The NASA SCI Files™

The Case of the Great Space Exploration

Segment 1

Excited about the new vision for space exploration, the tree house detectives want to learn about manned (crewed) and unmanned (uncrewed) missions. With hundreds of exciting careers to choose from in the space industry, the detectives decide to investigate a few as they learn the mission requirements of the next generation of explorers who will go back to the Moon, on to Mars, and beyond. The detectives visit Dr. Carol Stoker at NASA Ames Research Center in California. Dr. Stoker discusses the importance of robotic missions in space exploration and explains the role of the *Phoenix* Lander, the next lander scheduled to go to Mars in search of water ice and possible evidence of previous life. As the detectives continue their investigations, they join Dr. D at the Virginia Air and Space Museum in Hampton, Virginia where they learn about some truly "strange matter."

Objectives

Students will

- identify the characteristics of a living thing
- demonstrate how robotic technology can be used to collect data
- construct a simulated robotic hand
- learn about the power of solar radiation
- explain the importance of water to life
- demonstrate the presence of microbial life
- understand how technology can be used to solve problems
- demonstrate how magnets can be used to move liquid

Vocabulary

aerogel – an extremely lightweight, strong material that is 99% air

dormant – inactive

ferrofluid – a liquid that contains tiny particles of suspended magnetic solids

lander – a spacecraft designed to land on a planet and collect data from one location; does not have the capability to move from one location to another

manned mission – exploration in space that includes human beings; also known as a crewed mission

microbes – tiny organisms too small to be seen with the unaided eye

organic – containing carbon; produced by animal or plant activities

subsurface – below the top layer

unmanned mission – exploration to space that uses robotic technology in place of human beings; also known as uncrewed mission

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Before viewing Segment 1 of *The Case of the Great Space Exploration*, read the program overview to the students. List and discuss questions and preconceptions that students may have about space flight, the importance of exploration, and the difference between manned and unmanned space flights.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. To locate the following tools on the NASA SCI Files™ web site, select **Educators** from the menu bar, click on **Tools**, and then select **Instructional Tools**. You will find them listed under the **Problem-Based Learning** tab.

   Problem Board—Printable form to create student or class K-W-L chart

   Guiding Questions for Problem Solving—Questions for students to use while conducting research

   Problem Log and Rubric—printable student log with the stages of the problem-solving process

   Brainstorming Map—Graphic representation of key concepts and their relationships

   The Scientific Method and Flowchart—Chart that describes the scientific method process
3. **Focus Questions**—These questions at the beginning of each segment help students focus on a reason for viewing. They can be printed ahead of time from the **Educators** area of the web site in the **Activities/ Worksheet** section under **Worksheets** for the current episode. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.

   "What's Up?" Questions—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. Print them by selecting **Educators** on the web site in the **Activities/Worksheet** section under **Worksheets** for the current episode.

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Great Space Exploration* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Students should work in groups or as a class to discuss and list what they know about space flight and the reasons we explore. Have the students conduct research on the differences between manned and unmanned space flights and the technology, such as robotics, which helps us explore. Brainstorm for ideas about what space flight may be like in the future. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide them with the information needed.
4. Have the students complete **Action Plans**, which can be printed from the **Educators** area or the tree house **Problem Board** area in the **Problem-Solving Tools section** of the web site for the current online investigation. Students should then conduct independent or group research by using books and Internet sites noted in the **Research Rack** section of the **Problem Board** in the **Tree House**. Educators can also search for resources by topic, episode, and media type under the **Educators** main menu option **Resources**.
5. Choose activities from the Educator Guide and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. For related activities from previous programs, download the appropriate **Educator Guide.** On the NASA SCI Files™ home page, select **Educators**. Click on **Episodes** in the menu bar at the top. Scroll down to the 2002–2003 Season and click on *The Case of the Biological Biosphere*. In the green box, click on **Download the Educator Guide**.

a. In the Educator Guide you will find

1 **Segment 1** – *Growing Cold, page 18*

2. **Segment 1** – *Virus Versus Bacteria, page 20*

Close the PDF window to return to the **Educator Guide** page. Using the yellow back arrow on the NASA SCI Files™ page (do NOT use the back button on your browser), return to the Episode description page. In the green box, click on **Activities/Worksheets**

b. On the web site in the **Activities/Worksheet** section, you will find

1. *Coconuts for You* (microbes)

7. Have the students work individually, in pairs, or in small groups on the problem-based learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on **Tree House** and then the **Problem Board**. Choose the 2004–2005 Season and click on ***Mars or Bust!***

- To begin the PBL activity, read the scenario (Here's the Situation) to the students.
- Read and discuss the various roles involved in the investigation.
- Print the criteria and problem log for the investigation and distribute.
- Have students begin their investigation by using the **Research Rack** and the **Problem-Solving Tools** located on the bottom menu bar for the PBL activity. **The Research Rack** is also located in the **Tree House**.

8. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.
9. Have students complete a **Reflection Journal**, which can be found in the **Problem-Solving Tools** section of the online PBL investigation or in the **Instructional Tools** section under **Educators**.
10. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Careers

astronaut
microbiologist
museum exhibit or designer
researcher
robotics engineer
scientist

Resources *(additional resources located on web site)*

Books

Beyer, Mark: *Robotics*. Scholastic Library Publishing, 2001, ISBN: 0516240072.

Birch, Beverly: *Pasteur's Fight Against Microbes*. Barnes and Noble Books, 2001, ISBN: 0760726612.

Bocknek, Jonathan: *The Science of Magnets*. Gareth Stevens Audio, 1999, ISBN: 0836825721.

Branley, Franklyn Mansfield: *Is There Life Out There?* HarperCollins Publishers, 1999, ISBN: 0064451925.

Branley, Franklyn Mansfield: *Mission to Mars*. HarperCollins Publishers, 2002, ISBN: 0064452336.

Burgan, Michael: *John Glenn: Young Astronaut*. Simon and Schuster Children's, 2000,
ISBN: 0689833970.

Cole, Joanna and Nancy Krulik: *The Magic School Bus in a Pickle: A Book about Microbes*. Scholastic, Inc., 1998, ISBN: 0590393774.

Gifford, Clive: *How To Live on Mars.* Scholastic Library Publishing, 2001, ISBN: 053116201X.

Murphy, Patricia: *Exploring Space with an Astronaut*. Enslow Publishers, 2000, ISBN: 0766011992.

Schraff, Anne E.: *Are We Moving to Mars?* Avalon Travel Publishing, 1996, ISBN: 1562613103.

Schyffert, Bea Uusma: *The Man Who Went to the Far side of the Moon: The Story of Apollo 11 Astronaut Michael Collins*. Chronicle Books, 2003, ISBN: 0811840077.

Siy, Alexandra: *Footprints on the Moon*. Charlesbridge Publishing, 2001, ISBN: 1570914095.

Video

Careers for Kids: *I Wanna Be an Astronaut*
(Hosted by Steve Pool) Grades K–6

NASA Space Series: *Life on Mars?*
Grades 4 to adult

Schlessinger Media: *Electromagnetic Energy*
Grades 5–8

The Learning Channel: *Android*
Grades 6 to adult

Web Sites

NASA: How To Become an Astronaut
Use this web site to find out how to become an astronaut. There is also great information on what astronauts actually do.
http://www.spaceflight.nasa.gov/outreach/jobsinfo/astronaut.html

NASA: Astronauts in Training
This great site shows how astronauts train to prepare for space. There are links to more information and video clips to demonstrate some of the training tools astronauts use.
http://www.nasa.gov/audience/forstudents/5-8/features/F_Astronauts_in_Training.html

NASA: Astronaut School
Visit this web site to play a simulation of astronaut school, watch video clips, and learn fun facts about what it takes to be an astronaut.
http://edspace.nasa.gov/astroschool/

NASA: Manned vs. Unmanned Space Flight
This web site describes and examines the differences between manned and unmanned space flight.
http://www-spof.gsfc.nasa.gov/stargaze/Spaccrft.htm

The *Phoenix* Mission to Mars
Visit this web site for detailed information about the Phoenix Mars Lander, including the mission summary and the science objectives for the mission.
http://phoenix.lpl.arizona.edu/

NASA: Mars Activities
This site has a comprehensive list of classroom activities related to Mars exploration: directions for an edible rover, searching for life on Mars, and exploring the surface.
http://marsrovers.jpl.nasa.gov/classroom/pdfs/MSIP-MarsActivities.pdf

Robotics
Visit this site to learn about the history and workings of robotics, to see robot art, to get more classroom activities, and to control your own remotely operated vehicle.
http://www.thetech.org/robotics/

NASA: Mars, Water, and Life
Find out why scientists want to explore Mars and what they are looking for on Mars.
Also learn the importance of water on Mars.
http://mars.jpl.nasa.gov/msp98/why.html

Virginia Air & Space Center
Take flight to the Virginia Air & Space Center, the visitor center for NASA Langley Research Center and Langley Air Force Base. Your imagination will soar as you launch

a rocket, pilot a space shuttle, become an air traffic controller, fly an airplane, and more! Come face-to-face with the Apollo 12 Command Module that went to the Moon. See a Mars meteorite and a DC-9 passenger jet. Experience a 3D IMAX film in the giant-screen Riverside IMAX Theater...you have to see it to believe it! There is always something new landing at the Virginia Air & Space Center! http://www.vasc.org/

Strange Matter
Discover the secrets of everyday stuff. This web site lets you explore everyday materials to see what they are made of, how you can transform them, and what the properties of certain materials are. Discover some innovative uses for some materials. There is also a link to a family guide of home activities, including an activity with ferrofluids.
http://www.strangematterexhibit.com/index.html

NASA: Space Wardrobe
Find out on this interactive web site why astronauts wear space suits and why space is a harsh environment. The site provides two different levels for a variety of learners.
http://starchild.gsfc.nasa.gov/docs/StarChild/space_level2/wardrobe.html

Microbes Around Us
Unravel the mysteries of microbes on this interactive web site. Learn what microbes are, where they live, and how we use them.
http://www.microbe.org

The Microbe Zoo
Discover the many worlds of hidden microbes. Visit the major attractions, such as Space Land, Water World, and Dirt Land, as you learn more about microbes here on Earth and the possibility of finding them on other planets.
http://commtechlab.msu.edu/sites/dlc-me/zoo/

Activities and Worksheets

I'm Alive! I'm Alive!

Segment 1

Purpose

To create an operational definition of life and to identify the characteristics of a living thing

Background

All living things have processes not found in nonliving things. There are six main life processes. The first life process is to obtain energy. Plants and animals vary in the ways they get energy, but both must get energy to sustain life. The second life process is to use energy. The energy that is used allows living things to get the nutrients necessary to survive. The third life process is to release waste. Waste products are poisonous and must be released or the organism will die. The fourth life process is the ability to respond to a change in the environment. A hibernating bear is an example of a living thing responding to a change in its environment. The fifth life process is reproduction. Some individuals of a species must reproduce or create others of the same kind. Without reproduction, a species would become extinct. The sixth life process is to grow. Growth is the process of making more living material.

Procedure

1. In your science journal, write or draw the characteristics that make something living or nonliving.
2. Use the dictionary and/or encyclopedia to find pictures and definitions of living and nonliving things.
3. Discuss your findings with your group.
4. Measure and pour 50 mL of water into each beaker.
5. Use masking tape and a marker to label one beaker "sugar" and the other beaker "no sugar."
6. In the space provided on the Living or Nonliving chart, write your prediction for what will happen when yeast and water are mixed and when yeast, water, and sugar are mixed.
7. Add one yeast package to each beaker of water.
8. Use a craft stick and stir gently.
9. Observe the mixture.
10. Use the ruler to measure, on the outside of the beaker, the height of the mixture from the bottom of the beaker to the top of the mixture (including any foam).
11. Record your observations in the chart, noting the time and height of the mixture.
12. Use a measuring spoon to measure 10 mL of sugar.
13. Add the sugar to the beaker marked "sugar."
14. Gently stir the mixture.
15. Observe the sugar mixture and record your observations in the chart, noting the time and height of the mixture.
16. For 30 minutes total, check the beakers every 5 minutes and record your observations in the chart at each interval.
17. Stir the mixtures every time you check them.
19. Share your group's results with the class and find the average height of each mixture at each interval.
20. Use the average height data and create a class graph.

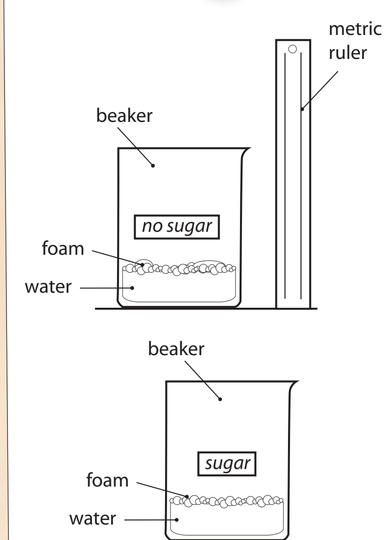
Materials

Per student:

Life Criteria Chart, page 19
Living or Non-Living
graph paper
science journal

Per Group

dictionary
encyclopedias
examples or pictures of living things
100-mL room temperature water
2 beakers or plastic cups (250 mL each)
2 packages of rapid rising yeast
10 mL of sugar (2 tsp)
2 craft sticks
plastic centimeter ruler
permanent marker
masking tape
scissors
metric measuring spoons
timer or clock



I'm Alive! I'm Alive!

Segment 1

21. In the Life Criteria Chart, list as many criteria for life as you can for yeast.
22. Choose 4 other living things and write their names in the living organisms column.
23. For each organism, write as many criteria for life as you can in the appropriate row.
24. Share your findings with your group and class.

Conclusion

1. Did your observations of the yeast match your predictions? Why or why not?
2. What role did sugar have in the experiment?
3. What do you think would happen if you added more yeast?
4. What do you think would happen if you added more sugar?
5. Is the yeast living? Explain your answer.
6. What are the main criteria for life?

Extension

1. Make a Venn diagram to compare the characteristics of living organisms and nonliving organisms.
2. Measure the temperature of each yeast mixture at each 5-minute check. Make a line graph to show the temperature changes.
3. Look at the yeast mixtures under a microscope.
4. Try a similar experiment with other substances, such as baking powder or fizzing cold tablets, instead of the yeast.

LIFE CRITERIA CHART

Predictions:

Yeast and Water: ______________________________

Yeast, Water, and Sugar: ______________________________

	Yeast + Water		Yeast + Water + Sugar	
Time	Appearance	Height of Mixture (cm)	Appearance	Height of Mixture (cm)

Living Organisms	Criteria	Criteria	Criteria	Criteria	Criteria
Yeast					

I Want To Hold Your Hand

Segment 1

Purpose

To construct a robotic-like hand and to demonstrate how data are collected when using robotic technology

Background

A robot is a machine that collects information from its surroundings. It uses that information to follow instructions and to complete a task. Today's Robots have multiple sensors and are able to make their own decisions based on given information. Robots come in all shapes and sizes. The jobs they do are also varied. Some robots are used in factories. Others are experimental robots that use artificial intelligence. Artificial intelligence allows robots to behave more like human beings and to act independently in a changing environment. Today, robots are used in hospitals, space and ocean exploration, and other dangerous areas.

Materials

Per Group

narrow rubber bands
drinking straws
cardboard
tape
scissors
nylon cord
centimeter ruler
pen

Procedure

1. To make the palm of the robotic hand, cut a piece of cardboard 10 cm x 10 cm.
2. To make the fingers, cut three pieces of cardboard 2 cm x 9 cm.
3. To make one of the fingers jointed, cut one of the cardboard pieces into three equal pieces. See diagram 1.
4. Place the three equal finger pieces back together and use tape to reconnect them. Label one side of the taped finger "inside." See diagram 2.
5. Cut a rubber band 5 cm long.
6. Turn the segmented finger over so the "inside" is face down.
7. Put the rubber band across the middle of the first joint. See diagram 3.
8. Tape the rubber band on both sides of the joint, making sure to leave the ends of the rubber band untaped.
9. Fold the ends of the rubber band so that they rest on top of the tape and tape them firmly in place. See diagram 4. Taping prevents the rubber bands from slipping.
10. Repeat steps 5 through 9 for the second joint.
11. Tape the finger onto the palm with "inside" facing up.
12. Turn the hand over.
13. Cut a rubber band 5 cm long.
14. Put the rubber band across the last joint (touching the palm).
15. Repeat steps 8–9 for the last joint, connecting the finger to the palm. See diagram 5.
16. Cut a piece of nylon cord 35 cm long.
17. Tape one end of the nylon cord over the end of the finger. See diagram 6.
18. Cut four pieces of straw 2 cm each.
19. Thread the pieces of straw onto the nylon cord.
20. Tape a piece of straw in the middle of each finger section.
21. Tape the last straw to the palm. See diagram 7.

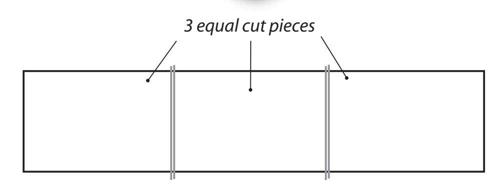


Diagram 1

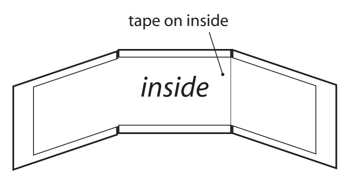


Diagram 2

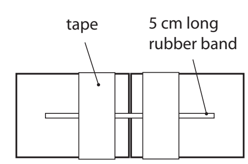


Diagram 3

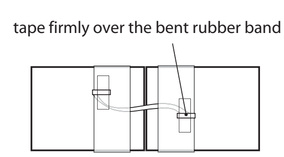


Diagram 4

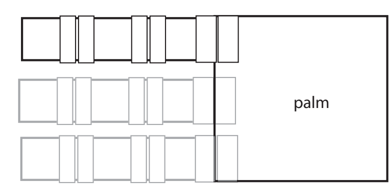
I Want To Hold Your Hand

Segment 1

22. Repeat steps 3–21 for the last two fingers.
23. Operate the hand by pulling the nylon cord.
24. You should be able to pick up an empty soda can or other lightweight objects.

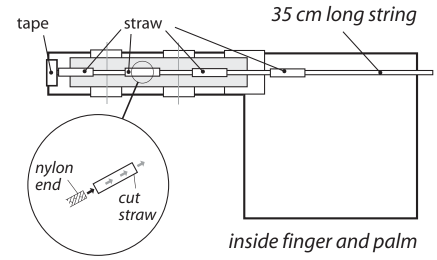
Tips:

- *You may need to cut the tape pieces to make them thinner.*
- *Make sure the rubber bands are taped firmly. If there is any loose area, the hand will not work properly.*



connecting fingers to palm

Diagram 5



inside finger and palm

Diagram 6

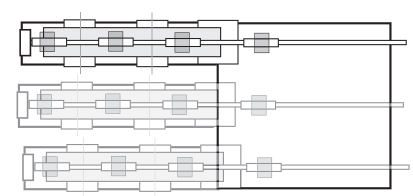

inside finger and palm finished

Diagram 7

Conclusion

1. What items can you pick up with your robotic hand?
2. What would happen if you added more fingers?
3. What would happen if you added a thumb?
4. Why is it difficult to pick up certain items with your robotic hand?
5. What could a real robotic hand be used for? Write or draw your ideas in your science journal.

Extension

1. Fold your thumb in toward the palm of your hand. Wrap a piece of masking tape around your hand to immobilize your thumb. Now try to do various daily tasks without the use of your thumb. Were you able to tie your shoes, put a button through a buttonhole, or fasten a snap? Try holding a fork or spoon or peeling a banana. Can you catch a ball?
2. Make a Venn diagram to compare your hand to the robotic hand you made.
3. Add more fingers or a thumb to your robotic hand. Does it make a difference?
4. In your science journal, draw or write about some of the things you can and cannot pick up. Write why you think some things cannot be picked up with your robotic hand.

There's a Radio in My Meter

Segment 1

Purpose

To demonstrate how a radiometer works and to understand the power of solar radiation

Background

Solar radiation is radiation from the Sun made up of a wide range of wavelengths. The wavelengths can range from the long infrared to the short ultraviolet. The solar radiation Earth receives is more limited because the ozone layer and atmosphere absorbs many wavelengths. Therefore, the Earth generally receives mostly the visible and near-infrared radiation.

In 1875, Sir William Crookes conducted experiments in a vacuum. From these experiments he devised a device, named after him, called Crookes Radiometer. Unfortunately, it didn't have any practical use, but it is still sold today as curiosity item.

When a radiometer is exposed to light, the vanes revolve. The gas near the black surface is warmer than the shiny surface because dark colors absorb more solar energy than light colors. The faster gas molecules from the warmer side strike the edges of the vane at an angle and create a higher force than the colder molecules on the other side.

Materials

Per Group

black marker
yellow marker
1 foil gum wrapper
jar
pencil
strong glue
thread
used matchstick
tape
stopwatch or clock

Procedure

1. Have an adult strike a matchstick, blow it out, and allow it to cool.
2. Using the black marker, color the paper side of the foil gum wrapper.
3. Cut the wrapper into 4 equal pieces (2 cm x 2.5 cm). See diagram 1.
4. On the black side of one piece, place a small yellow dot in the corner.
5. Using strong glue, attach the pieces of paper to one end of the matchstick. Make sure to have all the shiny surfaces face the same direction. See diagram 2.
6. Attach 12 cm of thread to the other end of the matchstick.
7. Wrap the other end of thread (the loose end) around a pencil and secure with tape.
8. Place the pencil on top of the jar with the thread and matchstick hanging inside the jar. Make sure the matchstick is suspended and not touching the bottom of the jar. See diagram 3.
9. Place the jar in a sunny location.
10. Observe the piece of paper with the yellow dot. Try to count the number of times it passes a given point in 10 seconds.
11. Record your observations in your science journal.
12. Move the jar away from the sunny area and repeat steps 10–11.

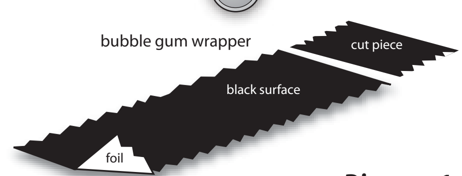


Diagram 1

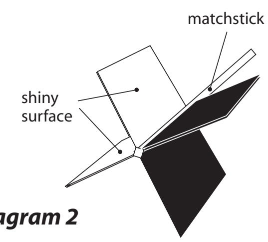


Diagram 2

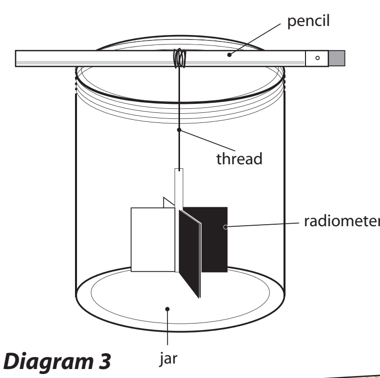


Diagram 3

Conclusion

1. What happened to the radiometer after it was placed in the sunlight? Why?
2. What would happen if all the shiny surfaces faced different directions?
3. What would happen if the matchstick were resting on the bottom of the jar?
4. Why might a radiometer be important to a scientist?

Extension

1. Use different sources of light, such as a flashlight, lamp, and so on and record the number of spins (in 10 seconds) for each source. Repeat for several trials and find the average number of spins. Create a class chart and graph.
2. Move the radiometer forward and backward from a light source and note any changes.
3. Conduct research to learn more about the different types of radiation. In your science journal, draw and describe the instruments used to measure the types of radiation.

Squiggly Little Things

Segment 1

Materials

2 empty jars
hay
pond or creek water
corn syrup
microscope slides and slip covers
microscope
2 eyedroppers
antibacterial soap for cleanup
science journal

Purpose

To understand the importance of water to life

To demonstrate the presence of microbial life

To observe microbes such as algae, protozoa, and bacteria

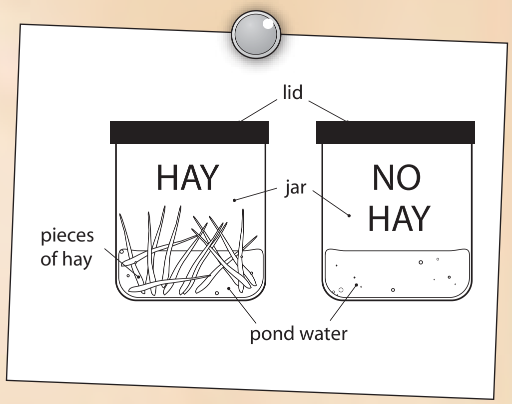
Background

Microbes are tiny creatures that are everywhere. They include bacteria, archaea, fungi, protists, and viruses. These creatures are too small to be seen without a microscope. There are more microbes on a person's hand than there are people on the entire earth! Microbes are in the air we breathe, the ground we walk on, and the food we eat. Without them we couldn't digest food, plants couldn't grow, and garbage wouldn't decay.

A hay infusion is a great way to produce a variety of microbes during any time of the year. The water is necessary for the microbes to reproduce. The sugars in the dried grass or hay provide food for the bacteria and other microbes. The bacteria serve as food for other microbes, such as protozoa. Since the protozoa breathe oxygen, it is important to pump air into the hay infusion at least once a day. Use an eyedropper to pump in the air. Although most bacteria are harmless to people, be sure to wash your hands, equipment, and counters with antibacterial soap.

During the first week of the hay infusion, a scum may form on top of the water. This scum is perfectly normal. It may actually contain rod-shaped cells that may be a form of sulfur bacteria. After the first week, protozoa should be visible under the microscope. In weeks four and five, flagellates and diatoms should be present. By the tenth week, amoebas should be present in the bottom water samples. Spiral bacteria may also be present at this time. The bacteria may produce a somewhat unpleasant smell in the hay infusion.

Procedure



1. Put equal amounts of pond water into each jar.
2. Label one jar "No Hay" and the other jar "Hay."
3. Add pieces of hay to the jar labeled "Hay" and cover the jar loosely.
4. Loosely cover the other jar.
5. Collect a drop of water from the "Hay" jar and place it on a microscope slide. NOTE: Be careful to keep the eyedroppers separated and use the same one for each jar.
6. Place the slipcover over the drop of water on the slide and place a prepared slide under a microscope to examine the water drop.
7. In your science journal, draw what you see.
8. Repeat steps 5–7 with the "No Hay" jar.
9. Set both jars aside but remember to use the eyedropper to pump oxygen into the water each day.
10. On the second, fourth, and sixth day, make a new microscope slide for each jar and record your observations in your science journal. Be sure to date the entries to measure change over time.
11. On about the seventh or eighth day, the hay infusion population will peak.
12. For the best chance of getting different types of microbes, use the eyedropper to take samples from the top, near the top, and middle of each jar. NOTE: If the microbes on the microscope slide move too quickly to compare, add a drop of corn syrup to the sample.
13. Record your observations in your science journal and date them.
14. Each week add more pond water to each jar and add more hay to the "Hay" jar.

Squiggly Little Things

Segment 1

15. Repeat steps 12–13 to make new slides from the water samples of each jar every four to five days.
16. Record your observations and any changes or new microbes in your science journal.
17. Using the Internet or other reference materials, identify as many of the organisms as you can.
18. Research why microbes are important to us in everyday life.
19. Learn about harmful and helpful microbes.
20. Make a poster to show what you learned about these microbes.

Conclusion

1. What changes did you notice each day in the hay infusion jar?
2. Why was the water important to the project?
3. Which water sample produced the most microbes?
4. How many different microbes were you able to draw?
5. Explain how we use microbes.

Extension

Try organic matter other than hay.

Just a Little Air in My Gel

Segment 1

Purpose

To understand how technology can be used to solve problems

Background

Aerogel is an amazingly strong, lightweight man-made material. It is the least dense material on Earth. Aerogel, sometimes called frozen smoke, is composed of 99% air and 1% silica dioxide, the substance used to make glass. A block of aerogel the size of a person may weigh less than half a kilogram (kg) yet support the weight of a small car (about 454 k). A thickness of only 2.5 centimeters (cm) has the same insulating power as more than 15 cm of fiberglass and can withstand temperatures up to 1,400º C (2,552º F). Aerogel begins as a silica dioxide gel, much like the gelatin you might eat. The material then goes through a process known as supercritical drying, in which the liquid is removed without collapsing the gel.

Aerogel has been used to provide insulation on various spacecraft and is currently being used to capture comet particles that are traveling at 6 times the speed of a rifle bullet. When these particles hit the aerogel, they leave behind cone-shaped hollow tracks. Scientists can then follow each cone to its point to collect the particle. The particle is captured intact, without any damage to it. The track of the particle through the aerogel also gives scientists important information about the path of the particle and the direction it was traveling when captured.

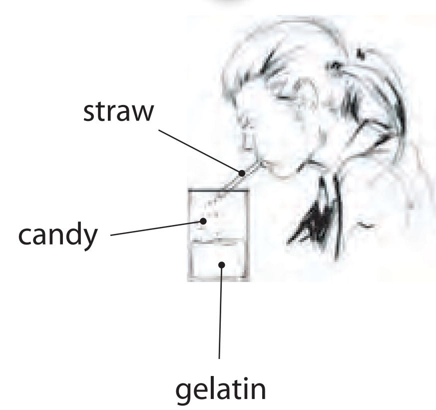
Materials

Per Group

- 1 package gelatin
- 415-mL boiling water
- 1–2 drops of blue food coloring (optional)
- clear plastic cups
- straws
- Nerds® candies
- science journal

Procedure

1. With an adult's help, mix the boiling water, the food coloring, and the gelatin.
2. Let the mixture cool slightly.
3. Pour the cooled mixture into clear plastic cups, filling each one about half full.
4. Refrigerate overnight.
5. Remove the cups from the refrigerator and let stand at room temperature for about two hours.
6. Put a few of the candies in the end of a straw. The candies represent comet particles in space.
7. Point the straw towards the cup of "aerogel" and blow as hard as you can.
8. Examine the tracks left by the "comet particles" in the gel.
9. Record your observations in your science journal.



Conclusion

1. What is aerogel used for now?
2. What can scientists learn about comets by capturing the particles in space?
3. Why is aerogel an important discovery?
4. What other uses might be found for a product like aerogel?

Extensions

1. Examine a piece of bubble wrap. What do you see? What is between the layers of plastic? How do you know? Find out how bubble wrap is used. Make a clay ball about the size of a walnut. Using the bubble wrap, create a way to catch the clay ball that will not change the shape of the ball as you drop it.
2. Collect other foam products. Be creative. Some of these products, like sponge cake, may be edible. Try the clay ball experiment with other products. Did you get the same results? Did some of the products work better than others? Why do we use foam products? What makes the foam lightweight?

Ferreting Out the Fluids

Segment 1

Purpose

To demonstrate how magnets can be used to move liquid and to understand the importance of spinoff products to everyday life

Background

Ferrofluids are substances that behave like liquids but have the magnetic properties of solids. The ferrofluids actually contain tiny particles of a magnetic solid suspended in a liquid. Ferrofluids were originally discovered in the 1960s at a NASA Research Center where scientists were investigating possible methods for controlling liquids in space. The benefits of a magnetic liquid were obvious. The location of a liquid could be controlled through the application of a magnetic field and liquids could then be forced to flow without the aid of gravity. Ferrofluids can also be used to form tight seals in rotating generators and are used in high-speed computer disk drives to eliminate harmful dust particles or other impurities that can damage the data-reading heads. Ferrofluids have also been used to improve the performance of loudspeakers, leading to an overall improved sound quality. Research is currently being conducted for biomedical applications in the hope that these liquids could be used to carry medications to specific parts of the body through the use of magnetic fields.

Materials

baby oil
iron filings or shavings
strong magnet
small jar or bottle with a tight-fitting lid
tap water
plastic cup
craft stick
safety glasses
food coloring
science journal

Teacher Notes

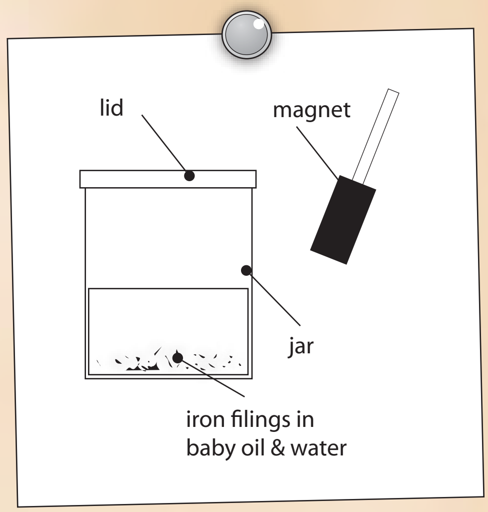
Although actual ferrofluids are available for purchase, these products must be used with extreme caution. The following classroom simulation activity safely and effectively demonstrates the use of ferrofluids.

Iron filings can be purchased from a science supply store. A quick, inexpensive way to obtain the filings is to purchase a magnetic drawing game at a toy store. Open the game and carefully remove the filings for use.

NOTE: *A magnet with a handle and a jar with smooth sides work best.*

Procedure

1. Put safety glasses on to protect your eyes from the iron filings.
2. Place about 5 mL of iron filings in the bottom of a small jar.
3. Put the lid on the jar.
4. Using a powerful magnet, rearrange the iron filings by running the magnet along the outside of the jar.
5. Notice the shape and position of the filings.
6. Record your observations in your science journal.
7. Record what happens to the filings when you remove the magnet from the side of the jar.
8. Open the jar.
9. Add just enough baby oil to the iron filings to moisten them thoroughly, mixing with a wooden stick to make a paste.
10. Add a few drops of food coloring to a cup of tap water.
11. Slowly pour the tap water into the jar with the iron filings, filling the jar about halfway.
12. Replace the lid.



Ferreting Out the Fluids

Segment 1

13. In your science journal, record the location of the iron mixture in comparison to the water.
14. Move the magnet over the outside of the jar.
15. Observe what happens to the iron filings.
16. Using the magnet, move the iron mixture up the side of the jar above the water line.
17. Move the magnet away from the side of the jar and observe what happens.
18. In your science journal, record your observations.
19. Compare and contrast the movement of the filings suspended in the baby oil to the dry filings you observed earlier.

Conclusion

1. What happens to the dry iron filings when the magnet is nearby? Why?
2. What happens to the dry filings when the magnet is removed? Why?
3. What happens to the filings suspended in the baby oil when the magnet is nearby?
4. What happens to the filings suspended in the baby oil when the magnet is removed?
5. Why are ferrofluids important in space?

Extension

Ferrofluids were designed for space use but have applications in the everyday world around us. We call products that come from basic research, spinoffs. You may have scratch resistant lenses in your glasses, but did you know that they were a spinoff of the NASA space program? Night vision cameras and heart monitors are two other commonly used NASA spinoffs. Find out about more spinoff products at ***http://www.sti.nasa.gov/tto/*** and make a poster or PowerPoint presentation showing the importance of spinoff products in our lives.

Answer Key

Segment 1

I'm Alive! I'm Alive

1. Answers will vary.
2. The sugar provides "food" (energy) for the yeast.
3. Because the yeast would have to share the food, little growth would occur.
4. The yeast should begin to once again reproduce and grow. (Note: yeast growth is dependent on temperature; the experiment must be completed while the mixture is still warm.)
5. Yes. The yeast grows; reproduces; responds to its environment, particularly temperature and light; gives off waste; and uses energy obtained from the sugar.
6. A living organism must be able to grow, reproduce, respond to stimuli, get and use energy, and produce waste materials.

I Want To Hold Your Hand

1. Answers will vary.
2. The hand should be able to pick up more items because more fingers will add strength.
3. Having an opposable, or moving thumb, allows us greater dexterity. Adding a thumb to the hand should allow you to pick up smaller items and complete tasks that require some skill.
4. Answers will vary.
5. Answers will vary.

There's a Radio in My Meter

1. The vanes on the radiometer began to spin. The gas molecules near the black surface are warmer than the ones near the shiny surface because dark colors absorb more solar energy than light colors. The faster gas molecules from the warmer side strike the edges of the vane at an angle and create a higher force than the colder molecules on the other side.
2. There would be no movement in the radiometer because the gas molecules would be trapped between the vanes.
3. The friction between the matchstick and the bottom of the jar would prevent the radiometer from spinning.
4. Although Crookes thought his radiometer could be used to measure solar radiation, it actually has no practical purpose. Advanced, very high-resolution radiometers are used today to remotely determine cloud cover and Earth surface temperature. A series of sensors on the vanes collects different bands of radiation wavelengths. The data are then interpreted to determine surface temperature.

Squiggly Little Things

1. Answers will vary, but more microbes should be seen each day in the hay infused jar than in the jar without hay.
2. Water is the source of life. All living things known to us at this time require water to survive. The water provides an environment for the microbes as well as a way to release the nutrients in the dried hay.
3. Although different microbes should be seen at different levels, approximately the same number should be found throughout the water samples. The later samples will reveal the most microbial life.
4. Answers will vary.
5. Answers will vary but may include these: help decompose trash, thicken products, ward off spoilage.

Just a Little Air in My Gel

1. Aerogel is being used on the Stardust mission to capture pieces of a comet.
2. Scientists are able to study the material that makes up a comet, as well as the comet particles' path, direction, and speed.
3. Aerogel is extremely lightweight, yet very strong. It can insulate at very high temperatures.
4. Answers will vary.

Ferreting Out the Fluids

1. The filings stand up on end and begin to arc toward the poles of the magnet, showing the magnetic field. Iron is a magnetic material and is attracted to the magnet.
2. As soon as the magnet is removed, the filings fall back to the bottom of the container. As the magnet is removed, the force of attraction becomes less and less until the distance is so great that there is no longer any magnetic force to act upon the iron filings and they fall.
3. The filings are attracted toward the magnet and can be moved throughout the liquid in the jar.
4. The filing mixture runs down the side of the jar, behaving as a liquid, flowing toward the bottom of the jar.
5. Ferrofluids are used to help move liquids, such as rocket fuel, in microgravity environments.

On the Web

Why Explore?

1. Unmanned missions allow scientists to gather data in locations that are not accessible to human beings. The environment may be too harsh for human beings, temperatures may be too extreme, or radiation may be too high for safety. Even distance is a factor. If a site is too far for human space travel, an unmanned mission may collect the data from the far reaches of the solar system and beyond.
2. Answers will vary.
3. Answers will vary.