Discovering the Scientific Method

Teacher's Guide

EVERYDAY SCIENCE

Discovering the Scientific Method

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EVERYDAY SCIENCE
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Viewing Time: 20:15

PROGRAM SUMMARY

This program introduces students in grades 3 to 6 to the principles of science and scientific inquiry. The program will help students learn how knowledge of science can increase their understanding of and appreciation for their environment. The program demonstrates that science can be entertaining and stimulating. Teachers can use the principles covered in the program to extend to other common experiences or other subject matter in the curriculum.

PROGRAM GOALS

The materials in this program are designed to assist students in developing a fundamental knowledge of…

- The importance of the basic processes of scientific inquiry and discovery.
- Using creative and deductive thinking to explain common experiences.
- The variety of applications for scientific principles.
- The fundamentals of appropriate scientific methodology.
- An expanded base of scientific terms and concepts.
- The scientific principles behind some of their everyday experiences.

STUDENT OBJECTIVES

After viewing the complete program and participating in the related exercises and activities, students should be able to do the following:

1. Discuss the importance of scientific inquiry as it leads to scientific discovery and give examples of applications of scientific inquiry and discovery to everyday phenomena.

2. Demonstrate creative and deductive thinking in applying scientific concepts to everyday phenomena.
3. Apply the following scientific principles to everyday phenomena:
   - Density is mass divided by volume.
   - Density of a substance changes as a function of temperature.
   - Transformations of state are temperature dependent.
   - Prisms separate white light into component colors.
   - The colors of the spectrum are red, orange, yellow, green, blue, indigo, violet; these colors are all in white light.
   - Sound is produced by vibrations in a space; the size of that space determines the pitch of the sound.
   - Heat energy may be converted to mechanical energy.
   - Warm air rises; cool air falls.
4. Define the steps and significance of the scientific method:
   - Recognize a problem
   - Form a hypothesis
   - Design an experiment
   - Test the hypothesis by making observations
   - Draw a conclusion
5. Define and apply the following terms:

prism	vibration
volume	sound
work	pitch
energy	white light
mechanical energy	light spectrum
convection	density
transformation of state	Fahrenheit
freezing point	Centigrade / Celsius
boiling point	

6. Apply scientific principles to a variety of situations or problems.

SUGGESTED INSTRUCTIONAL PROCEDURE

Teacher Preparation

It is important for you to be aware that the video presentation is appropriate for all students in grades 3 to 6 while the discussion, activities, and quizzes presented in this guide and in the blackline masters should be carefully reviewed to determine their appropriateness for the grade level and ability of your students.

1. Preview the video, read the information in this guide, and carefully review the blackline masters. Select those masters which you will use and duplicate them as necessary. Some of the blackline masters are appropriate for pre or post tests. Make those choices now.

2. While the entire video may be run during one class session, three different subjects (color, density, and sound) are handled in separate scenes, so you may choose to break up the materials for presenting in different sessions. Decide which approach you wish to take.

3. Compare terminology and examples given in this program to that which may be included in your students' textbooks / workbooks so that your own terminology is consistent and different wordings can be explained to the students to enrich rather than confuse them. You may also wish to integrate material covered with other course material, such as mathematical problems (e.g. units and dimensional analysis, fractions). Blackline Master 9 provides students with some mathematical problems related to this program. These problems are probably suitable for 6th graders and some gifted 5th graders. Blackline Master 10 is suitable for students who have learned about areas and volumes. Blackline Master 4 can be used for grades 3 and up. For all problems, complete explanations of solutions are provided in this guide.

4. At the end of the video program, there is a five-minute interactive video instructional quiz. Here are some options for use of the quiz:
   - Have students reply verbally during the quiz (if you have a convenient pause control on the VCR).

- Have students number a sheet of notebook paper and record their answers to each question.
- Distribute Blackline Master 17, which is a reproduction of the video quiz, and have students fill in the answers during the quiz or after the quiz is viewed.
- Distribute Blackline Master 17 before viewing the video and use it as a pretest with instructions for students to answer what they can and then ask them to watch for the answers as they view the video. Students who have been given a pretest will view the video intently, seeking answers to questions posed.

Note: The video instructional quiz is NOT intended as an evaluation tool. Lesson quizzes and exercises are provided for evaluations.

Introducing the Video

Before the students view the video, we suggest the following:

1. Engage the students in discussion about phenomena encountered every day. Use students' experiences as starting points for discussion of scientific principles, applications of mathematics, and vocabulary building.

2. Share with students the objectives stated in this guide beginning on page 1.

3. Relate to your students that this program on "everyday science," the scientific explanations of everyday observations, is to make them aware of the scientific principles behind things they observe and to increase their respect for nature. Tell them you hope that learning about everyday science will encourage them to ask questions about things they don't understand and will help them understand some things they experience.

4. Distribute Blackline Master 1, which lists terms used in the video program and some which are not (such as homo- and heterogeneity). If it is consistent with your plans, advise students that they should

familiarize themselves with the terms presented as they will be tested on them (Blackline Master 2 is provided for that purpose).

5. For students in grades 3 or 4, you may want to provide Blackline Master 12 to stimulate them to think about the effect of temperature on changes between liquid and solid states.

6. Explain to students the following principles:

- The science classroom or laboratory is a place for making inquiries and finding answers to questions as safely as possible; however, simple (and safe) inquiry and experimentation is possible in many locations.
- Science involves making unpredicted observations or discoveries (and noting them) and trying to explain them.
- Science encourages curiosity and objective thinking.
- The laboratory or science room is a place to learn fundamental principles of science, but principles of science can be learned on field trips and by making observations in the home and many other places. Hands-on learning is important to scientific education. Science trains a student to think methodically.

Present the Video

The viewing time is 20 minutes, 15 seconds. Remember that if you plan to use the video quiz at the END of the video lesson, pause the video after the lesson portion and distribute the video quiz (Blackline Master 17), then collect the papers and run the video quiz with the answers.

Follow-Up Discussion and Activities

Following the video presentation, use these suggested discussion points and exercises:

1. State scientific principles and give examples of applications. Not all examples will be suitable for all students. Present those that you feel are the easiest for your students to understand.

a. Sunlight is white light; prisms separate white light into component colors (light of different wavelengths for some advanced students).

   i. Some fluorescent and incondescent lights have different wave lengths. Note that we hear warnings about exposure to some wavelengths of sunlight and some sunglasses are marked to show which parts of the sun's rays are screened out (filtered) by the glasses. (You may want to bring in a pair of sunglasses or contact an optician or ophthalmologist for information.) Green plants can be grown indoors with the help of light bulbs which contain the sun's spectrum of colors which plants need for health.

   ii. Light bulbs emit different combinations of colors, even if we perceive them as white light.

b. Density of a substance changes as a function of temperature. Review the fact that ice floats. Cover the material in Blackline Master 12 or use it as an exercise.

c. Temperature change can affect properties of materials, such as viscosity (resistance to flow). *Note: You may wish to avoid the word viscosity here until you demonstrate:*

   Exercise: Place oil in three temperature-resistant test tubes; put one vessel in a warm water bath, another in a refrigerator or in an ice bath, and leave the other at room temperature. After 15 minutes, the viscosity (resistance to flow) of the warmed and cooled oil will be changed: the cooled oil will be relatively hard to swirl and the warmed oil will be easy to swirl.

d. Transformations of state (liquid to solid; solid to liquid) are temperature dependent. (The following exercise presumes the availability of a laboratory thermometer.)

   Exercise: Place a (temperature resistant) vessel (Pyrex cup or test tube, for example) that contains oil and another that con-

tains water in a freezer. Be sure to mark or label the vessels. Depending on timing of classes, observe that the temperature of the water at the freezing point is higher than the freezing point of oil. Use a hot plate or a burner to heat two vessels (carefully), one with oil and one with water (small saucepans heated over a stove are fine if that is feasible). The boiling point (point where the liquid state changes to the gas state) is lower for water than for oil (an appropriate thermometer may be used to demonstrate this to students a few at a time). **Lesson:** Liquid hot (nearly boiling) oil is more likely to burn you severely than hot (nearly boiling or boiling) water because the nearly boiling oil is hotter.
Question: Would it take a longer or shorter time to cook a potato wedge / slice in boiling oil or boiling water?
Answer: Cooking the food with the boiling water which has a lower temperature than boiling oil will take longer.

e. Sound is made by making vibrations in a space; the amount of space contributes to determination of the sound, that is whether the notes are high or low relative to each other.

   i. Set up glasses or bottles or jars with different amounts of water and have students tap them with a spoon or other implement to get different sounds. See Blackline Master 12 for a class exercise.

   ii. Tune a ukulele or guitar demonstrating that the length of the string affects the sound. The placing of a finger on a fret of a string instrument affects the pitch. You might ask a music teacher to talk about pitch. A musician (student, parent, teacher) may be able to provide a demonstration.

f. Energy may be converted from one form to another – for example, heat energy may be converted to mechanical energy; electrical energy can be converted to heat (such as in the case of a hot plate).

g. Heat convection is the transfer or movement of heat. It can occur in liquids as well as in air or gas. Convection of gas is caused by the fact that warm air is less dense than cold air. The phrase "warm air rises" is more correctly stated: cool air falls, displacing warm air under it. The air moves and warmer material transfers heat by convection. In most liquids, warm liquid is less dense than colder liquid throughout the temperature range. Water is unusual: its highest density is a little above the freezing point, so ice will float to the top of a body of water, as explained in the video.

In the video, warm air causes a convection current to turn a party decoration. What happens when we heat water on a stove? The bottom of the pot conducts heat from a burner or hot surface to the lower layers of water. The heat causes the water to expand and become less dense than the cooler water above it. The denser water falls to the bottom and pushes the less dense warm water to the top. The warm water is displaced by the falling cool water. It is displaced by convection. Then what happens to the cooler water that has fallen to the bottom of the pan? *Answer: It is heated by conduction, and the process is repeated.*

2. Students should learn and understand the equation for density. Students who have mastered division and decimals should master the mathematical manipulations of the equation. Other students can understand the concept (without the math) in terms of weight for a given space of an object or substance.

density = mass / volume

What are the units of density if mass is given in grams and volume is given in liters? *(Answer: g/l)*
What are the units of density if mass is given in ounces and volume is given in quarts? *(Answer: oz./qt.)*

If, at room temperature (25 degrees centigrade) a substance weighing 15 grams has a density of 1.3 grams per milliliter, how much volume does it take up? *(Answer: density = weight/volume, so volume = weight/density. 15 g / 1.3 g/ml = 11.5 ml.)*

Is the substance denser or less dense than water? (Water has a density of 1.0 gram / ml at 25 degrees centigrade.) *(Answer: A substance with a density of 1.3 has a higher density than a substance (water) with a density of 1.0).* This may be an appropate time to discuss Fahrenheit and Centigrade or Celsius temperature scales, metric units, and other relevant subjects.

For students in grades 3 and 4, you might observe that a ping pong ball and a golf ball are similar in size and amount of space they take up, but the golf ball is much heavier. It has more weight for its volume and is therefore denser than the ping pong ball. For more advanced students, if a good scale or balance is available, weigh out identical volumes (in containers whose weight is known so that it can be subtracted from the weighed material of interest) of heavy cream, water, and oil. What is the order of density of the three substances? (Oil is the least dense and water the most dense.) You may wish to repeat this with vinegar and oil. (Oil is less dense than vinegar.) Then mix the oil and vinegar in a cruet or other vessel; the oil "floats." This is a classic example of everyday science.

3. Major general concerns for consequences of action and thinking ahead are behind laboratory safety rules. Reasons for those rules should be known and articulated whether working in a science class, a kitchen, or a workshop. Proper methodology is implicit in the video. Just as general safety rules have reasons (stop, look and listen before you cross the street), there are reasons for rules in the lab. Class discussion may address the following:

- Why was a tray put under the water glasses with ice cubes in the video?
- Why were safety matches used to light the candles?
- Why was the particular container used for freezing water and not just an ordinary glass?

Blackline Master 13 can be used as a homework exercise for 5th and 6th graders or to stimulate discussion in class for students in lower grades.

4. Possible hands-on activity: Sunlight is a mixture of different colors of light. The different colors can be separated by prisms into different component colors – the colors of the rainbow. The rainbow is often called the spectrum. The main colors (in order of their appearance from the outside in) are: Red, Orange, Yellow, Green, Blue, Indigo, and Violet.

You can remember the order of colors by remembering an acronym which forms a man's name. Each letter in the name stands for a color. The name is ROY G. BIV.

Select a place to work outside in sunlight or in front of a window through which there is a stream of sunlight. "Make a rainbow" by placing a container, such as a baking dish, in the sunlight, as shown in the diagram on Blackline Master 3. Fill it nearly full with clean water. Place a white card or piece of cardboard next to the container (between the light source and the container). Place a mirror in the water with the reflective surface reflecting the sunlight. The water meets the mirror in a curved surface which makes a prism. This prism separates the white sunlight into colors just as the glass prism does. You may have to adjust the angle of the mirror and the white card to "catch" the rainbow reflected on the white card. *Note: Try this before your demonstration to be sure the placement of objects is correct. Be aware that you will need to do this on a sunny day, and the shifting of the sun's position may drastically change your required setup.*

5. Possible hands-on activity: For teachers who thoroughly enjoy math and for 5th and 6th grade students or other gifted students ready for actual determination of relative densities of material: determine which material is denser, rocks or coins? If you or the students are uncomfortable with this material, this exercise could be skipped.

You may wish to demonstrate the following and / or have students follow directions for a slightly simpler experiment as shown on Blackline Master 4. The principles in the exercise below and the simpler one outlined on Blackline Master 4 are the same.

Materials: 5 rocks, each about the size of a coin
5 pennies
5 dimes

Select the rocks and coins for the experiment. Weigh separately the 5 rocks, the 5 pennies, and the 5 dimes. Record the weights. Fill a tall, thin, clear container or vessel of constant diameter, such as a large test tube or graduated cylinder or jar. Fill the vessel about halfway with water. Measure the height of the water in the vessel. Record the height of the water. Add the rocks to the vessel. Measure the difference in height resulting from the rocks displacing water; that is, take the difference of the height of the water level with the rocks and the height of the water level without the rocks. Repeat this exercise to determine the height of water DISPLACED by the 5 pennies and the 5 dimes. Place the three materials in order of increasing density.

Note the students do not need to empty the vessel for each addition of material. They may simply measure the amount of water displaced by adding the stones and then the pennies and then the dimes. That is, measure the height of water, add the required material, and determine the new height of water. The new height of the water minus the former height of the water is proportional to the volume of water displaced by the added material. Note: This exercise will be easier if you use a graduated cylinder with volumes marked on the surface. Then volumes may be read off directly and the changes in volumes easily calculated.

The key is to have the student realize a) that the density of water is 1.0 (1 g / ml) so that the weight displaced (in grams) = the volume displaced (in ml), and b) that the volume of water displaced is proportional to the height of water displaced, since vol = area x height. Therefore…

$$\text{density of rocks} = \frac{\text{weight of 5 rocks}}{\text{volume of water displaced by the rocks}} = \frac{\text{weight of 5 rocks}}{\text{area of vessel x height of water displaced by the rocks}}$$

This same formula applies for pennies and dimes.

Since the area is the same (or constant) in all three cases, the densities vary as the weight of solid / height of water displaced by solid varies.

Area Review: (Be sure this is grade appropriate before introducing this material.) The area of a rectangle is its length times its width; the formula is Area = l x w. The area of a circle is pi x r x r or pi x r^2 where pi is 3.14. The volume of a rectangular object is area x height, and the volume of a cylindrical object is area x height. For a rectangular object, the volume = l x w x h; for a cylindrical object, the volume = pi x r^2 x h.

6. We use the fact that coins have different properties (sizes, densities) in certain machines or mechanical devices in common use. Children of all ages are familiar with the concept although they probably haven't thought about it. Ask the students to give examples of different machines that make use of the different sizes and densities of coins. Answers might include:

pay telephones
automatic toll booths
vending machines for food, beverages
turnstiles in some transportation systems (train / bus stations)

7. Possible hands-on activity: Demonstrating how sound is created can be accomplished with a few marbles. Place 6 marbles in a row so they are touching each other. Each marble is a model for a particle or molecule of air. Flick a seventh marble so that it hits one end of the row of marbles. One at a time, each marble will hit the next one, and that one will hit the one after that. This way the marbles in succession pass energy along the line. When the last marble in the row receives the transmitted energy, it will roll away.

You can see vibrations with a tuning fork and a container of water. Tap the tuning fork so that it vibrates. Place the tines of the fork in the water. The vibrations of the tuning fork cause the water to shake.

For sophisticated students, some of whom have radio transmission or electronics as a hobby and who are familiar with the concept of waves and wavelengths, you may wish to explain that sound waves may be high or low in height and therefore loud or soft. Sound waves may be close together, with high frequency, or far apart with low frequency. You may want to comment that when we change a station on a radio, we are selecting a specific wavelength or frequency. Sound waves or vibrations with high frequency are high in pitch. Sound waves or vibrations with low frequency are low in pitch.

SUMMARY OF LESSON
POINTS TO BE NOTED AS EXERCISES/QUIZZES ARE RETURNED AND DISCUSSED

- Awareness of scientific principles should be a part of the life experience. Ability to apply knowledge to new situations is important to discovering new applications, efficient handling of available materials, and to understanding how things work. It also enriches our appreciation of our environment.

- Science fosters inquiry and seeking of answers to questions about nature and our environment. We use the scientific method to answer our questions.

BLACKLINE MASTERS/ANSWER KEY

- **Blackline Master 1, VOCABULARY,** is for student information and study. It contains words and phrases which are used in the video presentation and some which are not used.
- **Blackline Master 2 , VOCABULARY TEST,** assesses student comprehension of the words and phrases presented in the video and on Blackline Master 1.
- **Blackline Master 3, HOW TO MAKE A RAINBOW,** is an experiment.
  Answer: The diagram should show that on the white card, the spectrum is displayed with the red "line" on top and the violet "line" on the bottom, with orange, yellow, green, blue, and indigo in between
- **Blackline Master 4 i**s an experiment about density.
  Answers will depend on the cylindrical vessel used and the units of the coins. Teachers should try this with their own equipment so they know what to expect.
- **Blackline Master 5, WORD MATCH QUIZ**
  Answers:
  1. D
  2. E
  3. B
  4. C
  5. A
- **Blackline Master 6, QUIZ**
  Answers:
  1. a.The density of water is 1 gram per milliliter (not ounce)
  b.Warm (not cold) air rises. (You may also accept "Cold air falls.")
  c. The temperature of water under the ice in a frozen lake may be considerably warmer (not colder) than the air temperature. (The word

"typical" is important. It is possible to have a "February thaw," for example, when the air temperature is well above the freezing point and water does not instantly warm up.)

2. *The water carries the vibrations, not the air; the glass with the most water makes the lowest sound.*
3. *Count the "dings" you hear in one minute (or some fixed unit of time) using the different candles.*
4. *c*
5. *c*

   A discussion point: If one places an air-filled balloon in water, will it float? The answer is yes, because the air is less dense than the water. Note that the material in the balloon is a tiny fraction of the overall volume of the filled balloon. That is, the volume of the filled balloon contains a certain amount of weight contributed by air and the rest of the weight contributed by the material of which the balloon is made. Both the balloon material and air are less dense than water, so naturally an air-filled balloon will float on water.

- **Blackline Master 7, TRUE/FALSE TEST A**

  Answers:

1. T	*6. F*
2. T	*7. F*
3. T	*8. T*
4. F	*9. F*
5. F	*10. F*

- **Blackline Master 8, TRUE/FALSE TEST B**

  Answers:

1. F	*6. F*
2. T	*7. F*
3. F	*8. T*
4. T	*9. T*
5. F	*10. F*

- **Blackline Master 9, MATHEMATICS PROBLEMS RELATED TO EVERYDAY SCIENCE**

  Answers:

1. *density = weight/volume*
   density of new solution =

$$\frac{\text{(wt of sol. A in 2 ml of A)} + \text{(wt of sol. B in 1 ml B)}}{\text{1 ml of B + 2 ml of A}} =$$

$$\frac{2.6 + 1.8}{3.0} = \frac{4.4}{3.0} = 1.47 \text{ g/ml}$$

2a. 27 cm.

2b. 70.7 cm.

2c. The lowest sound is made by the pipe with the biggest space, or the second pipe.

3. *If you do not want the formula memorized, it can be reasoned out: We know the boiling point of water is 212 deg. F and 100 deg. C. We know the freezing point of water is 32 deg. F and 0 deg. C. Therefore, between freezing and boiling points of water, there is a difference of 180 degrees on the Fahrenheit scale and 100 degrees on the Centigrade scale.*

   $$\frac{\text{degrees F}}{\text{degrees C}} = \frac{180}{100} = 9/5\text{; however a correction is required}$$

   Since in one case the scale is from zero (freezing point of water) and in another it is 32, the correction required is 32; therefore:

   (deg F - 32) = (9/5) (deg.C)

   (Try it: Let deg F = 212; see if deg. C is 100 or vice versa)
   Answer: (9/5 (82) + 32 = 179.6 degrees Fahrenheit

4a. work = 987.0 ft x 0.007 lb = 6.909 foot-pounds
4b.6.909 foot-pounds x 1 joule/.738 foot-pounds = 9.362 joules, rounding off: 9.4 joules

- **Blackline Masters 10 through 15** are included for students from 3rd grade and up. They may be used for any grade level and do not demand advanced mathematics. The exercises are included to give students hands-on experiences in science that relate to principles mentioned in the video and to provide crossover or integrated training in Math, English, and Science.
- **Blackline Master 10, VOLUME AND DENSITY**
  Answers:
  Observations:

1. *rectangle or square (less likely, but possible, triangular; most students WILL NOT know how to compute the area of a triangle, so it is better to provide rectangular or square cartons.)*
2. *length x width*
3. *the measurement taken in the units usually used.*
4. *bigger*
5. *length x width x height*
6. *the observed volume delivered; be sure units are included in the answer.*
7. *the amount specified on the label; be sure units are include in the answer.*
8. *the observed volume delivered; be sure units are included in the answer.*
9. *Probably a little cream is left on the sides of the container and a little less is delivered than the volume printed on the carton.*

10.volume of milk + volume of cream.

11.Cream on top, milk on bottom. You might ask how much volume of each there was, especially if the volumes of the milk and cream added were originally very different.

Note: You may want to discuss interconversions of ounces and grams, etc. at this point.

12.The <u>homogenized</u> whole milk looks the same (unchanged) after standing.

- **Blackline Master 11, VOLUME AND DENSITY (extra questions)**

  Answers:

  1. *They do not mix. Or they separate. Or they form two layers. The cream is lower in density than milk and comes to the top.*
  2. *Something that is homogenized has been made homogenous–the same throughout. The process of homogenization makes the milk's contents a true mixture that does not separate into materials of higher and lower density.*

     Exercise: *A similar exercise may be repeated using vinegar and oil with an additional opportunity for measuring teaspoons or tablespoons into a cup measured in units of volume. It is possible to practice unit conversions in completing this exercise.*
  3. *Answers will vary.*

- **Blackline Master 12, CHANGES OF STATE**

  Answers:

  1. b 6. a
  2. b 7. a
  3. c 8. b
  4. d 9. d
  5. c 10. b

- **Blackline Master 13**

  Answers:

  Observations and Exercises:

  1. *(Teachers should try this ahead of time so they know what to expect.) It should be about the same. You may have to adjust the bottles by adding a little water to some to make the same baseline note as suggested on the Blackline Master.*
  2. *The bottle with the most water (least air space) makes the highest note; the bottle with the most air space makes the lowest note.*
  3. *Answers will vary*
  4. *Add three volumes of water.*
  5. *Add the volumes delivered into the bottles:*

     1 + 2 + 3 + 4 + 5 = 15 volumes

     15 x volume delivered each time = total volume. You may wish students to add oz. or ml. or multiply 15 x the volume delivered each time or do the calculation both ways to check themselves. You may also note *that it would be a good idea to have just a little extra water in the pitcher to allow for some water staying on the sides of the pitcher or the funnel and for spills and to obtain the "baseline note" for each bottle.*

6. *The more air space, the lower the note, or the less air space, the higher the note.*

- **Blackline Master 14 is an optional WORKSHEET** to help with the exercise on volume and density.
- **Blackline Master 15, CONSEQUENCES OF ACTIONS, PRACTICAL APPLICATIONS OF SCIENCE**

  Answers:

  Note: Different wording for answers is acceptable. The answers are appropriate but by no means literally expected. Think about each recommendation before providing the reason for the recommendation in the space below each question. One option is to provide students with discussion about the principles and then give them the Blackline Master as a quiz. The advantage of including this material is that it is a gentle way of reminding students to follow directions. There are reasons for suggested procedures!

  1. *…the liquid might evaporate.*
  2. *…the volume of the water when frozen, that is the ice, will be greater than the volume of the original water. Therefore, the freezing will produce a bigger volume and is likely to cause the glass to break.*
  3. *…the liquid vapor (change in state from liquid to gas) from a liquid that evaporates easily can reach the area of the flame and cause a fire.*
- **Blackline Master 16, QUESTIONS ON TERMINOLOGY USED IN DISCUSSION OF THE SCIENTIFIC METHOD**

  Answers:

  •<u>hypothesis:</u> An assumption or set of assumptions temporarily (or tentatively) accepted as a basis for reasoning or experimentation or investigation; a theory. The tentative theory or theories are set forth to be tested in the scientific method. Students may use words such as "possible explanation for an observation."

  •<u>conclusion:</u> The decision or deduction or conviction reached or arrived at as a result of investigation or experimentation or reasoning.

  •<u>experiment:</u> An action or operation or task designed to discover or determine or test or demonstrate a truth, fundamental principle or effect–especially when trying to confirm or disprove something that is uncertain or which is in doubt.

  •<u>observation:</u> The act of noting or noticing or seeing a thing or process or phenomenon. Scrutiny of a phenomenon or event. A record of examination of a thing or event or process. Note: An observation may be subject to verification or examination or further study or investigation.

Examples of words used in sentences or paragraphs:
•hypothesis: During an election campaign, one candidate was expected to win. There was an upset. The election results were explained by the hypothesis that poor weather resulted in very few votes being cast, and the candidate who had the best name recognition won.
•conclusion: A student's poor marks on many tests led his parents to the conclusion that the student was not studying enough.
•experiment: The athletic coach told the soccer players to experiment with the amount of food they ate in the meal before a game so they would learn how much food they needed for energy and how much they should eat to feel comfortable throughout the game.

- **Blackline Master 17, VIDEO QUIZ**
  Answers:
  1. *a*
  2. *c (The ice is "above the brim." The weight of ice displaces the equal weight of water, so the weight of the ice plus water in the second glass = the weight of water plus the weight of water that has been displaced by the ice = the weight of water that would fill the glass if ice were not included.)*
  3. *red, orange, yellow, green, blue, indigo, violet*
  4. *d*
  5. *b, d, c, e, a*

SCRIPT OF RECORDED NARRATION

MRS. WILLIAMSON: Hi! Hello, Tom. It's good to see both of you.
ROSA: Hi, Mrs. Williamson.
TOM: Hello.
MRS. W: Take your time. We'll have a productive visit and have some fun. Just look around you, and wherever you look there's Everyday Science. Bye, Bye.
ROSA: On the way here we saw a rainbow.
TOM: All those colors.
ROSA: It was beautiful. What's a rainbow, Mrs. Williamson?
MRS. W: I think rainbows are beautiful too. And you're right. You don't see rainbows often and they don't last long.
ROSA: What's a rainbow?
MRS. W: Rainbows are caused by the sun shining on drops of rain in the air. Sunlight is a combination of lots of different colors of light all together - the combination is called white light because it just looks bright.
ROSA: You mean all those colors are in sunlight but we can't see them without rain?
MRS. W: Well, rain helps. As sun shines through each droplet of water, the light is split into its separate colors. These colors are called the spectrum. Let's see if we can make another rainbow today.
ROSA: What is she going to do now?
MRS. W: There...do you see it?
ROSA: I never saw a rainbow before today and now I've seen two. How did you do that?
TOM: Let me hold the hose?
ROSA: So how did you make the rainbow happen?
MRS W: That's the first thing we'll talk about when we get inside. I'll turn the water off and meet you there. You'll find some juice on the dining room table.
MRS. W: We can <u>all</u> make a kind of rainbow inside, too, using a prism. A prism has flat angled sides. It's solid and transparent, which means you can see through it. This is a prism. A prism can separate the white light into the colors of the spectrum. The prism separates the light and forms a flat sheet of colors instead of a rainbow. Let's experiment and put the prism in sunlight and look at the white paper on the other side of the prism and see the split or separated colors on the paper. What do you think will happen if we take the prism away?
ROSA: We won't be able to see the colors.
TOM: I agree.
MRS. W: Let's try it.

TOM: Take the prism away…
ROSA: ...we're back to plain white light again.
MRS. W: Any conclusions?
TOM: That must mean that rain acts like a prism to bend the sunlight, and without a prism to bend the sunlight we can't see all the colors.
MRS. W: Good, Tom.
ROSA: Let's see the colors again.
MRS. W: These are the same colors we saw outside. What do you see?
ROSA: There's Red, Orange, Yellow, Green, Blue, Purple.
MRS. W: You were observant to hesitate Rosa because there's another color in there. In the spectrum of colors a prism makes, we call the second blue Indigo and the purple color is called Violet.
TOM: It's really beautiful!
MRS. W: A great way to remember the colors of the spectrum is an acronym that spells out the first letter of each color. In this case, a man's name.
TOM: ROY...Red, Orange, Yellow.
ROSA: G is for green and BIV is for Blue, Indigo and Violet.
MRS. W: ROY G. BIV. Excellent!
ROSA: I still don't understand why we don't we see a rainbow every time it rains?
TOM: Maybe if it's too cloudy there isn't enough sunlight to make a rainbow like we just saw.
ROSA: But the sun is there above the clouds, but we just don't see it.
MRS. W: Well you're both right. To see a natural rainbow conditions have to be just right. And there have to be water droplets in the air, too, even if we can't see them.
MRS. W: Speaking of water, I'd like a glass. You kids still thirsty?
ROSA: No, I'm fine.
TOM: No thanks.
MRS. W: Let's talk about my glass of water for a minute. If I put an ice cube in my glass of water, where do you think it will go…sink to the bottom, settle in the middle, or float to the top?
ROSA & TOM: The top!
ROSA: Its kind of <u>on</u> the water. Is that because ice is lighter than water?
TOM: Ice <u>is</u> water - just frozen water. How can water be lighter than water?
ROSA: Then why does the ice float?
MRS. W: An important question. Let's try something. Since the ice is above the water, you might think that as it melts, the level of the water will rise. Should we worry that if the ice melts, the liquid will overflow?

MRS. W: I'll tell you what. I'll add some more ice so the glass is really full. You know the expression, a watched pot never boils? Could it be that watched ice never melts? Why don't you watch it for a while and observe what happens while you finish your juice.
ROSA: I think it will overflow.
TOM: I think it will too, and it's going to get all over the table...maybe we should take some ice out so it doesn't overflow.
MRS. W: While we're waiting for the ice to melt, let me show you something. I put a tiny amount of water in this little Pyrex dish that can be frozen safely, and it's just beginning to freeze, kind of like a little pond in winter. The ice is strong enough to hold a little bit of weight, but if we put too much weight on the thin ice, the ice won't be strong enough to hold the penny and the penny sinks to the bottom, like a skater falling through thin ice. The penny goes to the bottom and pieces of ice float. So remember, when you're told, don't walk on the ice, it's too thin...you're the penny. Now should we try this again with the tooth pick?
ROSA: Let me try.
TOM: Did you ever put a toy wooden boat in the tub when you were little, or row in a rowboat made of wood? See, wood floats on water. So, even if the toothpick started out on the ice and somehow the ice broke, it would still be OK because wood loats on water.
MRS. W: That's it. The wood is less dense than the water, so it floats. And we'll see what that means in a minute. Now, let's see what's happening to our melting ice in the glass of water. What do you observe?
ROSA: Most of the ice has melted, but the level or height of the water hasn't changed.
MRS. W: When we put ice into water, the ice pushes water out of the way. That's called displacing the water.
TOM: That makes sense, because you can't have two things in the same space at the same time.
MRS. W: Actually, the weight of the displaced water is exactly equal to the weight of the ice, but the volume of the ice - that's the space the ice takes up, is BIGGER than the volume of the melted ice, water.
TOM: So, the amount of space a certain weight of ice takes up is bigger than the space of the same weight of water.
MRS. W: Right. So if the ice fits in the glass, and the volume of water the ice yields when it melts is less than the volume of the ice...
ROSA: So...the glass won't overflow.
MRS. W: Good conclusion, Rosa. Remember, density of a material is its weight per unit volume.
MRS. W: Next, we're going to talk about using heat to run things - or in scientific language, changing heat into mechanical energy.

TOM: I don't understand your scientific language.
ROSA: I think she's saying "using heat to run things."
MRS. W: This is a simple decoration for special occasions, and it runs by using heat. We use heat energy to make it move.
ROSA: I've seen one of these before, but I never thought about how it works.
MRS. W: Here we have four candles which, when lit, heat the air around them. When the air is heated, it drives the particles in the air - the air molecules - apart and expands the air a little bit. So the bits of air take up more space when they are heated. The expanded air has a lower density - ahh, there's that word density again. The expanded air has a lower weight for a given volume – or if you want to, you can think of it the other way around...for a given weight the heated air takes up more space, or volume, than the unheated air. The air particles move faster and faster and rise up in the bits of air that is heated. You may have heard the expression "Warm Air Rises." The rising of warm air is called convection.
TOM: Oh, I've heard that word before. My neighbor has a convection oven. Is that the same word?
MRS. W: Not only is it the same word, Tom, it's the same idea. The rising of warm air – here or in a convection oven – is called a convection current, because the currents convey, or move, heat from one place to another. The currents are the movements of bits of air as they go upward from where they are warmed. The moving, heated air pushes against the paddles of the fan.
TOM: These? I like this.
MRS. W: Yes. The paddles are slanted to catch the moving air at the bent parts which makes them rotate.
ROSA: This is neat! The paddle fans turn, and that make the angels mounted on them turn.
MRS. W: The heat makes the air move and the moving air makes the angels turn.
TOM: Like this other one set up with the rods hits these little bells.
ROSA: Angel bells, kind of like a ringing machine made by heat.
MRS. W: Have you ever noticed how some bells make a high sound and some make a low sound? Why?
TOM: Don't know.
ROSA: Me neither.
MRS. W: OK, then. Let's try an experiment. Why don't you turn around, so you can't see me filling the bottle. Then I'll start to fill the bottle, and you turn around when you think it's almost full and see if you're right. You ready?
ROSA & TOM: It's full.
TOM: Gosh! I've heard the sound before, but I never thought about what the it meant.

ROSA: So, when the air space is smaller the sound gets higher. I never questioned things like that.
MRS. W: Actually, I think you ask good questions and questioning is how we learn. Hundreds of years ago, some scientists came up with a method to answer questions and try to solve problems. It's called the "scientific method." The first step is to recognize a question or problem that exists in the world around us, as we've been doing today. Next, we guess or predict the answer. This is called making a hypothesis. Then, we set up experiments to test our predictions.
TOM: You mean our hypothesis?
MRS. W: Right. As we conduct our experiments we observe what's going on and very often record the results. Finally, we draw conclusions about our hypothesis to answer our questions.
ROSA: So we've been using the scientific method all day.
MRS W: Using what we've found out with the scientific method from our experiment with the bottle, we know that the smaller the air space, the higher the sound. We can also make music by filling glasses or bottles and tapping the glasses or bottles to make a sound. In this case, the vibrations go through more or less water. And we have less water, higher sound. More water, lower sound.
ROSA: So the amount of liquid in the bottle or glass will change the sound.
MRS. W: Exactly. We can change the sound by changing the amount of water. We can also make music by blowing over bottles with different amounts of water in them. In this case, we're forcing air into more or less air space. Try it.
ROSA: Less water, lower sound.
TOM: More water, higher sound.
MRS. W: Let's go into the other room, and we can talk about musical instruments – not just glasses and bottles just sounding different as they fill up. All musical instruments work by making vibrations.
ROSA: Like the bottles and the glasses.
MRS. W: You bet. Here is a picture of a group of saxophones: soprano, alto, tenor, and baritone saxophones.
ROSA: Like a band instrument.
TOM: It IS a band instrument.
MRS. W: You're right. Different saxes sound different from each other. That's why a certain piece of music is played with one and sometimes other ones are played. The bigger the sax...
TOM: …the lower the sound.
MRS. W: And the smaller the sax...
TOM: …the higher the sound.

MRS. W: You've got it. Remember the larger the air space inside the instrument, the lower the sounds they make. When musicians blow into a pipe, the pipes make a sound when the air inside the pipe moves or vibrates.
ROSA: So if an instrument is made from a long, long pipe, it will play low notes.
TOM: But if it's really long, it would take up too much room. That's probably why this one makes all these loops and bends. Look Rosa...
ROSA: Hmmm. And the loops and bends make the pipe bigger and longer.
MRS. W: Good. Some instruments are made from brass metal pipes; for example, trumpets and trombones. That's why they're called brass instruments. They work by the skilled players forcing air into more or less space. Trombones have a sliding section of pipe that changes the length of the path that the air goes through to make different notes. Other instruments, like this clarinet or flute, have valves that change the amount of space inside the pipe to make different notes. Both this clarinet and flute are called woodwinds because their tubes were originally made out of wood. As you can see, the clarinet is still made of wood and the flute is made of metal, just like the saxes in the picture we were looking at before. The woodwinds have holes along them which can be covered with your fingers or with pads to close the holes, so the amount of space inside the tube changes.
ROSA: And the notes change.
MRS. W: This recorder, which is made of plastic, is also called a woodwind because it works the same way and also because originally recorders were made of wood, too.
ROSA: It was fun.
TOM: It was a blast!
MRS. W: I had a good time. Thanks for coming. I hope I see you again soon.

Video Quiz

Question 1. As a jug or container is filled, there is a sound something like a swish. As the container fills, the sound gets…
a. higher, b. lower, c. the sound stays the same.
The correct answer is a. As the container fills, there is less air in the container. The bigger the air space, the lower the sound; the smaller the air space, the higher the sound.
Question 2. One glass is filled to the brim with water. A second glass has two ice cubes in it and is then filled to the brim with water. Which statement is true?

a. The glass filled only with the water weighs more than the glass with the ice, b. The glass filled with the water weighs less than the glass with the ice, c. Both glasses weigh the same amount.
The correct answer is c. It does not have as much water as the glass with only water, but the ice weighs a certain amount that is exactly equal to the WEIGHT of the water it would displace even though the VOLUME of the ice for that weight is greater than the volume of water displaced. That is why the ice floats.
Question 3. What colors are found in the rainbow? Name as many as you can in the next ten seconds.
The answer is Red, Orange, Yellow, Green, Blue, Indigo and Violet. You can remember them by the acronym: the man's name ROY G. BIV.
Question 4. We used lit candles to make a party decoration turn in order to demonstrate conversion of heat to mechanical energy. The <u>process</u> by which the heat energy was transferred is called a. reflection, b. density, c. mixing, d. convection, or e. boiling. The correct answer is d., convection. Convection is movement - in this case, movement of warm air from a warmer area to a cooler one.
a. is wrong. Reflection means bending back or returning as in the production of an image on a mirror which is a reflecting surface.
b. is wrong. Density means weight per unit volume.
c. is wrong. Mixing is combining or blending into one. In cooking we use a mixer to mix ingredients. Cement mixers mix all the components that go into making what we call cement.
e. is wrong. Boiling is the conversion from a liquid state to a gas, and the temperature at which this occurs is called the boiling point.
Question 5. To learn the explanation for the way things are, a scientist may go through certain steps called the Scientific Method. Place the steps in the correct order:
a. draw a conclusion, b. recognize a problem, c. design an experiment, d. form a hypothesis, e. test the hypothesis by making observations.
The correct order of the steps is b, d, c, e, a. First we recognize a problem. Then we form a hypothesis, design an experiment to test the hypothesis, make observations that will either support the hypothesis or not, and finally we would draw a conclusion.

MRS. W: These are just a few questions about why things we observe every day are the way they are. When you find yourself asking other questions, use the scientific method to help you find the answers.

Just look around you, and everywhere you look, there's Everyday Science.

Everyday Science

Discovering the Scientific Method

Blackline Masters

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VOCABULARY

Words and Phrases	Definitions
prism	Transparent solid with flat, angled sides that disperse light by bending light of different colors by different amounts.
volume	Amount of 3-dimensional space taken up. volume = area x height = length x width x height (for a rectangular object) = area of circle x height (for a cylindrical object)
work	Moving of something; amount of work done = force x distance
energy	Ability to do work. When energy moves things it is the same as work and is called kinetic energy. When there is energy in something before the thing begins to move, the energy is called potential energy. Energy has units of work (foot-lbs, ergs, joules, calories).
mechanical energy	Energy (or work) that makes things operate; for example, machinery, working arm or leg muscles, a rolling wagon.
convection	Movement (general definition); swirling movement that occurs because of differences in temperature or density between one place and another within a space. (As air is heated, it expands and becomes less dense. As warm air rises, heat is transferred.)
transformation of state	Change of characteristics or properties of a substance that goes from solid to liquid, liquid to solid, liquid to gas, or gas to liquid; for example, the changing of water from water in the solid state, ice, to water in the liquid state, or from liquid water to water in the gas state, steam, as temperature increases.
freezing point	The temperature at which a substance goes from the liquid state to the solid state. The freezing point of water is the temperature at which liquid water turns to ice.
boiling point	The temperature at which a substance goes from the liquid state to the gas state. The boiling point of water is the temperature at which liquid water changes to the gas state, steam or water vapor.
vibration	Shaking back and forth (while going the same amount backward and forward).
sound	Vibrations in a space that can be heard. Particles of air bump into each other. The bumped particles get squashed and then recover or expand again. The squashing and expanding causes other nearby air particles to vibrate. A vibration passing from one molecule to another is called a sound wave.
pitch	High or low sound of a note.
white light	Combination of all the colors.
light spectrum	Colors of the rainbow.
density	Weight per unit of volume. The density of water is 1 gram/ml at 25 degrees Centigrade.
Fahrenheit	A particular temperature scale that is commonly used in the United States. Most countries and scientists in this country use the Centigrade or Celsius scale. On the Fahrenheit scale, water boils at 212 degrees and freezes at 32 degrees.
Centigrage or Celsius	A particular temperature scale. In the Centigrade or Celsius scale, water freezes at 0 degrees and boils at 100 degrees.

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VOCABULARY TEST

Words and Phrases	Fill In The Definition
prism	
volume	
work	
energy	
mechanical energy	
convection	
transformation of state	
freezing point	
boiling point	
vibration	
sound	
pitch	
white light	
light spectrum	
density	
Fahrenheit	
Centigrade or Celsius	

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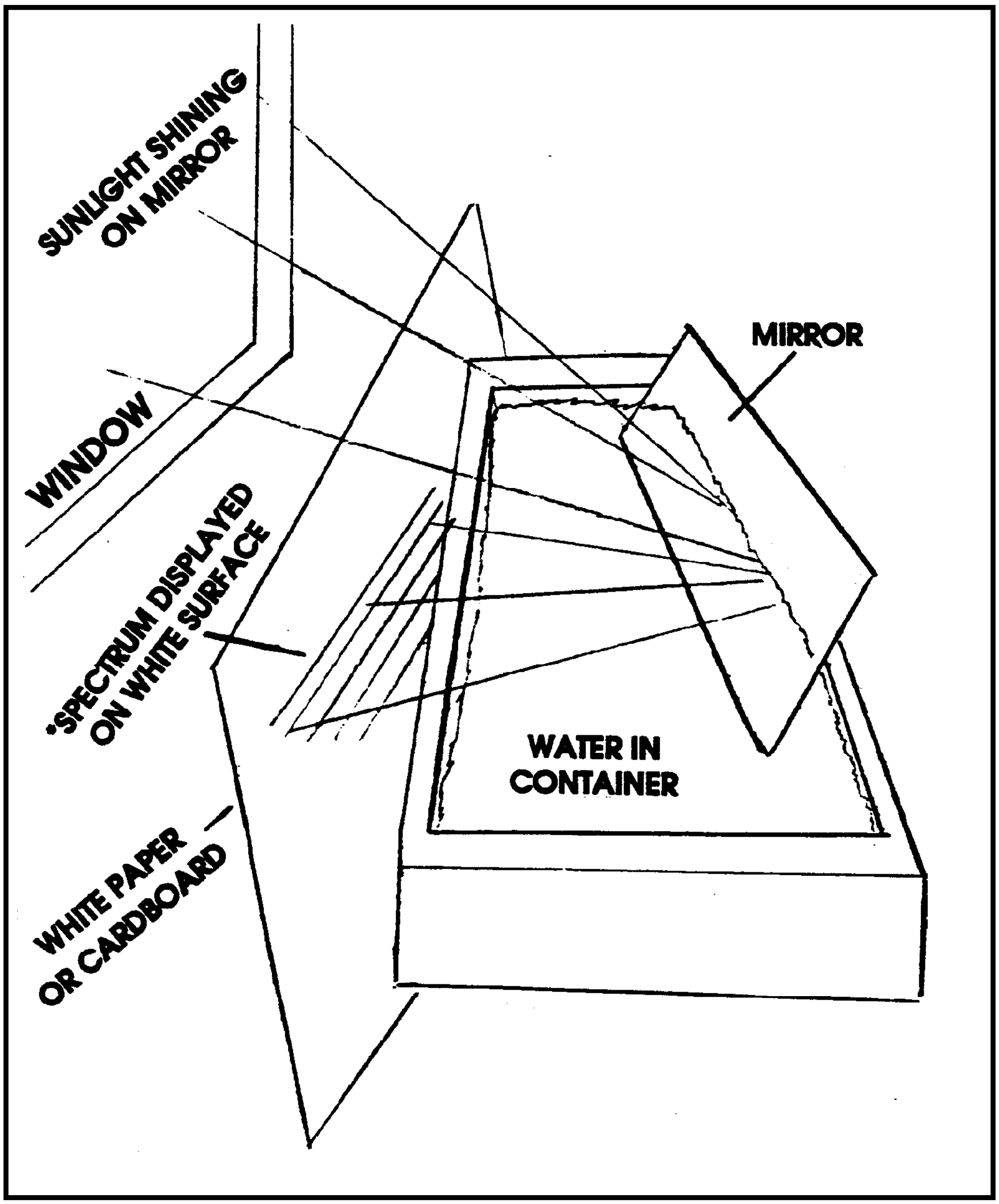
HOW TO MAKE A RAINBOW

Materials Needed:
- container for water
- clean, clear water
- mirror
- sunlight (outdoors or a window)
- white paper or white cardboard

Diagram: Color the spectrum* in the following diagram to show what you expect the rainbow to look like if the display in the diagram is set up correctly. Use colored pencils or crayons.



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EXERCISE

Dimes may be worth more, but are they more or less dense than nickels?

What you will need to work with:

✓A narrow jar or other clear container that has a constant diameter (does not get narrower or wider) that is at least 5 times as tall as it is in diameter. A large test tube or laboratory cylinder would do.
✓Water in a pitcher or bottle from which you can pour easily
✓A small scale
✓20 nickels
✓20 dimes
✓A ruler
✓A marker (felt tip or wax pencil)

✐ Fill the container (test tube or cylinder) half full of water and make a (removable) mark on the outside of the container (with a felt marker or wax pencil).

✐ Weigh 20 nickels. Weigh 20 dimes. Record the weights.

✐ Starting with water in the container (filled up to the mark), carefully add 20 nickels. Measure the height of the water now that the nickels have been added. Record the observation.

✐ Empty the container.

✐ Fill the container with water up to the mark again. Add 20 dimes. Measure the height of the water now that the dimes have been added. Record the observation.

✐ Which type of coin is highest in density? Record your answers below.

1. weight of 20 nickels:_________ weight of 20 dimes:________

2. height of water in vessel before coins are added.:_____

3. height of water in vessel after 20 nickels are added:______

4. height of water in vessel after 20 dimes are added:________

5. height of water DISPLACED by 20 nickels:_______________

6. height of water DISPLACED by 20 dimes:_______________

Assume: height of water is proportional to volume of water, so density of water displaced is proportional to height of water displaced.

7. $\frac{\text{weight of nickels}}{\text{height of water displaced by nickels}}$ = _______________

8. $\frac{\text{weight of dimes}}{\text{height of water displaced by dimes}}$ = _______________

9. The coin that has more weight per height of water displaced is the denser. The denser coin is ______________.

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WORD MATCH QUIZ

Directions: Match the word on the left with the correct definition on the right.

		WORD		DEFINITION
_____	1.	density	A.	movement
_____	2.	volume	B.	combination of all the colors
_____	3.	white light	C.	vibrations that make a sound high or low
_____	4.	pitch	D.	mass/unit of volume
_____	5.	convection	E.	amount of space taken up

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QUIZ

1. Correct the wrong word or words in the following sentences or add words to correct the statements:

   a. The density of water is 1 gram per ounce.

   ____

   b. Cold air rises.

   ____

   c. The temperature of water under the ice in a frozen lake on a typical winter day may be considerably colder than the air temperature.

   ____

2. A large glass holds about 1/4 quart or 1/4 liter of water. An identical glass contains 1/8 quart or 1/8 liter of water. When tapped with a metal spoon, which glass will make a lower tone? ______________________________

3. You have two identical decorations (with candles and angels) of the sort shown in the video; lit candles cause the turning of the figures supported by the device. You are trying out different brands (sizes, colors, styles) of candles you may want to use for a party. You find one brand of candles seems to burn faster than the other. Other than watching the figures turn and trying to keep track of which figure was which, how could you tell if the faster burning candles made the figures turn faster than the slower-burning candles?

   ____
   ____

4. In the decoration shown in the video, the candles are placed symmetrically around the base. Why? (Circle the correct answer.)

   a. It is easier to make the decoration that way.
   b. It is safer to have a symmetrical placement. It would be dangerous to light all the candles on one side.
   c. The convection currents will be symmetrical (unless there are possible drafts), and the paddle fans will turn more evenly.

5. Circle the correct answer.

   Balloons filled with air can be batted around easily. Balloons filled with helium will rise, if we let go of them. Circle the correct choice to complete the sentence: This is possible because

   a. the balloons are made of different material.
   b. the density of helium is greater than the density of air.
   c. the density of helium is less than the density of air.

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TRUE/FALSE Everyday Science TEST A

Directions: This test will measure your understanding of the scientific principles presented in the video. The statements below may or may not be correct. Read each statement. If it is correct, write the word True in the space provided to the left of the statement. If the statement is false, write False in the space provided.

________ 1. Warm air rises.

________2. When you fill a bottle with water, the sound made as the bottle becomes fuller gets higher.

________3. Heating a space can cause a convection current, which is the movement of warmer air to a part of the space with cooler air.

________4. When a penny is placed in a glass of water, and the water is stirred fast, the penny may rise to the top of the water.

________5. Mixing any two colors together makes white light.

________6. The density of frozen water or ice is higher than the density of liquid water.

________7. A brass instrument with a very long pipe with many bends in it is measured. The straight line between the end of the instrument and the tip of the mouth piece is 5 cm less than an instrument of the same diameter but with no bends. The instrument with the many bends will have a higher pitch than the instrument that is 5 cm shorter as measured.

________8. Heat energy can be changed to mechanical energy.

________9. Three of the colors found in the rainbow are green, red, and white.

________10. All materials in the liquid state have a lower density than when they are in the solid state.

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TRUE/FALSE Everyday Science TEST B

Directions: This test will measure your understanding of the scientific principles presented in the video. The statements below may or may not be correct. Read each statement. If it is correct, write the word True in the space provided to the left of the statement. If the statement is false, write False in the space provided.

________1. Three of the colors found in the rainbow are green, red, and white.

________2. Warm air rises.

________3. All materials in the liquid state have a lower density than when they are in the solid state.

________4. Heating a space can cause a convection current, which is the movement of warmer air to a part of the space with cooler air.

________5. Mixing any two colors together makes white light.

________6. When a penny is placed in a glass of water, and the water is stirred fast, the penny may rise to the top of the water.

________7. The density of frozen water or ice is higher than the density of liquid water.

________8. When you fill a bottle with water, the sound made as the bottle becomes fuller gets higher.

________9. Heat energy can be changed to mechanical energy.

________10. A brass instrument with a very long pipe with many bends in it is measured. The straight line between the end of the instrument and the tip of the mouth piece is 5 cm less than an instrument of the same diameter but with no bends. The in strument with the many bends will have a higher pitch than the instrument that is 5 cm shorter as measured.

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MATHEMATICS PROBLEMS RELATED TO EVERYDAY SCIENCE

1. One solution, solution A has a density of 1.3 grams/ml. A second solution, solution B has a density of 1.8 grams/ml. The two solutions can be mixed completely with each other; that is, they form a true mixture.

If we add 1.0 ml of solution B to 2.0 ml of solution A, what will be the density of the new solution?

2a. One pipe is 24 cm long and has an inside diameter of 1.2 cm.
The volume of the pipe is ___________ cm.

2b. A second pipe is 10 cm long and has an inside diameter of 3 cm.
The volume of the second pipe is _________ cm.

2c. If we support these pipes on a string and tap them with a spoon, which pipe will make the lowest sound?____

3. The temperature of a solution is 82 degrees Centigrade. What is the temperature in degrees Fahrenheit?

4. A penny falls from a window on the top floor of a very tall building. How much work is done on the penny as it falls to the earth? The weight of the penny is 0.007 pounds. The distance the penny drops is 987.0 feet.

a. What is the work done on the penny in foot-lbs?

b. What is the work done on the penny in joules? Note a joule = 0.738 foot-lbs.

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VOLUME and DENSITY

PURPOSE: To determine volumes and densities of common substances.

MATERIALS:
1. A measuring cup that can hold the contents of a carton of milk
2. A small carton of skim milk (an individual serving)
3. A carton or container of heavy cream or whipping cream (containing less liquid than the carton of milk)
4. A large measuring cup that can hold the contents of a small carton of milk plus the small carton or container of heavy cream
5. A small carton (the same size as the carton of skim milk) of whole, homogenized milk

PROCEDURE:
1. Determine the shape of the base of the skim milk carton.
2. Measure each side of the base of the carton.
3. Measure the height of the carton up to the level of skim milk in the full carton.
4. Read the volume (amount) contained in the carton; the volume is printed on the carton.
5. Open the carton and pour the contents of the skim milk carton into a measuring cup.
6. Read the volume (amount) contained in the carton of cream.
7. Open the carton of cream and pour the contents into the large measuring cup.
8. Read the volume (amount) of cream delivered into the large measuring cup.
9. Add the skim milk, the contents of the small measuring cup, to the cream in the large measuring cup.
10. Read the total volume of the skim milk and cream mixture in the large measuring cup.
11. Let the skim milk and cream mixture stand overnight, covered with plastic wrap (in a refrigerator if possible).
12. Observe how the skim milk and cream look the following day.
13. Open the carton of homogenized whole milk and pour its contents into a measuring cup. Let it sit (covered with plastic wrap) overnight.
14. Observe how the whole milk looks the following day.

OBSERVATIONS:
1. The shape of the base of the carton is _______________
2. How would you determine the area of the base of the carton? ______________________________
3. The height of the carton up to the level of skim milk is ______ .
4. Put an X in the correct space to complete the sentence: The outside dimensions of the carton are ___ bigger ___ smaller than the inside dimensions of the carton.
5. What is the measured volume of the container as determined by the outside measurements? ______________________
6. The measured volume of skim milk delivered into the small measuring cup is __________________.
7. The volume (amount) contained in the carton of skim milk according to the label is ___________.
8. The volume of cream delivered into the large measuring cup is_______________.
9. Is the amount of cream delivered the same as what is printed on the carton? _____
10. The total volume of the skim milk and cream mixture in the large measuring cup is _________.
11. How does the combination of skim milk and cream look after sitting overnight? ____
12. How does the whole milk look after sitting overnight? ____

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VOLUME and DENSITY

EXTRA QUESTIONS about density and solutions:

1. Why do the skim milk and cream look the way they do after sitting overnight?

____

____

____

____

2. What does the word homogenized mean?

____

____

3. The word that means the opposite of homogenous is heterogenous. Use the word heterogenous in a sentence.

____

____

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CHANGES OF STATE

When a substances changes from a liquid to a solid or a gas to a liquid, that is called a change of state. Match the types of change in state in the right column with the list of things that occur in everyday life in the left column.

Occurrence	**Type of Change in State**
1. ___ gelatin gelling (making Jello)	a. solid to liquid
2. ___ water in an ice cube tray turning to ice	b. liquid to solid
3. ___ nail polish remover evaporating	c. liquid to gas
4. ___ water droplets forming on the inside of a cold window	d. gas to liquid
5. ___ boiling water in a pan for a long time until the water level drops a lot	
6. ___ butter melting in a pan	
7. ___ ice cream melting	
8. ___ pancake batter cooking	
9. ___ a bathroom mirror fogging up when someone takes a hot bath or shower	
10. ___ fat from cooking of meat forming a greasy glob on a cold plate or pan	

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PURPOSE: To observe the difference air space makes in a note produced by blowing over a bottle, determine volumes and compare densities of common substances.

MATERIALS:

1. 5 empty identical bottles with a small mouth such as a pop bottle. Each bottle should be able to contain 6 - 8 oz. or 75 - 250 ml. Each bottle should be marked with a number on the bottom with a piece of tape or a marker, so that it cannot be seen when the bottle is standing on its bottom.
2. A pitcher containing about 1 quart or 1 liter of water
3. A funnel
4. A small measuring cup that can measure water in 1 oz or 50 ml amounts

You may keep track of your observations by using a worksheet.

PROCEDURE:

1. a. Blow over each of the empty bottles to make a note sound.
   b. If the empty bottles do not all sound alike add water to the bottles so that they do make the same note. This is your corrected baseline note before adding any more water.
2. Measure out one volume (a convenient amount for which an identical duplicate measurement can be made, for example 1 oz. or 50 ml.)
3. Using the funnel, pour the volume of water into the first bottle. Blow a note and compare it to the sound made with an empty bottle.
4. Pour one volume of water into the second bottle and into all the other bottles. Blow a note with each bottle and compare the notes to each other.
5. Add one more volume of water to the second bottle.
6. Add two more volumes of water to the third bottle.
7. Add three more volumes of water to the fourth bottle.
8. Add four more volumes of water to the fifth bottle.

OBSERVATIONS and EXERCISES:

1. Is the note made the same for each empty bottle? ______________________
   If not, how did you correct the situation so the note for each bottle is the same?
   ____
2. Which filled bottle makes the highest note and which bottle makes the lowest note?
   ____
3. Shut your eyes. Have someone scramble the order of the bottles. Can you guess in which order the bottles should go if the person who scrambles the bottles blows a note using each bottle? Check your conclusions by picking up each bottle, straight up above your eye level and looking at the number on the bottom of each bottle (being careful not to spill the water).
4. How could you match – at least approximately – the notes produced by bottle number one (with one volume of water) and bottle number 4 (with 4 volumes of water)
   ____
5. If you were going to repeat this experiment, what is the least amount of water would you need in the pitcher of water to be sure you had enough for the exercise? ____________________________
6. Finish the sentence: The reason for the different sounds of notes produced by different amounts of water in the bottles is:____

Name ________________________________

WORKSHEET to help with the exercise on volume and density

1. Empty bottles

	Any water needed to adjust the sound to the same baseline note?
1	____________________________
2	____________________________
3	____________________________
4	____________________________
5	____________________________

Total amount of water added if necessary _________________

2.

Bottle	Volume of water added	Sound Made (rank the sound from the lowest note, 1, to the highest note, 5)
1	____________	_______________
2	____________	_______________
3	____________	_______________
4	____________	_______________
5	____________	_______________

Total volume of water added to bottles including any water used to adjust the bottles to sound the same if necessary:

____________ (don't forget units)

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CONSEQUENCES OF ACTIONS
PRACTICAL APPLICATIONS OF SCIENCE

Think about each recommendation before providing the reason for the recommendation in the space below each question.

1. Bottles and jars containing liquids to be stored for a long time at room temperature should be tightly covered. Otherwise you might be surprised by the amount remaining in a container. The reason is...

____

____

____

____

2. Don't freeze water in a tightly sealed glass container, even if the container is one that can be frozen safely. The reason is...

____

____

____

____

3. Some liquids are labeled "flammable" because they can easily catch fire. Do not use or pour these liquids if there is a flame nearby. The reason is...

____

____

____

____

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QUESTIONS ON TERMINOLOGY USED IN DISCUSSION OF THE SCIENTIFIC METHOD

Directions: Define the words in the first table below, and in the second table use the words in a sentence or short paragraph.

WORD	DEFINITION
hypothesis	
conclusion	
experiment	
observation	

WORD	EXAMPLE OF USE IN SENTENCE OR SHORT PARAGRAPH
hypothesis	
conclusion	
experiment	
observation	

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VIDEO QUIZ

1. As a jug or bottle is emptied, there is a sound something like glug, glug, glug. As the container empties, the sound...

   a. gets higher
   b. gets lower
   c. stays the same

2. One glass is filled to the brim with water. A second glass has two ice cubes placed in it and is then filled to the brim with water. Which of the following statements is true?

   a. The glass filled only with the water weighs more than the glass with the ice.
   b. The glass filled only with the water weighs less than the glass with the ice.
   c. Both glasses weigh the same amount.

3. What colors are found in the rainbow? Name as many as you can in the next ten seconds.

   ____

   ____

4. We used lit candles to make a party decoration turn in order to demonstrate conversion of heat to mechanical energy. The process by which the heat energy was transferred is called...

   a. reflection
   b. density
   c. mixing
   d. convection
   e. boiling

5. To learn why things are the way the are, a scientist goes through certain steps. Put the steps in the correct order.

   a. draw a conclusion
   b. recognize a problem
   c. design an experiment
   d. form a hypothesis
   e. test the hypothesis by making observations

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