Eighth Grade Science Overview

	First Semester	Second Semester
Science	Controlled experiments Periodic table of the elements Mixtures and compounds Force vectors Mass, weight, and gravity Laws of motion Types of energy Student-led scientific inquiry	Properties of waves Electromagnetic spectrum Reflection, absorption, and refraction of light Electric charge and electrical current Mesuring and controlling electricity Magnetism and electromagnetism Mechanical advantage Principles of aerodynamics Student-led scientific inquiry

Grade 8

Physical Science Lab Manual

Oak Meadow

Oak Meadow, Inc.
Post Office Box 615
Putney, Vermont 05346
oakmeadow.com

Table of Contents

Unit IV: Energy

Unit V: Waves

Unit VI: Electricity and Magnetism

Unit VII: Engineering Design

Appendix

Introduction

Ready to dive into the fun of physics? This lab manual is packed with active explorations of the basic concepts of physical science. These lab investigations are designed around Next Generation Science Standards (NGSS).

The labs included in this book can be used as a supplement to any physical science course, and are a required part of Oak Meadow Physical Science for grade 8. Students in other grades can also use, enjoy, and benefit from these science explorations.

A complete Materials List is found in the appendix.

Enjoy learning about how the principles of physics influence our daily lives!

Lab Investigation: Sink or Float?

We all know light things float and heavy things sink. But some heavy things, such as ships, also float. How does the shape of an object influence its ability to sink or float? Your job is to design an experiment that tries to answer this question.

Materials

- clay (about the size of a baseball)
- bucket of water

Procedure

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.

2. Consider the variable factors that might influence whether an object floats or sinks. List as many factors as you can.

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 the value of the constant. The first one is done for you.

Weight or mass: Each shape tested will be made from the same ball of clay, with no clay added or subtracted. This will control the weight and mass of the object.

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.

5. Now you will design your experiment, making sure to control all factors except 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.

6. Perform the experiment, and record your results by writing down what you observe when you put each shape into the water. You can use the data table below or write your observations in list form. Use descriptive details to record exactly what happened.

Data Table: Buoyancy of Objects of Different Shapes

Object/Description	Observations

Conclusions

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

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?

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?

Scientific Inquiry: Modeling an Element or Molecule

The goal of this Scientific Inquiry is to create a three-dimensional model of an atom or molecule. You can be as creative as you like, as long as your model is scientifically accurate. After you have finished your project, complete the project reflection.

Here are the basic steps of your Scientific Inquiry (these are more fully explained below).

- ☐ **Question:** Identify a question or pose a hypothesis.
- ☐ **Research:** Investigate your topic by gathering data.
- ☐ **Design:** Plan your project and what you'll end up with when it is finished.
- ☐ **Discuss:** Discuss your project idea with others and refine your design.
- ☐ **Create:** Create something you can share with others.
- ☐ **Share:** You might share your project at home with friends and family, in the community, or online.
- ☐ **Reflect:** Assess your project design and reflect on the learning experience.

Scientists often work in groups, so you might consider working with one or more partners on your project. Feel free to collaborate with others on any phase of your project.

Project Design and Implementation

The following procedure will lead you through your project step by step. Of course, you are free to go in another direction and create your own project steps, if you have other ideas. This project is designed to be done in one week, but you may choose to do a longer, more complex project. One week may sound like a long time to create a model but modeling projects can present surprises and design elements that are trickier to construct than first imagined. You'll want to start on your project right away so you have plenty of time to work on and refine your design.

If you have questions or need help for any of these stages, ask an adult to guide you. **Read through all the steps before you begin** so you have an idea of the scope of the project from beginning to end.

Question: For this project, the initial question has been posed: "How can I create a three-dimensional model of an element or molecule of multiple elements?"

What element or molecule will you model? (You may need to do some research before deciding—you don't want to pick something too complicated or too simple.) ______________________

Research: Think about what you will need to know in order to choose and model an element or molecule.

For each element you will be modeling, you will need to know the following:

- Element name and symbol
- Number of protons and neutrons in the nucleus
- Number of electrons
- Number of electron shells
- For molecules of two or more elements, the number of atoms of each element (if you are modeling a molecule, you don't have to represent the electrons)

Design: Once you have decided on what you will be modeling, you can start to think about how you will create your model. You might use materials from nature, food, clay, balls, beads, toothpicks, wire, cloth, or other craft items.

List the materials you'd like to use.

____

____

____

Describe how you will use these materials to make your model. Explain how you will hold the atoms together for a molecule or connect the orbiting electrons for an atom.

____

____

____

Discuss: Discuss your project idea with others. Ask them for their ideas on refining your design. You might use some of their ideas, or their ideas might help you discover a new way of improving your design.

Feedback from others:

____

____

____

____

____

Write a new materials list and description of your project, based on your discussions.

Create: Construct your design. You may have to create more than one model, especially if the model doesn't hold together or it turns out to be too difficult to create as originally designed. Make adjustments and keep trying!

When creating your model, was it successful the first time? If not, what went wrong?

What did you do to fix it?

Share: This project can be shared in person (show it to a friend or relative and explain what the model shows) or you can take a photo of it to share with friends, family members, or the online community. If your model came out quite successfully, you might want to recreate how you made it on video and upload it to the internet so other students can replicate your project.

How will your share your model? ______

Reflect: Fill out the project reflection below to assess your project design and reflect on the learning experience.

Project Reflection

After you have finished your project, complete this self-assessment. Consider each question carefully. Take the time to reflect on the experience before answering.

Thinking back on the process of creating your project, what worked out better than expected?

What didn't work out as planned?

Were you able to find enough helpful, reliable resources? Did you use a variety of resources?

Once you began creating your project, did your plans change? If so, how and why?

Did you have enough time to complete your project to your satisfaction? If not, what do you feel you could have done better or differently if you had more time?

Would you like to try planning and implementing a longer project next time?

What might you do differently if you were to do this project again?

What advice would you give other students who undertake a project like this?

Fill in the blanks for the following statements.

The most interesting aspect about this project was

The most difficult part for me was

I'd like to improve my skills in

I'm happy with the way I

Lab Investigation: Oxidation and Combustion

For this investigation of oxidation and combustion, you will be covering a lit candle with a glass jar to see how long it burns before going out. Then you will allow different amounts of air into the jar to see how it affects burn time.

Note: This lab involves fire and adult supervision is required.

Materials

- glass jar
- candle (small enough to fit inside the jar)
- matches or lighter
- toothpick
- butter knife
- metric ruler or tape measure
- clock, watch, or stopwatch

Hypothesis

Read through the procedure you will be performing. Predict what you think will happen. Write your prediction as a hypothesis.

Explain why you made this prediction.

Procedure

1. Place the jar upside down on the toothpick so that the jar is tilted slightly with the toothpick holding one side up. Measure the gap created by the toothpick. (If your measuring tool doesn't have small enough increments, you can use the following estimate: width of toothpick = $\frac{1}{16}$ inch = 0.0625 inch = 1.6 mm or .16 cm.) Record this measurement in the left-hand column of the data chart. Make sure to include the unit of measure you are using and use the same unit for all your measurements.
2. Remove the toothpick and replace it with the handle of the butter knife, so the knife handle is propping up one side of the jar. Measure the gap and record the measurement.
3. Light the candle (have an adult supervise for safe handling of fire).
4. Place the glass jar upside down on top of the candle. Use a stopwatch or clock with a second hand to time how long the flame burns before extinguishing. Record the time on the data chart.
5. Relight the candle. Place the glass jar upside down on top of the candle with the toothpick underneath one edge of the jar. Count the number of seconds the flame stays lit and record the data from your observation.
6. Repeat the process using the butter knife to create a larger gap under the edge of the jar. Record how much time the candle stays lit before going out.
7. Repeat the experiment two more times using different objects to change the size of the gap each time. Record the type of object and the gap measurement on the data table before you light the candle.

Data Table: Oxidation and Combustion

	Total burn time
Upside-down jar **(no gap)**	
Jar with toothpick **Gap measurement:** ________	
Jar with butter knife **Gap measurement:** ________	

	Total burn time
Jar with ______________ **Gap measurement:** ______________	
Jar with ______________ **Gap measurement:** ______________	

Conclusions

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

____

____

____

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

____

____

____

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

____

____

____

____

____

Lab Investigation: Insulators and Conductors

In this lab, you will test the heat transfer capabilities of different materials.

Materials

- ice cubes
- 2 metal baking pans
- 2 ceramic plates
- 2 paper towels

Hypothesis

Begin by making a hypothesis about which material will be the best insulator or conductor of heat: metal pan, metal pan with paper towel, ceramic plate, or ceramic plate with paper towel. Form a hypothesis that predicts which of the four options will be best at insulating (preventing the transfer of heat) and which will be best at conducting heat. State your hypothesis as clearly as you can.

Procedure

1. Fold the paper towels in half, and then in half again, so you have four thicknesses of paper towel.
2. Place one folded paper towel in one of the metal pans and the other paper towel on one of the ceramic plates. Arrange the two pans and two plates in a line on a table or counter (they should all be on the same surface). Make sure they aren't touching one another.
3. Place one ice cube in the center of each of the pans and dishes. Make sure the ice cubes are centered on the folded paper towels.
4. Write down the time. You might want to create a simple data table to keep track of your results.

5. Leave everything to rest at room temperature. Observe how fast the ice cube melts in each one. You don't have to watch it the whole time, but check back every five minutes to watch the progress of the melting ice cubes.
6. Note what time it is when each ice cube melts completely into water. Write down your results.

Conclusions

1. Which ice cube melted the quickest? ________________________
2. Which melted the slowest? ________________________
3. Using your knowledge of heat insulators and conductors, explain what your experiment demonstrated about heat transfer.

____

____

____

____

____

Lab Investigation: Thermal Expansion and Contraction of a Gas

This investigation explores how temperature influences the way molecules in gas move.

Note: This lab involves heating water on the stove; adult supervision is required.

Materials

- glass bottle (such as a soda or juice bottle)
- cooking pot
- small balloon (the kind you inflate)

Procedure

1. Pull the balloon over the mouth of a bottle.
2. Place the bottle in the cooking pot with 2 inches of cold water.
3. Put the pot on a stove and slowly heat the water almost to the boiling point.
4. Observe what happens to the balloon.
5. Take the pot off the stove. Using oven mitts, carefully lift the bottle out of the water and set it aside to cool.
6. Observe what happens to the balloon.

Conclusions

1. Describe your observations.

2. Explain the forces that caused your results. Include the terms *molecule*, *gas*, *heat*, *expansion*, and *contraction* in your answer.

Lab Investigation: Water Depth and Pressure

This lab explores water depth and pressure by seeing if water flows faster out of a smaller can or a larger can. You will need a partner for this lab. Read all the instructions first so you can figure out the best way to carry out the procedure.

Materials

- small can (such as a soup can), empty, with lid removed
- large can (such as a large juice can), empty, with lid removed
- can opener
- hammer
- nail
- ruler

Procedure

1. With the hammer and nail, punch a hole in the side of each can, very close to the bottom. Make sure the holes are equal in size.
2. You will cover the hole in each can with a finger—you can cover both holes (using two hands), or you can cover the hole in one can while your partner covers the hole in the other can.
3. With the holes covered, fill each can with 3 inches of water. Use the ruler to measure and make sure each can has the same depth of water. (It might be hard to see the waterline on the ruler, but when you pull the ruler out, you'll be able to see how much of it is wet. Dry the ruler in between measurements to help you take accurate readings.)
4. Position the cans next to the sink with the holes facing the sink.
5. At the same time, uncover the holes in both cans.
6. Observe what happens.
7. When the water stops draining, pour out any remaining water.

8. With the hole covered, fill the small can to the brim with water and pour this amount into the large can (make sure the hole is covered on the large can!). Then cover the hole in the small can, and fill it to the brim with water again. Now both cans have exactly the same volume of water in them.
9. Place the cans next to the sink with the holes facing the sink.
10. At the same time, uncover the holes in both cans.
11. Observe what happens.

Conclusions

1. Did the streams of water shoot out from both cans at the same distance when the cans had the same depth of water (3 inches)? Why or why not?

2. Did the streams of water shoot out from both cans at the same distance when the cans had the same volume of water (one full small can of water in each one)? Why or why not?

3. How did your results differ between having the same depth of water and the same volume of water? Why? Use scientific concepts and terminology in your response.

Appendix: Materials List

Lab	Materials
Lab Investigation: Sink or Float?	clay (about the size of a baseball) bucket of water
Lab Investigation: States of Matter	long-neck glass bottle with a small opening ice cube hot water
Lab Investigation: Oxidation and Combustion	glass jar candle (small enough to fit inside the jar) matches or lighter toothpick butter knife metric ruler or tape measure clock, watch, or stopwatch
Lab Investigation: Chocolate Solution	3 small pieces of chocolate (uniform in size) or other candy
Lab Investigation: Mixtures and Solutions	8 glass jars with lids hot water spoon Small amounts of the following: vinegar rubbing alcohol solid (powdered) laundry soap liquid soap (hand, dish, or laundry soap) flour ground-up chalk dirt cooking oil

Lab	Materials
Lab Investigation: Saturation of Sugar Solution	granulated sugar 3 glass jars with lids (all the same size) measuring spoons cold, warm, and hot water thermometer
Lab Investigation: Insulators and Conductors	ice cubes 2 metal baking pans 2 ceramic plates 2 paper towels
Lab Investigation: Thermal Expansion and Contraction of a Gas	glass bottle (such as a soda or juice bottle) cooking pot small balloon (the kind you inflate)
Lab Investigation: Water Depth and Pressure	small can (such as a soup can) large can (such as a large juice can) can opener hammer nail ruler
Lab Investigation: Mass and Gravitational Force	2 candles of the same size and weight cork metal knitting needle large darning needle 2 drinking glasses of the same size matches baking sheet aluminum foil
Lab Investigation: Gravity, Buoyancy, and Weight	sturdy rubber band paper clip ruler bucket or pot of water clay (a ball the size of a large walnut)

Lab	Materials
Lab Investigation: Center of Gravity of Irregular Shapes	cardboard scissors string paper clip pushpin bulletin board
Lab Investigation: Inertia	drinking glass aluminum pie plate empty toilet paper tube (or other short cardboard tube) hard-boiled egg
Lab Investigation: Equal and Opposite	3 tennis balls 3 pushpins string, cut into 3 lengths of 30 inches (.75 meters) each
Lab Investigation: Converting Mechanical Energy to Thermal Energy	insulated cup with lid (the kind you find in a coffee shop) thermometer timer or clock 1 cup of dry sand $\frac{1}{2}$ cup measuring cup
Lab Investigation: Generating Power	2 one-gallon jugs full of liquid (such as water, juice, or milk) stopwatch or clock with second hand bathroom scale metric ruler
Lab Investigation: Solar Heating	4 clear plastic cups black construction paper tape 2 large glass bowls, dishes, or jars thermometer marking pen
Lab Investigation: Transverse Waves and Wave Interference	rope (10 to 20 meters long) measuring tape stopwatch or watch with a second hand

Lab	Materials
Lab Investigation: Reflection and Absorption of Sound	2 cardboard tubes, each approximately 2 feet long (you can make them out of cardboard) clock that ticks loudly (or other source of noise of consistent sound intensity and pitch) thick piece of cardboard, approximately 1 foot square piece of wood, approximately 1 foot square and 1 inch thick metal baking sheet metal muffin baking pan pillow table
Lab Investigation: Transmission of Sound Waves	2 paper cups paper clip string, approximately 10 meters
Lab Investigation: Rainbow Disc	white paper 3 small round bowls or cups, each a different diameter cardboard ruler pencil or pen 6 colored markers: red, orange, yellow, green, blue, and purple string, 1 meter scissors Phillips-head screwdriver
Lab Investigation: Refraction and Dispersion	short, clear drinking glass spoon white paper small, flat mirror that will fit into the glass
Lab Investigation: Image Projection	magnifying glass (convex lens) stiff white paper or cardboard candle matches or lighter clay or beeswax metric tape measure

Lab	Materials
Lab Investigation: Charged Balloons	2 balloons sweater, sock, or scarf made of wool or nylon curtain or cotton cloth string, approximately 1 meter
Lab Investigation: Attraction and Repulsion	plastic comb sweater, sock, or scarf made of wool or nylon newspaper shredded into strips salt* pepper* flour* sugar* paper towel *You need only a pinch of each of these substances.
Lab Investigation: Electroscope	glass jar paper clip, large scissors cardboard or index card aluminum foil comb wool sweater or scarf tape
Lab Investigation: Electrical Conductors	6-volt battery (rectangular, with two terminals on the top) insulated copper wire, approximately 10 cm or metal scissors (with no insulating plastic or rubber on them) flashlight bulb (such as a #502 bulb) pocket knife or wire-strippers pencil with eraser and metal end sawn off tape assorted objects, such as a key, button, spoon, quarter, glass marble, and wooden block

Lab	Materials
Lab Investigation: Voltaic Pile	volt-ohm meter 10 pennies 10 nickels 10 dimes thin carboard or index card vinegar scissors
Lab Investigation: Magnetic Force	2 magnets of different strengths glass jar wooden ruler paper clip
Lab Investigation: Magnetic Strength along a Magnet	bar magnet ruler 24 metal paper clips pencil
Lab Investigation: Magnetic Induction	large steel nail magnet 12 metal paper clips hammer safety goggles
Lab Investigation: Electromagnetic Fields	45–60 cm of wire 1.5-volt D cell battery magnetic compass knife or wire-strippers nail
Lab Investigation: Archimedes Screw	1-liter plastic bottle (without the cap) glue duct tape cardboard, thin (such as a cereal box) knife or box cutter scissors wooden dowel popcorn or dry cereal

Lab	Materials
Lab Investigation: Lever and Fulcrum	wooden ruler 5 nickels wood, cut into a triangular shape (to use as a fulcrum) tape
Lab Investigation: Torque and Mechanical Advantage	manual pencil sharpener (or other hand-crank device) books twine, 1.5–2 meters duct tape screwdriver
Lab Investigation: Mechanical Advantage of a Block and Tackle	2 broomsticks rope, approximately 6 meters (20 feet) long
Lab Investigation: Aerodynamic Design	clock or stopwatch measuring tape
Lab Investigation: Digital Communication	graph paper (4 pieces) ruler