrate and explain the process of oxidation. You can draw a diagram, create a cartoon-style drawing, or write a simple children's book explaining the process of oxidation using either rust or fire as your example. Explain the process as simply as possible, with illustrations and words. Make sure to define *oxidation*.

   The student's drawing and explanation should explain that oxidation is the process where oxygen reacts with another element. When oxygen and water come into contact with a metal containing iron, the compound iron oxide (or rust) is slowly formed. When oxygen combines with carbon-based fuel that is heated to its ignition temperature, it creates a reaction and combusts; fire is the result of materials oxidizing very quickly.

4. The chemical formula for water is H_2O, which means there are two atoms of hydrogen and one atom of oxygen in each water molecule. Using the following chemical formulas for ordinary household products, list how many atoms of each type are in each molecule. (You will need to refer to a periodic table of elements to identify the chemical symbols for each atom.)

   a. Chalk: $CaCO_3$

      Calcium: 1

      Carbon: 1

      Oxygen: 3

   b. Sugar: $C_{12}H_{22}O_{11}$

      Carbon: 12

      Hydrogen: 22

      Oxygen: 11

   c. Sodium bicarbonate (baking soda): $NaHCO_3$

      Sodium: 1

      Hydrogen: 1

      Carbon: 1

      Oxygen: 3

d. Monosodium glutamate (MSG): $C_5H_8NNaO_4$

Carbon: 5

Hydrogen: 8

Nitrogen: 1

Sodium: 1

Oxygen: 4

Lab Investigation

Complete the following lab investigation.

- **Lab Investigation: Oxidation and Combustion**

All lab investigations are found in the lab manual, *Lab Investigations: Physical Science*.

Lab Investigation: Oxidation and Combustion

Conclusions

Check that the student has filled in the data table using accurate measurements and clear unit labels.

1. Based on your knowledge of oxidation and and the process of combustion, explain what is happening in this experiment.

   Students should be able to communicate the idea that oxygen is reacting with the fuel and the fire is the rapid oxidation process. When the available oxygen is used up, the flame will extinguish.

2. What was the purpose of changing the size of the gap? What effect did it have?

   Changing the size of the gap allowed more oxygen to flow into the jar. The larger the gap, the longer the flame burned before there wasn't enough oxygen left to sustain the flame.

3. Was your original hypothesis correct or incorrect? Use your data as evidence to support your answer.

   Answers will vary. Students should cite their data as evidence of why their hypothesis was correct or incorrect.

Test

Answer the following questions using the knowledge you have gained in this lesson. Use correct terminology and refer to scientific concepts to support your answer whenever possible.

1. Imagine carefully weighing a metal can, leaving it out in the rain for weeks and weeks until it was very rusted, and then carefully weighing it again. Would the can be heavier or lighter after it was rusted? Why?

   The can will be heavier because when elements react with oxygen and oxidize, the resulting compound weighs more than the original elements.

2. What is the difference between a mixture and a compound?

   The components of a mixture can be separated into their original parts but the components that create a compound are formed into something new and cannot be reconstituted into their original parts. The components in a mixture do not chemically bond so they retain their original properties. The components in a compound chemically bond together so the resulting substance has new and different properties.

3. What is oxidation?

   Oxidation is the process where oxygen reacts with another element.

4. Based on the following equation for the chemical process of photosynthesis, explain what is occurring chemically.

   $6CO_2 + 6H_2O$ + light energy and chlorophyll → $C_6H_{12}O_6 + 6O_2$

   This shows that 6 molecules of CO_2 (carbon dioxide) and six molecules of H_2O (water) combined with light energy from the sun and chlorophyll from the green plants results in the chemical compound of a carbohydrate ($C_6H_{12}O_6$) with six molecules of O_2 or oxygen left over.

5. When a piece of paper or wood is burned, you are left with ashes that seem to weigh less than the paper or wood before it was burned. Yet when a substance is burned, it is oxidized and therefore must weigh more than it did before it was burned. Explain what happened to the "missing" weight.

   Some of the weight is released into the air as particles of dust and ash.

Learning Checklist

Use this learning checklist to track how your skills are developing over time and identify skills that need more work.

SKILLS	Developing	Consistent	Competent	Notes
Interpret a chemical formula				
Follow a lab procedure accurately				
Take accurate measurements and compile data				
Use data as evidence to support a claim				
Illustrate and explain the process of oxidation				