Grade 8
Physical Science

Oak Meadow
Teacher Manual

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Lesson 1 Measurements and Quantitative Data

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Reflect on how knowledge is built upon the work of others.
- ☐ Identify objective and subjective observations.
- ☐ Record qualitative and quantitative observations.
- ☐ Measure and describe household objects.
- ☐ Optional activity: Scientists and Scientific Discoveries
- ☐ Complete lesson 1 test.

Learning Objectives

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

- Demonstrate objective observations.
- Differentiate between subjective, objective, qualitative, and quantitative observations.
- Identify the basic components of a scientific argument.

Reading

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

- The Flow of Discovery
- Scientific Inquiry
- Measurements and Quantitative Data
- Scientific Argument

Before you begin reading, glance over the length of the reading selections in this week's lesson. This is a good habit to get into—at the beginning of each lesson, scan all the work ahead of you. If you find a lot of reading material in a lesson, try to read one or two sections and then take a break before reading more. That way, you are more likely to remember what you read rather than if you had rushed through it.

In addition to the reading selections in this coursebook, you are encouraged to learn more about topics you are interested in by visiting the library, reading newspapers and scientific journals, and doing research online. You'll find a list of online resources at www.oakmeadow.com/curriculum-links/. You can use these links to learn more about lesson topics.

While you may not have time to read the material in each lesson, you can encourage your student to discuss the reading. This lets you get a sense of how well the information has been absorbed. Feel free to ask questions to prompt a discussion or request an expanded explanation.

Many students benefit from help with time management, especially at the beginning of a course. You might want to sit down with your student at the beginning of the week to look over the lesson material and make a plan for breaking the tasks into smaller sections spread out over the week. A student planner can be used to clarify what needs to be done and check off things that have been completed.

Assignments

At the beginning of each lesson, read the assignments, lab investigations, and activities to see what you'll be doing that week. Yes, this will take a little time, but it will help you get a good sense of how long things will take so you can manage your time better. You have a full week to complete each lesson, so there's no rush.

1. Think of a time when you have built on the knowledge of someone who came before you, and consciously taken it to the next step. Was this next step an improvement or a better design? Perhaps an activity you do is now more efficient. Write about one or two of your experiences.

   Answers will vary. Hopefully, students will be able to articulate an experience of taking information or a skill learned from someone else and changing it to better suit the purpose at hand. If your student has trouble thinking of an example, you might relate one from your own life.

2. Identify which of the following observations are objective and which are subjective.

Statement	Objective	Subjective
The cat is 20 inches long.	✓	
Its tail is striped orange and white.	✓	
It is friendly.		✓
The cat is fat.		✓
It weighs 20 pounds.	✓	
Its whiskers are white.	✓	
The fur on its paws is orange.	✓	
It enjoys lying in the sun.		✓

3. Practice careful and objective observation. Choose something to observe, either outdoors or indoors. Consider what you might need to do for the observation to be repeatable. If you're observing your dog playing in your backyard, you need to record the dog's actions as well as the time of day, the weather, the sounds around you, who else is there, etc. All these things are important and helpful information. For example, if you don't note that a thunderstorm comes up, and you just say, "The dog suddenly stopped chasing the stick and hid under a bush," we're not getting the full picture. You will need to use all your senses and record your data carefully and thoroughly. Be sure to be objective. Instead of saying, "My dog kept jumping up happily," you should say, "My dog jumped two feet off the ground six times in ten seconds while wagging his tail." That way the reader decides if the dog seems happy or not. Use clear and precise language when describing your observations. Make sure to include both qualitative and quantitative data.

   The observations should be clearly written with specific detail. Quantitative observations will include numbers—these are generally easy for students to record objectively. Qualitative observations are more challenging to form without judgement or bias. If necessary, ask questions to point out subjective observations and help students reframe them as objective statements. For instance, if the student writes, "The first bird aggressively attacked the second bird and chased it away," you might ask, "What makes the first bird appear aggressive?" After discussing the specific behavior that was observed, the statement might be rewritten to say, "The first bird flew directly toward the second bird at high speed, and the second bird abruptly changed direction and flew out of the area."

4. Find five objects in your house that are rectangular or square. The objects should be different sizes. At least one should be smaller than your hand, and at least one should be larger than a chair (such as an appliance). Take careful measurements using a metric ruler or tape measure and complete the table below. After measuring the item (quantitative data), write down one objective qualitative observation.

   The student will fill in the table in the coursebook. Check that the measurements include unit labels (centimeters, inches, etc.). Note the language used in the qualitative observation to make sure it is objective, and that another observer would agree with the statement, regardless of opinion. Qualitative observations might include the type of material (such as wood, iron, or plastic), color, texture, density, or appearance.

Activities

All the activities in this course are optional. Although these activities are not required, you are encouraged to choose any that interest you to help you gain a better understanding of the course material.

Activity: Scientists and Scientific Discoveries

The activities in this course are optional. Students are encouraged to choose those that interest them. See the coursebook for the full description of each activity.

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. Explain the difference between an objective observation and a subjective observation.

   An objective observation is one that all observers would agree on, regardless of personal opinions or perspective. A subjective observation is based on a person's individual viewpoint, feelings, beliefs, or opinion.

2. Give three examples of quantitative observations.

   Examples will vary, and may include statements like the following:

   The tree is 30 feet tall and has leaves approximately 4 inches long.

   The ball is approximately 35 centimeters in diameter. When dropped from a height of 2 meters, it bounced approximately 1.5 meters high.

3. Give three examples of qualitative observations.

   Examples will vary, and may include statements like the following:

   The beavers' lodge appears as a rounded mound above the water.

   The fawn was light brown with white spots, and stood close to the hindquarters of the doe.

4. List and define the steps of a scientific argument.

   As explained in the reading, a scientific argument includes a claim, evidence, and reasoning. (This is a basic explanation of a complex process.) The claim is a conclusion or inference based on data, showing a relationship between factors. Evidence is the data that indicates the relationship. Often evidence is presented in a compiled form, such as a graph or table. Reasoning is used to explain how the data shows the relationship or supports the conclusion. If students struggle to understand how data might be used to support a claim, you might look for examples in recent news. For instance, you might find data that indicates a connection between the amount of sleep and academic performance, or data on rising sea levels and shrinking ice sheets, or on shrinking ice sheets and rising temperatures.

Learning Checklist

This learning checklist can be filled out by either you or the adult who is supervising your work. This checklist will help you keep track of how your skills are progressing and what you need to work on. You or your home teacher can also add notes about where you'd like help.

Here is what the different headings mean:

Developing: You still need to work on this skill.

Consistent: You use this skill correctly most of the time.

Competent: You show mastery of this skill.

Please remember that these skills continue to develop over time so you aren't expected to be able to do all of them yet. The main goal is to be aware of which skills you need to focus on.

SKILLS	Developing	Consistent	Competent	Notes
Differentiate between subjective and objective observations				
Define quantitative and qualitative data				
Record accurate measurements				
Use scientific terminology in explanations				

Lesson 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. Possibilities may include houseplants that thrive in one place in the house but not another, where snack foods are stored and how often snacking occurs or what is eaten, or the preferred paths of passing from room to room for people or pets. 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 physical science lab manual. 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 lab manual 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				

Lesson 6 Types of Mixtures

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Identify homogeneous and heterogeneous substances.
- ☐ Create a graphic showing different types of matter.
- ☐ List soluble and insoluble substances.
- ☐ Answer questions about temperature and solubility of gases.
- ☐ Identify compounds and mixtures.
- ☐ Lab Investigation: Chocolate Solution
- ☐ Lab Investigation: Mixtures and Solutions
- ☐ Lab Investigation: Saturation of Sugar Solution
- ☐ Optional activities:

  Activity A: Soda Shake

  Activity B: Oil Marble

  Activity C: Ocean in a Bottle
- ☐ Complete lesson 6 test.

Learning Objectives

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

- Demonstrate mixtures, solutions, and saturated solutions.
- Explain the variables that influence solubility.
- Differentiate between compounds and different types of mixtures.

Reading

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

- Different Types of Solutions
- Solubility, Concentration, and Saturation
- Solutions, Colloids, and Suspensions
- Separating Mixtures

Assignments

1. Look for homogeneous and heterogeneous substances in your refrigerator or food cupboard. Make a list of what you find.

   Answers will vary depending on the food on hand. Homogeneous substances have a uniform appearance, and include such items as mayonnaise, broth, molasses, soy sauce, plain yogurt, and clear juice. Heterogeneous substances are varied in appearance, with individual elements visible, and include such items as chicken soup, chili, chunky tomato sauce, yogurt with fruit, macaroni and cheese, and refried beans.

2. Create a graphic or visual representation to show how matter is either an element, a compound, or a mixture. Also on your graphic, show that a mixture can be either a solution, a colloid, or a suspension. You might draw a concept map or Venn diagram to show this information (look up what these are if you aren't familiar with them).

   Students are free to create any type of graphic organizer. It should clearly show that elements, compounds, and mixtures are all matter, and that there are three different types of mixtures (solution, colloid, and suspension).

3. List three soluble substances and three insoluble substances.

   Answers will vary. Examples of soluble substances are sugar, salt, vinegar, and soap. Examples of insoluble things include coffee, tea, rocks, and a cat. This asks for things that dissolve (or don't) in water, so there may be some very creative answers.

4. Thermal pollution is caused when warm water is released into rivers from power plants and factories, raising the temperature of the river in that location and far downstream. All aquatic life depends on the oxygen that is in solution in the water (known as *dissolved oxygen*). What happens to the dissolved oxygen level if the water is warmed up, and how would this affect the aquatic life?

   Since gases dissolve better in cooler water, that means that cooler water can hold more oxygen. When the water in the ocean warms, it holds less dissolved oxygen. This means that there is less of this gas available to support aquatic plants and animals, and many are likely to sicken and die.

   Some students may wonder how dissolved oxygen gets into water. Anything that moves the water, like rain, wind, or currents, will increase the presence of oxygen in the water. That's why trout love cold running water, because both the cold and the churning of the water incorporate oxygen. Also, plants add oxygen to the water, as well as phytoplankton, which actually provide a third of the oxygen we breathe.

5. Indicate if the following items are compounds or mixtures, and for the mixtures, indicate which type.

Item	**Compound**	**Mixtures (solution, colloid, or suspension?)**
air		solution
seltzer water		solution
mayonnaise		colloid
salt	yes	—
salad dressing		suspension
bronze		solution
baking soda	yes	—
sweetened iced tea		solution
vegetable soup		suspension
whipped cream		colloid
strawberry ice cream (with real strawberries throughout)		Suspension (the ice cream is a colloid with the strawberries suspended in it)
mud		suspension
iron oxide (rust)	yes	—
butter		colloid

Lab Investigation

Complete all three of the following lab investigations.

- **Lab Investigation: Chocolate Solution**
- **Lab Investigation: Mixtures and Solutions**
- **Lab Investigation: Saturation of Sugar Solution**

All lab investigations are found in the lab manual.

Lab Investigation: Chocolate Solution

Conclusions

1. In your experiment, what was the solvent and what was the solute?

   The saliva was the solvent and the chocolate or candy was the solute.

2. Based on your results, what conclusions can you draw about the variables that affect how fast a solute dissolves? Explain your answer, using the terms *particle size, solution, solute, solvent*, and *dissolve*.

   Students should note that moving the candy around in their mouth caused it to dissolve more quickly than just letting it sit on the tongue, and breaking it into smaller particles with their teeth caused it to dissolve the fastest.

Lab Investigation: Mixtures and Solutions

Procedure: Part I

Check that the data table is filled out completely and accurately.

Conclusions

For each of the eight jars:

- Describe what you mixed
- State whether the result was a solution or a mixture, and explain your answer
- For solutions, identify which substance was the solvent and which was the solute
- For mixtures, state whether the mixture is miscible or immiscible

Jar 1 ingredients: water and vinegar

Solution

Solvent: water

Solute: vinegar

Jar 2 ingredients: water and rubbing alcohol

Solution

Solvent: water

Solute: rubbing alcohol

Jar 3 ingredients: water and powdered laundry soap

Solution

Solvent: water

Solute: powdered laundry soap

Jar 4 ingredients: water and liquid soap

Solution

Solvent: water

Solute: liquid soap

Jar 5 ingredients: water and flour

Mixture

Immiscible

Jar 6 ingredients: water and chalk

Mixture

Immiscible

Jar 7 ingredients: water and dirt

Mixture

Immiscible

Jar 8 ingredients: vinegar and oil

Mixture

Immiscible

Procedure: Part II

1. Choose one of your mixtures (not a solution) from part I. Think of a way to separate the substances. Write down your hypothesis (how you think you can separate the substances).

   One possible way to separate the substances is to allow the particles to settle, and then either drain off the liquid or allow it to evaporate. Other separation techniques include filtration and strong rotational or centrifugal force.

2. Perform your experiment (try to separate the substances). Record your results.

   Students should clearly describe what happened. If the results aren't clearly explained, ask questions to help the student identify where more description is needed.

3. How well did your separation technique work? Can you think of a better way to perform the separation?

   Answers will vary. Your student's response may provide a good starting point for a discussion about the lesson material.

Lab Investigation: Saturation of Sugar Solution

Conclusions

Check the student's line graph. The water temperature should appear at the bottom with units of measure (degrees C or degrees F) clearly marked. Three data points should appear on the graph directly above the labels "Cold," "Warm," and "Hot." The three data points should be connected with a line, and the line is expected to rise from left to right, with the right side (the

data for the hot water) to be the highest point of the graph. If the graph is unclear or shows something different, ask your student to explain what the graph shows.

1. Compare the three solutions. Do they have the same appearance? If not, how do they differ?

   Students will probably note that the hot water solution looks more cloudy as it has a higher salinity content than either the warm or cold solution.

2. Based on your results, what conclusions can you draw about how temperature affects the solubility of a solute? Did it take longer to get the sugar to dissolve in the cold water? How great was the difference in the amount of sugar that dissolved in the hot water versus the warm water, or the warm water versus the cold water? Write a conclusion, explaining what you observed. Cite your specific quantitative data in your explanation. Use the following terms in your conclusion: *temperature, solubility, solution, solute, solvent, dissolve,* and *saturated solution*.

   Observations should be written in clear, objective language, using correct terminology. There should be a marked difference in the amount of sugar in the hot-water solution compared to the cold-water solution, with the hot water holding more sugar before reaching its saturation point. Students will probably note that the sugar dissolved more quickly in the hot water.

   The conclusion should explain the scientific concepts behind the lab results and cite the quantitative data (the amount of sugar added to reach saturation point in each water temperature). Liquid solutions that are warm or hot can dissolve more of the solute than solvents that are cool or cold. The solubility of a solid—the amount of a solute that can be dissolved in a solvent—generally goes up with the temperature of the solvent.

   If something sounds confusing, ask your student to clarify. This will help you see if the student has grasped the concepts behind the lab.

Activities

Complete one or more of the following optional activities to learn more about the topics in this lesson.

- Activity A: Soda Shake
- Activity B: Oil Marble
- Activity C: Ocean in a Bottle

See the student coursebook for complete descriptions of the activities. Activities do not need to be graded in order for them to be beneficial to the student.

Test

1. List the three types of mixtures and explain the similarities and differences between them.

   The three types of mixtures are solutions, colloids, and suspensions. The size of the particles determines what type of mixture it is. In a solution, the particles are broken down or dissolved by the solvent into the size of molecules, and the molecules are evenly mixed together so that the substance is homogeneous. In a colloid, a substance is broken down into microscopic particles so it can mix well with another substance, but the particles are insoluble, so they won't dissolve but instead remain suspended. In a suspension, you can easily see particles of the components floating around and the substance is heterogeneous, not homogeneous. If the suspension is allowed to rest, the particles will either float to the top or sink to the bottom.

2. Define solute and solvent.

   The solute is the substance that is dissolved, and the solvent is the substance that acts to break down or dissolve the solute.

3. Give an example of a homogeneous mixture and a heterogeneous mixture, and explain the difference between them.

   Answers will vary. See assignment #1 for definitions and examples.

4. What are immiscible liquids? How do they differ from miscible liquids? Give an example of each.

   Immiscible liquids are those that do not dissolve when mixed together; miscible liquids dissolve when mixed together. Vinegar and water are miscible liquids because they dissolve to form a solution when mixed together. Vinegar and oil are immiscible liquids because they do not dissolve into a solution when mixed together. Student examples will vary.

5. Explain how temperature influences the solubility of gases in liquids.

   The solubility of a gas in liquid increases as the temperature of the liquid goes down. This means that more gas is held in a dissolved state in a cool liquid than in a warm liquid.

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
Identify similarities and differences between types of mixtures				
Differentiate between homogeneous and heterogeneous substances				
Differentiate between miscible and immiscible liquids				
Use scientific terminology in writing lab results and conclusions				
Record observations with accuracy and clear language				

Lesson 7 Temperature and Pressure

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Experience and explain the concept of thermal transfer.
- ☐ Apply knowledge of convection currents to weather.
- ☐ Research why popcorn pops.
- ☐ Predict how a change in water properties would affect aquatic life.
- ☐ Calculate metric temperature conversions.
- ☐ Lab Investigation: Insulators and Conductors
- ☐ Lab Investigation: Thermal Expansion and Contraction of a Gas
- ☐ Lab Investigation: Water Depth and Pressure
- ☐ Optional activity: Sensing Temperature
- ☐ Complete lesson 7 test.

Learning Objectives

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

- Explain thermal transfer and equilibrium.
- Identify thermal conductors and insulators.
- Perform metric temperature conversions.

Reading

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

- Thermal Energy and Heat Transfer
- Conduction, Convection, and Radiation
- Conductors and Insulators
- Thermal Expansion and Contraction
- Special Properties of Water
- Temperature as a Measurement of Thermal Energy
- Increasing and Decreasing Pressure

Assignments

1. With bare feet, stand with one foot on a rug, and the other foot on a tile, linoleum, or wood floor. Which one feels colder? Which one is really colder? Explain what is going on.

   Both types of surfaces are the same temperature, but the rug will feel warmer. This is because the tile or wood floor conducts heat much more easily than the rug, and your body heat will move into it more quickly. The rug is less dense than the solid floor and has more air, which makes it a better insulator. This means that less heat energy is transferred from your warm foot to the rug.

2. Land masses heat up and cool down faster than bodies of water. When land heats up (by the sun's radiation), the heat travels by conduction to the air above the land, which then moves by convection. Knowing this, if you are near the ocean on a sunny day, which way will the breeze be blowing, toward the shore (onshore breeze) or away from the shore toward the water (offshore breeze)? Which way will it be blowing in the middle of the night? Why?

   During the day, there is usually an onshore breeze (a breeze blowing toward the shore) because the air over the land heats up and rises, causing cooler air to move in from the ocean to replace it. At night, the breeze reverses, and you have an offshore breeze as the land cools more than the ocean. This causes convection currents to rise over the ocean where the air is warmer, pulling the cooler air from the land toward the sea.

3. What causes popcorn to pop? Research popcorn and find out how it relates to this lesson. Write a brief explanation or draw a diagram showing what happens when popcorn kernels pop.

   Popcorn pops because of the expansion of gases. The moisture in the corn kernel, when it is heated, changes to steam. Once it is a gas, it expands dramatically, building pressure inside the kernel until it explodes, spilling out the fluffy white starch. If you've ever used very old popcorn that has dried out, you'll see that it doesn't pop well because it has a lower moisture content.

4. Think about the fact that water is most dense at 4°C, and ice is much less dense than water. What would happen to a lake or a pond in the winter (in a cold climate) if this wasn't the case? What if the solid form (ice) was more dense than liquid water? How would this affect the life in the lake?

   Since water is most dense at 4°C (39°F), the water at the bottom of a lake in winter (in a cold climate) might be no colder than this. Since ice is less dense than water, it will always float on a lake or pond. This is important to aquatic life because it means that when ice forms on top of the lake, there will still be liquid water at the bottom.

5. Complete the following conversion:
   a. Convert the following Fahrenheit temperatures to Celsius (you may use a calculator):
      - 98.6°F (normal body temperature) **37°C**
      - 68°F (room temperature) **20°C**
      - 23°F (a cold day) **−5°C**

   b. Convert the following Celsius temperatures to Fahrenheit:
      - 10°C **50°F**
      - 35°C **95°F**
      - –40°C (that's cold!) **−40°F (yes, Celsius and Fahrenheit temperatures are the same at this temperature!)**

Lab Investigation

Complete the following lab investigations (found in the lab manual).

- **Lab Investigation: Insulators and Conductors**
- **Lab Investigation: Thermal Expansion and Contraction of a Gas**
- **Lab Investigation: Water Depth and Pressure**

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 Investigation: Insulators and Conductors

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, and 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.

Answers will vary and will probably be similar to this example: The metal pan will be the best conductor of heat and the ice cube will melt the fastest in the metal pan; the ceramic plate with the paper towel will be the best insulator (poorest conductor of heat) and that ice cube will melt the slowest.

Conclusions

1. Which ice cube melted the quickest?

   Results should show the ice cube in the metal pan melted the fastest.

2. Which melted the slowest?

   Results should show the ice cube in the ceramic plate with the paper towel melted the slowest.

3. Using your knowledge of heat insulators and conductors, explain what your experiment demonstrated about heat transfer.

   The ice cube on the metal pan melted the fastest because metal is a good conductor of heat. This allows the heat of the metal pan and the counter it was sitting on to flow into the ice cube easily, melting it. This is because the molecules in the metal pan are able to vibrate more than the molecules in the ceramic plate and paper towel; the vibrating molecules transfer heat more easily. The ceramic plate with the paper towel formed the best insulator, preventing the transfer of heat to the ice cube; this caused the ice cube to stay frozen longer.

Lab Investigation: Thermal Expansion and Contraction of a Gas

Conclusions

1. Describe your observations.

   Answers will vary. Observations should be written in clear, descriptive language. If the observations seem confusing, ask your student to elaborate.

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

   As the water heats, the bottle and the air (gas) in it are heated by conduction. The gas expands because of the increased movement of the molecules, causing the balloon to increase in size as it fills with air. When the bottle is allowed to cool, the air inside the bottle contracts, and the balloon deflates as the air molecules take up less volume.

Lab Investigation: Water Depth and Pressure

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?

   When the cans are filled to the same depth, the two streams of water will probably shoot out of the holes the same distance. This is because the water pressure for both cans is the same. Pressure depends on the depth of the water, not on the amount of water or the size of the container.

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?

When the cans have the same volume of water, the depth will be different because the cans are different sizes. Since the depth is different, the pressure is different. The smaller can will have a higher water pressure because it has the greatest depth, so the water should shoot farther from the smaller can.

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.

   It is the depth of water, not volume, that influences water pressure. No matter how large or small the volume of water—a swimming pool or an ocean—the pressure will be the same at any particular depth. This is because water pressure is determined by the weight of the water above pushing down. If you are swimming in the ocean, all of the water above you is pressing on your body. If you were to swim deeper, the pressure on your body would increase because there is more water above you.

Activities

This optional activity explores the concept of heat transfer.

Activity: Sensing Temperature

In this activity, the student is likely to observe that hands are not reliable indicators of temperature. When the hand is hot from the hot water, the molecules are moving quickly. The lukewarm water felt cold because the molecules were going so much slower. The molecules in the hand were moving quickly from the hot water, and when placed in the cooler water, they transferred heat rapidly into the water, cooling down the hand and slowing the molecules. The hand that had been in the cold water suddenly felt quite warm when put in the lukewarm water because there was an immediate increase in the speed of the molecules on the surface of the hand because of the energy transferred from the water. The hands are feeling the relative temperature, not the actual temperature.

Test

Answer the following questions using scientific terminology and concepts in your responses.

1. Explain what is happening, in terms of heat transfer, when you take an ice cube out of the freezer and let it melt.

   Heat always flows from something that is warmer to something that is cooler. The air in the room caused the temperature of the ice cube to increase and melted the ice cube. When the ice cube is fully melted, the water will eventually warm up to the air temperature and the two will achieve a state of thermal equilibrium.

2. What is thermal equilibrium? Give an example that shows how this happens.

   Thermal equilibrium is when two nearby objects reach the same temperature and no heat transfer is occurring. The example given in the coursebook is when someone who is cold snuggles up to someone who is warm; the warm person's heat will spread to the colder person, and the two will eventually become the same temperature.

3. Explain each of the three ways that heat energy can be transferred.

   Heat is transferred through conduction, convection, and radiation. Conduction heat is transferred through a direct point of contact with a heat source (and is most apparent in solids). Convection heat is transferred through the movement of fluids (gases and liquids). Radiation heat is transferred by electromagnetic waves that travel outward even in the absence of matter.

4. What is the difference between a heat conductor and an insulator? Give an example of material that is a good conductor and material that is a good insulator.

   A heat conductor is a material that transfers heat quickly and easily. Metals are good heat conductors. An insulator is a material that does not transfer heat easily, so it effectively slows or prevents the transfer of heat. Good insulation materials are wood and air.

5. Does insulation help keep your house warm or cool? Explain your answer.

   Both! Insulation slows or prevents the transfer of heat. This means that a warm house will stay warm when it is cold outside, and a cool house will stay cool when it is hot outside. Students may be tripped up by this tricky question; if their answer is only partially correct, point out that blocking the transfer of heat works both ways: if it is hot outside, the heat can't get in the house, and if it is warm inside, the heat can't get out of the house.

6. Why do things expand as the temperature increases and contract when the temperature decreases?

   Molecules take up more space (expand) as they gain kinetic energy, which is the energy of motion. This kinetic energy generates heat as the molecule vibrates or moves more quickly. The movement of molecules increases as the temperature increases. A decrease in temperature—a decrease in the movement of molecules—results in a contraction as the molecules become closer together and more dense.

7. Imagine you have two identical buckets of water. One is filled with liquid water and one is frozen solid into a block of ice. Which one would be heavier to carry? Why?

   The bucket of liquid water will be heavier because ice is less dense than water. That's why ice floats.

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
Explain methods of thermal transfer				
Differentiate between thermal conductors and insulators				
Explain molecular activity related to thermal expansion and contraction				
Identify unique properties of water related to thermal expansion and contraction				
Perform calculations to convert between temperature units (C and F)				