Astronaut Geography (continued)

ALABAMA
Hartsfield
Hire
Jemison
K.Thornton
James Voss
C. Williams

ARIZONA
Creamer
S. Smith

ARKANSAS
Covey
Parazynski

CALIFORNIA
Caldwell
Chilton
Clifford
Coats
Hauck
Lindsey
Love
McCool
McCulley
Melroy
Morgan
Ochoa
O'Connor
Olivas
Poindexter
Ride
Robinson
Sturckow
Van Hoften
Walheim
Young

COLORADO
Brand
Carpenter
Carr
Lounge
Rominger
Roosa
Swigert

CONNECTICUT
Barry
Burbank
Mastracchio
Spring
Thuot

DELAWARE
Currie

FLORIDA
Boe
Davis
Lawrence
Lenoir
R. Richards
W. Scott
Thagard

GEORGIA
Bridges
Carter
Hammond
Kilrain
Walker
HAWAII
K. McArthur
Onizuka

KENTUCKY
Wilcutt

LOUISIANA
Gorie
Halsell

MAINE
Hobaugh

MARYLAND
Curbeam
Ivins
Jones
Reightler
Virts

MASSA - CHUSETTS
Apt
Bowen
Duffy
Linnehan
Loria
Lu
McCandless
Musgrave
O'Leary
Precourt
Wilson
MICHIGAN
Antonelli
Bloomfield
Chaffee
Jett
Leestma
Linenger
Lousma
McMonagle
Searfoss
Shaw
Worden

MINNESOTA
Cabana
Carey
D. Gardner
Nyberg
Stefanyshyn -Piper

MISSISSIPPI
Haise
Peterson
Truly

MISSOURI
Akers
Behnken
Godwin
Kavand i
Springer

NEBRASKA
C. Anderson

NEW HAMPSHIRE
Morin
Shepard

NEW JERSEY
Aldrin
Ham
M. Kelly
S.Kelly
Polansky
Reisman
Schirra
Schweickart
Sullivan
Zamka

NEW MEXICO
Gutierrez
Schmitt

NEW YORK
Adamson
M. Anderson,
Bobko
Cagle
Camarda
Cleave
E. Collins
A. Fisher
Fullerton
Garan
E. Gibson
R. Gibson
Grabe
W. Gregory
Hoffman
Hurley
Kregel
Massimino
Melnick
Parker
Runco
Stott
Swanson
Wetherbee
Wheelock
Lovell
Low
Overmyer
Resnik
Sega
D. Thomas
Walz
Weber
Williams

NORTH CAROLINA
E. Baker
Brady
C. Brown
Duke
Helms
W. McArthu
rM. Smith
W. Thornton

NORTH DAKOTA
Buchli
Hieb

OHIO
Armstrong
Bassett
Cameron
Eisele
Foreman
Gernhardt
Glenn
Good
Harbaugh
Henize
Henricks

OKLAHOMA
Cooper
Garriott
Herrington
Pogue
Stafford

OREGON
Griggs
Petit

PENNSYL- VANIA
A. Allen
Bagian
Bluford
Bursch
Conrad
Ferguson
Feustel
Fincke
Freeman
Frick
Hart
Robertson
Horowitz
Irwin
P. Richards
Tani
Weitz
RHODE ISLAND
Readdy

SOUTH CAROLINA
Bolden
Casper
Coleman
Culbertson
Fossum
McNair

SOUTH DAKOTA
Gemar
Fossum

TENNESSEE
M. Baker
Bull
Jernigan
Seddon
Shepherd
Wilmore

TEXAS
Ashby
Bean
Blaha
Cockrell
Creighton
Crippen
Fabian
W. Fisher
Forrester
Givens
Harris
Holmquest
Husband
Kopra
Lockhart
Mitchell
Mullane
D. Scott
See
White

UTAH
Lind

VERMONT
Graveline

VIRGINIA
Bowersox
D. Brown
Edwards
Gardner
Melvin
Oefelein
Phillips
Wisoff

WASHINGTON
Barratt
Dunbar
Gordon
G.C. Johnson
Oswald
Scobee

WEST VIRGINIA
McBride

WISCONSIN
Brandenstein
Chiao
Lee
Michel
Slayton
J. Williams

WASHINGTON DC
Drew
F. Gregory
Nowak
Stewart

Astronaut Geography (concluded)

Student Sheet

Procedure

1. Use the chart to color each state on the map.
2. Answer the questions on this page after coloring the map.

Questions

1. How many states have more than 20 astronauts?
2. How many states do not have any astronauts?
3. How many states have fewer than 10 astronauts?
4. Which state has the most astronauts?
5. Which states have six astronauts?
6. How many astronauts are from your state?

Map Key

#	COLOR	#	COLOR
1		10	
2		11	
3		12	
4		13	
5		14	
6		15	
7		16	
8		17	
9			

United States

The Taste of the Matter

Materials

paper plates
plastic spoons
food samples
drink samples
drink pitchers
small cups
water
crackers (5-8 per student)
pencil
napkins

Problem

To determine the acceptability of food products for space flight

Teacher Prep

Select 3-5 food samples from products that must be hydrated. For example, pudding mix, soup mix, instant oatmeal, and so on. Select 2-3 drink samples such as crystal drink mix, punch mix, instant tea, and so on. Calculate the approximate amount of food to be prepared for each student to have a small sample. Just before the test is conducted, prepare the products according to package directions. Either prepare test sample plates for each student, or place a spoon in each dish and have the students get their own samples. Give each student one cracker for each sample.

Background

Astronauts select their menus for space travel about five months before they fly. These foods will be stored in the galley. It does not help astronauts to take foods into space that they do not like and will not eat. Therefore, a special taste panel is set up for the astronauts to taste a variety of foods when they are selecting their menus. Foods are tested for appearance, color, odor, flavor, and texture. This taste panel helps to reduce the amount of waste from uneaten or partially eaten foods and ensures that the astronauts will eat well in space.

Procedure

1. Read the guidelines on the "Taste Panel Evaluation Form" (p. 34). Choose one food sample from your plate and write its name on the form at the top of the second column from the left.
2. Observe the food sample. Record its appearance, color, and odor in the correct columns.
3. Taste the food sample and record your observations for flavor and texture.
4. Rate this food sample using the scale at the bottom of the chart.
5. Write any comments you wish to make. Use the descriptive words given or your own.
6. To clear the taste of that food sample from your mouth, eat one cracker.
7. Repeat steps 1-6 with the other food samples.
8. Repeat steps 1-6 with the drink samples.
9. Clean up and restore your area.
10. Share your observations and results with the class.
11. Create a class chart of the scores given to each food and drink sample.
12. Create a graph depicting the results.

Conclusion

1. Which food would you prefer to take with you into space?
2. Which food received the highest score? Why? Lowest score? Why?
3. Why do you think it is important to test the food before it is taken into space?

Extension

1. From the evaluation forms, choose a meal of your choice and write a paragraph explaining why you chose those foods. Use descriptive words from the "Taste Panel Evaluation Form" (p. 34).
2. Use a food pyramid to evaluate your choices and determine if you chose a healthy, well-balanced meal.

The Taste of the Matter (concluded)

Taste Panel Evaluation Form

The following guidelines should be followed when rating a food product:

1. Emphasis is on quality of the food product rather than your own personal likes and dislikes.
2. If you absolutely dislike the product because of personal preferences, do not rate it.
3. The overall rating is your general impression of the product.
4. Do not compare notes with other taste testers.
5. In the comments section, explain why you rated the product as you did.

ITEM:				
Appearance				
Color				
Odor				
Flavor				
Texture				
Overall Rating				
Comments				

Ratings

1—Dislike Extremely	4—Dislike Slightly	7—Like Moderately
2—Dislike Very Much	5—Neither Like nor Dislike	8—Like Very Much
3—Dislike Moderately	6—Like Slightly	9—Like Extremely

Descriptive Comments

Here is a list of descriptive terms that can be used to describe the food samples.

Taste/Odor	Texture		Color/Appearance
bitter	crisp	pasty	dull
sweet	soft	rubbery	sparkling
sour	hard	sticky	bright
salty	stringy	stiff	light
rancid	tough	tender	dark
stale	chewy	greasy	greasy
tasteless	firm	juicy	glossy
flat	grainy		cloudy
musty	gummy		old
	lumpy		pale

Round and Round the Earth We Go

Problem

To use a model to observe how the phases of the Moon are created

Background

As Earth's only natural satellite, the Moon has long been an object of fascination and confusion. Over the course of a 28-day cycle (lunar cycle), the Moon shows us many different faces (shapes). These different shapes are called phases, and they are the result of the way the Sun lights the Moon's surface as the Moon orbits Earth. The Moon can only be seen as a result of the Sun's light reflecting off it. It does not produce any light of its own.

Materials

lamp without shade
table (optional)
tennis ball
darkened room

Procedure

1. Place the lamp (represents the Sun) on a table or have your partner hold the lamp up high.
2. After the lamp has been turned on, darken the room.
3. With your body representing Earth, hold the tennis ball, representing the Moon, in your left hand and at arms' length slightly overhead. See diagram 1. It is this inclined orbit that allows us to see a full Moon even when the Earth is between the Sun and the Moon.
4. Face the Sun.
5. Observe the ball. Note that the lamp has lit up the side of the Moon away from you (Earth) and you only see dark. This phase is called a new Moon, and it occurs when the Moon is between the Sun and Earth. You only see dark from Earth.

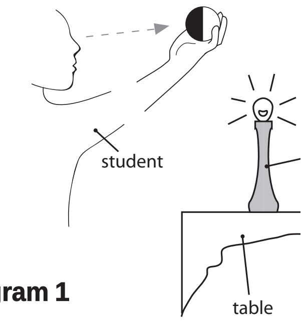


Diagram 1

6. While you (Earth) are still facing the Sun, hold the Moon straight out to the side and note which side of the Moon is lit. The Moon has now revolved one-quarter of the way around Earth. This takes approximately one week after a new Moon.
7. For the next phase, place your back to the Sun and hold the Moon straight out in front of you (Earth) keeping it slightly overhead. See diagram 2. The entire surface of the ball is lit, and this is a full Moon. The Moon has not completed half of its revolution around Earth.

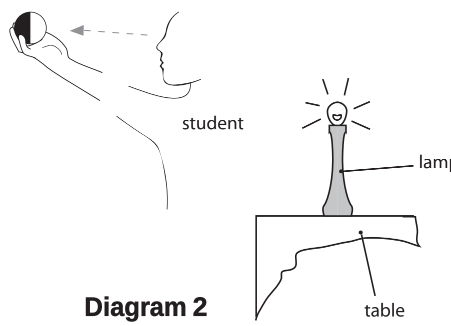


Diagram 2

8. Move the Moon to your right hand. Now move the right arm into a position straight out to the side. Once again, only half the Moon is lit. Note which half is lit. This phase is known as a third-quarter Moon and it appears approximately three weeks after a new Moon.
9. Face the Sun again and hold the Moon straight out in front and slightly overhead. Once again, you only see the darkened side of the Moon. The lunar cycle starts over again.
10. In your science journal, describe and illustrate what you observed.
11. Repeat with your partner as the Moon and you as the Sun.

Conclusions

1. What happened as you revolved around the "Sun?"
2. Why did the shadows change?
3. The Moon rotates on its axis once every 28 days, and it revolves around Earth once every 28 days. Knowing this information, explain why we only see one side of the Moon. Hint: Mark a spot on the ball (Moon) and revolve it around you (Earth) without letting it rotate about its axis. Note what you observe about the side of the ball (Moon) facing you (Earth). Now repeat while rotating the ball (Moon).

Extension

1. Research the phases of the Moon and create a diagram using the word bank below, that shows the phases of the moon as it orbits the earth.

Word Bank:
New Moon, Waxing Crescent, Full Moon, Waning Crescent, Third Quarter, First Quarter, Waxing Gibbous, Waning Gibbous

Doesn't Phase Me

Problem To understand the phases of the Moon

Materials

28 3" x 5" index cards
compass
metric ruler
pencil
black marker
stapler
hole-punch (optional)
2 brads (optional)

Teacher Note An alternative to index cards is to print the Moon Journal sheet from the NASA SCI Files™ web site http://scifiles.larc.nasa.gov in the "Educator" area under "Activities and Worksheets" for *The Case of the Galactic Vacation*. For a better flipbook, copy the sheet onto card stock and have students cut out the individual squares. You will need to copy approximately 3 sheets for each student or group.

Procedure

1. Discuss the phases of the Moon.
2. Place all index cards so that the unlined side of each card is facing up.
3. From the right side of each card, measure 1 cm from the edge halfway up and down the card and place a small pencil mark. See diagram 1.
4. Set your compass to draw a 6-cm diameter circle.
5. Place the pencil point of your compass on the mark you made in Step 3. Make sure the compass point is halfway up and down the card. See diagram 2.
6. Draw a circle.
7. Repeat Steps 4-6 until all cards have circles.
8. Using 8 cards, shade in the following Moon phases:
   a. new Moon
   b. waxing crescent
   c. first quarter
   d. waxing gibbous
   e. full Moon
   f. waning gibbous
   g. third quarter
   h. waning crescent
9. The changes in the Moon phases happen slowly over a 28-day period of time. To simulate the gradual change, progressively shade in the remaining cards using at least 2 but not more than 3 cards between each phase listed above. You might want to decide upon the number of cards between each phase before you begin.
10. Place the cards in order, with the new Moon on top and the circles on the right side.
11. On the left side, staple through all 28 cards in three places. Optional: If you are unable to staple through all the cards, punch holes on the left side of each card, making sure that the holes will align. Place brads through the holes to secure cards in place.
12. Flip the cards and watch the phases of the Moon.

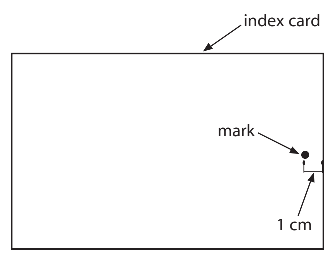


Diagram 1

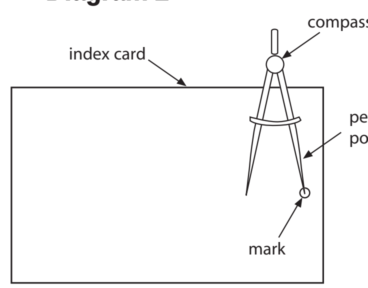
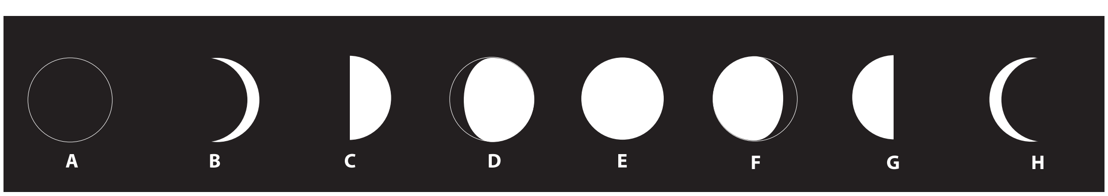


Diagram 2

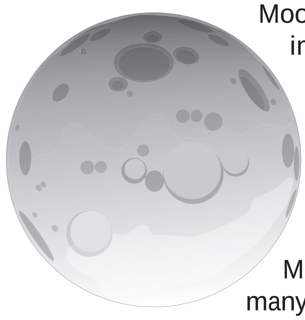


Moon Craters

Problem

To learn how craters are formed on the Moon

Background



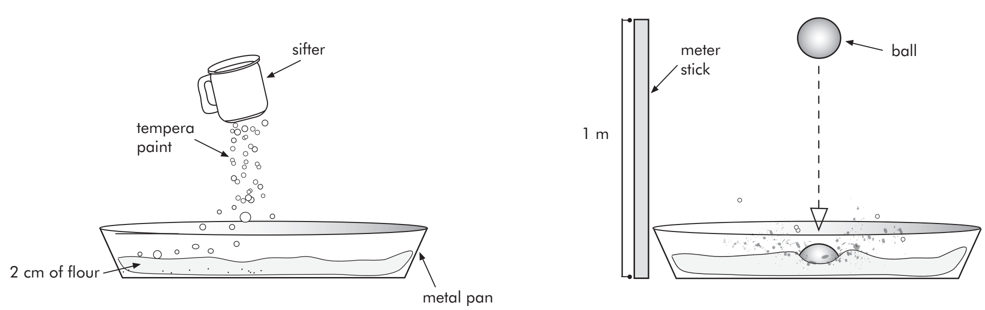
Have you ever looked at the Moon and thought it had a bad case of acne? Just what are all those circular features on the Moon's surface? They are impact craters formed when impactors, such as meteorites, smashed into the surface of the Moon. The explosion created by the impact caused the soil and rocks to be spattered out, leaving a hole. Around the circular hole, piles of rock (called ejecta) were created as well as bright streaks of target material (called rays) thrown for great distances. Impact craters are not unique to the Moon. They are found on all the inner planets and on many moons of the outer planets. Due to weathering and erosion, impact craters on Earth are not as easily recognized but there are several famous ones, including Meteor Crater in Arizona.

Materials

large metal pan
flour or sand
dry tempera paint or colored powdered drink mixes
sifter (optional)
metric ruler
meter stick
newspaper
various sized balls (marbles, golf ball, ping-pong ball, and so on)
science journal

Procedure

1. Spread several newspapers on the floor and put the metal pan in the center.
2. Pour flour into the metal pan to a depth of approximately 2 cm.
3. Shake the pan to evenly distribute the flour.
4. Dust the top of the flour with dry tempera paint. Use sifter to better distribute the dry paint.
5. Hold one of the balls 1 meter above the pan and release.
6. Observe the impact crater created and measure its diameter. Note the ejecta and rays. Record your observations in your science journal.
7. Using the other balls, repeat steps 5 and 6. If your surface is too small for all your balls, gently shake the flour to smooth it out and dust the surface again between drops.
8. Try dropping the balls from different heights and throwing them at different angles.



Conclusion

1. What happened when you increased the drop height of the balls?
2. At 1 meter, which ball made the largest crater? Smallest? Why?

Extension

Look at several different pictures of the Moon and compare and contrast the various craters.

Dressing for Space

Problem

To understand the complex nature of a space suit

Background

Before astronauts can venture out into space, they must put on several layers of special clothing. The first layer is like a pair of long underwear that has water-cooling tubes running all through it. This layer keeps the astronaut at a comfortable temperature. The space suit itself is also made of several layers. These layers were designed to protect the wearer from the many dangers found in space, such as extreme temperatures, radiation, and micrometeorites, or space dust. The inside layer is a pressure bladder – like a flat balloon that is filled with oxygen. Next, there is a layer of plastic for strength and several layers of fireproof material and thin sheets of metal. Early space suits were connected to the life-support system of the spacecraft by a tube called an umbilical. Space suits worn today have a life support system backpack built right into the upper part of the suit.

Teacher Prep

Have students bring in the following articles of clothing or provide them: tights or long underwear, pants, boots, long-sleeved T-shirt, knit hat, gloves, and a helmet. You will also need a long piece of rope.

Note: To make this experiment more realistic, attach the pieces of clothing together. Attach the socks to the bottom of the pants legs and then place the boots over the socks. Attach the long-sleeved T-shirt to the top of the pants and make it a "one-piece" space suit. If a snowsuit is available, you can also place the pants and T-shirt inside the snowsuit, and then attach the socks and boots to make it really bulky!

Procedure

1. Imagine that you are an astronaut who has a task to perform outside the spacecraft. You are inside an airlock on the space shuttle, and it is time to get into your space suit. Follow the directions below for getting into your "space suit."
   a. Long underwear: This is the first layer of your space suit. To put it on is like pulling on a pair of long underwear, but this underwear would have tubes running all through it, so it is not very easy to get into. First, put your legs in one at a time and then wiggle the suit high enough to get your arms into the openings and fasten this layer closed.
   b. Space Trousers—These are thick and bulky and have boots connected to them. Climb into the trousers and wiggle your feet into the socks and boots.
   c. Space Shirt—To cover your upper body (torso), put your arms into the shirt and close.
   d. For your communications carrier (a headset built into a cap), put on the stocking cap. Adjust so that it fits snugly over your ears.
   e. Gloves—Put on the thick gloves and wiggle your fingers.
   f. Helmet—Place the helmet on over your stocking cap.
2. In real life, you would have to connect many hoses and set many dials as you dressed. But for our pretend journey, you are ready to climb out of the hatch of the airlock into the cargo bay of the shuttle.
3. Attach your lifeline and pretend that you are floating in space inside your thick space cocoon!

Conclusion

1. Why are so many layers needed in a space suit?
2. What do you think it would be like to perform tasks in space in a space suit?

The Red Planet

Purpose

To understand why Mars is a reddish color

Materials

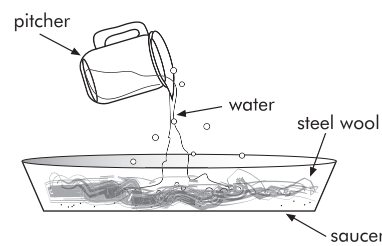
a piece of clean steel wool
water
dish or saucer
rubber gloves
science journal

Background

Mars earned its nickname "the Red Planet" because it looks red to observers in the sky. The color comes from the iron in its rusty-orange rocks and fine red sand. The planet's atmosphere of carbon dioxide is too thin to stop the heat from the Sun escaping into space. Mars is a cold desert.

Procedure:

1. Place the rubber gloves on your hands.
2. Stretch the wool to loosen the fibers.
3. Put the wool pad in a dish and pour enough water on it to wet it thoroughly but not soaked.
4. Let it stand for 3-5 days.
5. Observe the pad each day and record your observations in your science journal.
6. On the last day, pick up the wool pad and examine it closely. Record your observations.



Conclusions:

1. What happened to the steel wool in the pad?
2. What caused this reaction?
3. Using the same analogy, explain why the rocks on Mars appear to be red.

Mission to Mars

In his 1991 State of the Union message, President George Bush announced that a U.S. goal would be to send a human expedition to Mars by the 50th anniversary of the first human landing on the Moon. That anniversary will be in the year 2019!

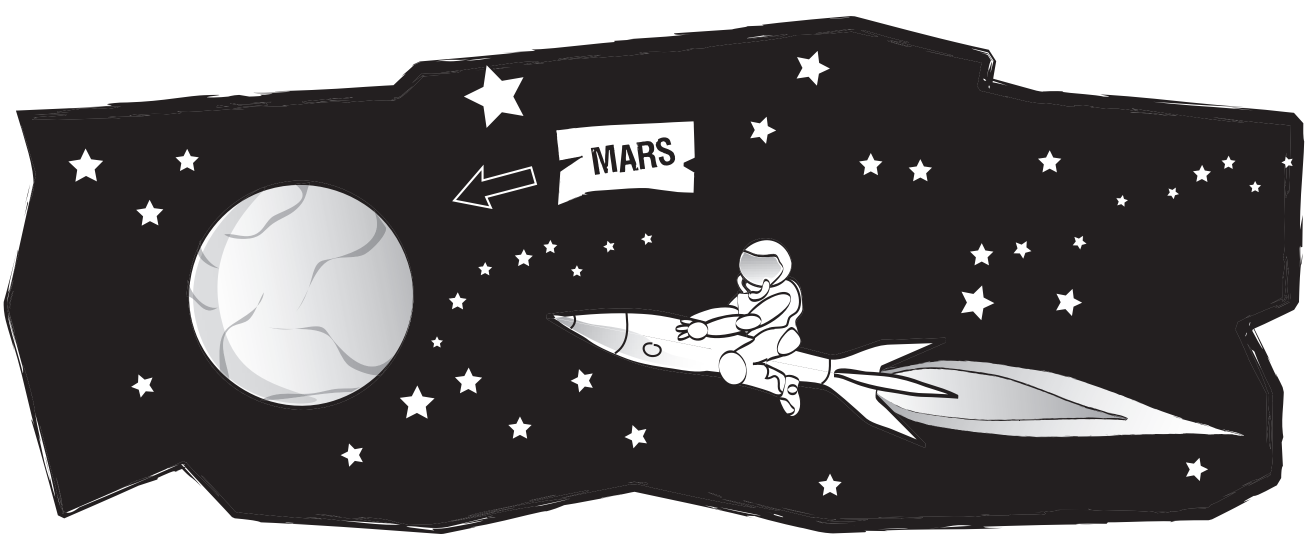
A trip to Mars will probably take nine months. The crew will have to spend about two months on Mars before they can head back to Earth. The return trip will also be nine months. The entire trip will be almost two years.

Before humans can be sent from Earth to Mars, it will be necessary to determine what types of professional people will be needed to properly establish the Mars colony. Your task is to create a list of the first crew and to justify your choices.

In your group, discuss and answer the following questions:

1. How many people should go on this first mission to Mars?
2. Which of the professions listed below are most necessary to the success of the mission? Which are the least?
   a. Doctor, geologist, chemist, zoologist, nurse, astronomer, botanist, computer expert, journalist, geographer, teacher, electrical technician, pilot, telecommunications expert, construction worker, dentist, physical fitness trainer, engineer, law enforcement officer, and lawyer
3. Should the crew be all military, all civilians, or a mixture of both?
4. Should the crew be all females, all males, or a mixture of both?
5. Who will be the first person to step on the surface of Mars? What should his/her first words be? Remember that everyone on Earth will be listening. Consider Neil Armstrong's message from the Moon, "That's one small step for man, one giant leap for mankind!" Write your own message.

Share your decisions and justifications with the class in the form of a written report, poster, video, Power Point presentation, or in some other appropriate way.



Answer Key

Astronaut Geography

1. There are nine states that do not have astronauts. They are Alaska, Idaho, Illinois, Indiana, Iowa, Kansas, Montana, Nevada, and Wyoming.
2. Thirty-three states have fewer than 10 astronauts.
3. California has the most astronauts with 21.
4. Answers will vary.
5. Answers will vary but might include that the populations of the various states might influence the number of astronauts, that different states may have programs that encourage space careers, and so on.

The Taste of the Matter

1. Answers will vary.
2. Answers will vary.
3. Answers will vary but should include that having astronauts taste the food prior to their going into space helps to ensure that the astronauts will have foods that they like and will eat and will also help ensure that they will receive a balanced diet.

Round and Round We Go

1. As you revolved around the "Sun," you saw different areas of the "Moon" illuminated.
2. The shadows changed because from where you were able to observe the "Moon," you could not always see the entire lit surface. Sometimes you just saw part of the lit half of the Moon.
3. We only see one side of the Moon because the Moon rotates at the same rate it revolves. For example, as the Moon revolves halfway around the Earth, it also rotates halfway around its axis, and the same side remains facing the Earth. Try it!

Moon Craters

1. When you increased the drop height of the balls, the crater became larger in diameter.

3. Answers will vary.

Dressing for Space

1. Many layers are needed to protect the astronaut. The underwear with tubes is used to cool the astronauts, and the many layers of the suit are to protect the astronaut from radiation, micrometeorites, and other hazards of space.
2. Answers will vary but should include that it would be very difficult to move and perform tasks in such bulky clothing.

The Red Planet

1. The steel wool in the pad became fragile and crumbly, leaving a reddish-orange residue (rust or iron oxide).
2. This reaction is caused as the iron in the steel wool mixes with water and oxygen in the air, thus creating the rust. Many rocks on Mars contain iron-bearing minerals. These minerals have slowly rusted, leaving a ruddy dust on the surface and in the atmosphere.

On the Web
Moonlight of the Night

1. After a full Moon, the Moon began to get smaller. From Earth, we are able to see less and less of the lit surface of the Moon.
2. After a new Moon, the Moon began to get larger. From Earth, we are able to see more and more of the lit surface of the Moon.
3. Waxing means to grow larger, stronger, fuller, or more numerous. When the Moon goes from a new Moon to a full Moon it is waxing. Waning means to grow gradually smaller or less. As the Moon goes from a full Moon to a new Moon it is waning.

Too Short?

1. The balloon on the baby food jar bulged upward when you pulled the neck of the balloon on the large jar upward.
2. Pushing down on the balloon made the balloon sink in.
3. On Earth, gravity holds the separate discs in the spinal cord tightly together. In a low-gravity environment such as space, a reduction in gravity allows the spinal cord to separate and pull apart.
4. The separating and pulling apart of the spinal cord in a low-gravity environment would result in an instant growth spurt.

Segment 3

After learning that space travel is going to take a little longer than the tree house detectives had anticipated, they decide to learn more about traveling in space. They meet up with Dr. D at Busch Gardens to ride a few roller coasters to learn about gravity, acceleration, G-forces, and weightlessness. After having way too much fun, they decide that their next stop is to visit NASA's Starship 2040, where Mr. Wang of NASA Marshall Space Flight Center explains and shows them what space travel will be like in about 50 years. The tree house detectives realize that no matter where they go for their "out-of-this-world" vacation, they will need to have a different rocket (propulsion) system than is currently available. They decide to visit Dr. Franklin Chang-Diaz of NASA Johnson Space Center to learn more about plasma rockets and how they will help us travel faster in the future.

Objectives

The students will

- understand that gravity is an attractive force.
- understand that microgravity is free-falling.
- learn what future space travel will be like.
- learn how rockets are powered.

Vocabulary

acceleration—the rate of change of velocity with respect to time

fusion—the act or process of melting or making fluid by heat; the union of light atomic nuclei to form heavier nuclei resulting in the release of enormous quantities of energy

inertia—a property of matter by which it remains at rest or in unchanging motion unless acted on by some external force

navigation—the science of getting ships, aircraft, or spacecraft from place to place; especially the method of figuring out position, course, and distance traveled

parabola—a curve formed by the intersection of a cone with a plane parallel to a straight line in its surface; something that is bowl-shaped

plasma—a collection of charged particles (as in the atmospheres of stars) that shows some characteristics of a gas but that differs from a gas in being a good conductor of electricity and in being affected by a magnetic field

propulsion—the action of pushing or driving, usually forward or onward

satellite—any object that revolves around another object

weightlessness—having little weight; lacking apparent gravitational pull

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. Prior to viewing Segment 3 of *The Case of the Galactic Vacation,* discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site and have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 2. Use tools located on the web, as was previously mentioned in Segment 1.
4. Focus Questions–Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program to answer the questions. An icon will appear when the answer is near.
5. What's Up? Questions–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. These questions can be printed from the web site ahead of time for students to copy into their science journals.

View Segment 3 of the Video

For optimal educational benefit, view *The Case of the Galactic Vacation* in 15-minute segments and not in its entirety. If you are viewing 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. Have students work in small groups or as a class to discuss and list what new information they have learned about the solar system, the Moon, Mars, and space travel. Organize the information, place it on the Problem Board, and determine if any of the students' questions from Segment 2 were answered.
4. Decide what additional information is needed for the tree house detectives to design their "out-of-this-world" vacation. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
6. If time did not permit you to begin the web activity at the conclusion of Segments 1 or 2, refer to number 6 under "After Viewing" on page 15 and begin the Problem-Based Learning (PBL) activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, PBL activity:

   • **Research Rack**–books, internet sites, and research tools

   • **Problem-Solving Tools**–tools and strategies to help guide the problem-solving process.

   • **Dr. D's Lab**–interactive activities and simulations

   • **Media Zone**–interviews with experts from this segment

   • **Expert's Corner**–listing of Ask-An-Expert sites and biographies of experts featured in the broadcast
7. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the PBL Facilitator Prompting Questions instructional tool found in the educator area of the web site.
8. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. Visit the Research Rack in the tree house, the online PBL investigation main menu section, "Problem-Solving Tools," and the "Tools" section of the educator's area for more assessment ideas and tools.

Careers

chemical engineer
roller coaster designer
flight controller
mission specialist
flight surgeon

Resources

Books

Challoner, Jack: *Eyewitness: Energy*. DK Publishing, 2000, ISBN: 0789455765.

Daynes, Katie: *Living in Space*. Usborne Publishing Ltd., 2003, ISBN: 0794503012.

Farndon, John: *Rockets and Other Spacecraft*. Millbrook, 2000, ISBN: 0761308407.

Hopping, Lorraine Jean: Sally Ride: *Space Pioneer*. McGraw-Hill Trade, 2000, ISBN: 0071357408.

Lafferty, Peter: *Eyewitness: Force & Motion*. DK Publishing, 2000, ISBN: 0789448823.

Langille, Jacqueline and Bobbie Kalman: *The Space Shuttle (Eye on the Universe)*. Crabtree Publishing, 1998, ISBN: 0865056889.

Simon, Seymour: *Destination: Space.* HarperCollins Children's Books, 2002, ISBN: 0688162908.

Skurzynski, Gloria: *Zero Gravity*. Simon & Schuster, 1994, ASIN: 0027829251.

VanCleave, Janice: *Janice VanCleave's Gravity: Mind-boggling Experiments You Can turn Into Science Fair Projects*. John Wiley & Sons, 1992, ISBN: 0471550507.

Vogt, Gregory: *Rockets (Exploring Space)*. Bridgestone Books, 1999, ISBN: 0736801987.

Wiese, Jim: *Cosmic Science: Over 40 Gravity-Defying, Earth-Orbiting, Space-Cruising Activities for Kids*. John Wiley & Sons, 1997, ISBN: 0471158526.

Web Sites

NASA's Beginners Guide to Propulsion
This web site provides background information for teachers on basic propulsion.
http://www.grc.nasa.gov/WWW/K-12/airplane/bgp.html

NASA's Beginners Guide To Model Rockets
This web site provides background information for teachers on basic rocketry.
http://www.grc.nasa.gov/WWW/K-12/airplane/bgmr.html

NASA Kids
This site is an extraordinary site for students and teachers. Kids can play games, learn what they would weigh on another planet, print coloring pages, explore space and rockets, and much more!
http://kids.msfc.nasa.gov/

Amazing Space: Gravity
Play "Planet Impact" and learn how a planet's gravity affects a comet path.
http://amazing-space.stsci.edu/capture/gravity/

Amazing Space
Visit this web site for a wealth of information and resources. Games, information, pictures, and lesson plans are available for just about everything that has to do with space, from black holes to the electromagnetic spectrum.
http://amazing-space.stsci.edu/capture/

Activities and Worksheets

There's a Micro in My Gravity? Two Fun Activities

Problem

To understand microgravity*

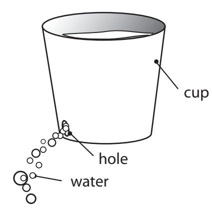
At the Drop of a Cup

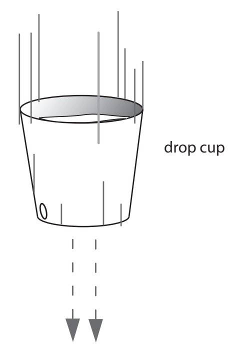
Materials

foam cup
pencil or scissors
water
large tub or basin
science journal

Procedure

1. Using a sharp pencil or scissors, punch a small hole in the side of the cup near its bottom.
2. Hold your thumb over the hole as you fill it with water. What will happen if you move your thumb?
3. Hold the cup over a large tub and remove your thumb. Observe and record your observations in your science journal.
4. Hold your thumb over the hole again and fill cup with water.
5. Hold the cup up as high as you can. Drop the filled cup into the tub. Record your observations.





Conclusion

1. What happened when you removed your thumb in step 2? Why?
2. What happened when you dropped the cup? Why?

The Weight is Falling

Materials

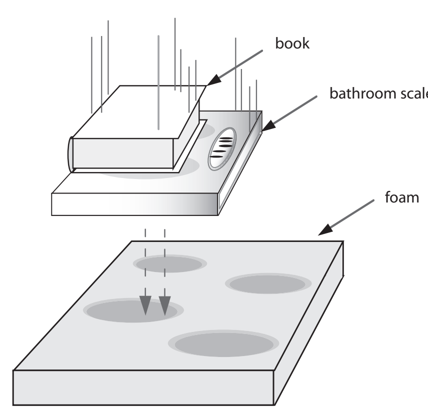
bathroom scale
heavy book
large pillow or foam
science journal

Procedure

1. Place a heavy book on a bathroom scale and record the book's weight in your science journal.
2. Hold the scale with the book on it 1 meter over a large pillow or piece of foam.
3. Let go of the scale so that the book and the scale fall together. As it drops, quickly observe the book's weight. Record.

Conclusion

1. What happened to the weight of the book when you dropped the book and the scale together? Explain.
2. Using what you have observed in these two activities, explain why astronauts experience microgravity in space.
3. Where can you experience microgravity?



*** Microgravity Defined**

The prefix micro- (m) derives from the original Greek mikros meaning small. By this definition, a microgravity environment is one in which the apparent weight of a system is small compared to its actual weight due to gravity. Quantitative systems of measurement, such as the metric system, commonly use micro- to mean one part in a million. Using that definition, the apparent weight experienced by an object in a microgravity environment would be one-millionth (10) of that experienced at Earth's surface. The use of the term microgravity in this guide will correspond to the first definition.

All Aboard for Destinations Unknown

Purpose

To build a model space ship to simulate travel to space

Materials

boxes of various sizes
Velcro®
poster board
markers
glue
2-liter bottles
milk cartons
various objects as needed

Procedure

1. You are in charge of the first tourist space mission and it is your job to design a spacecraft that will be comfortable, safe, and practical for trips into space.
2. Below find some suggestions on how to construct a spacecraft, but be creative!
   a. Stack three or four boxes of different sizes on top of each other. Cut a door in the biggest box and a hole in the top of it. Fasten a second, slightly smaller box over this box with the open side down. Make a cone from poster board and attach it to the top of the space shuttle. Paint the space shuttle with white paint and draw a NASA insignia on the side.
   b. Use a large refrigerator box with a cone-shaped roof attached. Cut windows in the side of the box and cover with clear plastic. Attached shuttle wings on the sides. Paint.
   c. For inside your space shuttle use Velcro® to attach items such as pens, small notebooks, glasses, telescopes, silverware, mirrors, toothbrushes, combs, etc.
3. Design life support gear for astronauts to wear while working outside the spacecraft. You might want to use plastic milk cartons with aquarium tubing attached to a 2-liter bottle (oxygen tank) to create space helmets. Also, don't forget to provide a way for the astronauts to tether themselves to the spacecraft while working outside. We wouldn't want to lose anyone!
4. Share and enjoy your spacecraft with your classmates! If possible, find music that is appropriate for "space" travel and play it to soothe the passengers.

Extension

1. Design a brochure describing the first tourist flight and the destinations that are planned for the trip. Be sure to include activities for your travelers while they are on their long journey.

Rocket Go Round

Problem To understand the action-reaction principle of a rocket

Background Newton's Third Law of Motion states that every action is accompanied by an opposite and equal reaction.

Materials

- wooden pencil with eraser
- straight pen
- round balloon
- flexible straw
- tape
- safety goggles

Procedure

1. To stretch out the balloon, blow it up and release the air several times.
2. Place the end of the straw without the bend inside the open neck of the balloon. See diagram 1.
3. Use a small piece of tape to seal the balloon to the straw. The balloon should inflate when you blow through the straw.
4. Bend the straw at a right angle. See diagram 2.
5. Place the straw and balloon onto one of your fingers and move it around until it balances.
6. At the balance point (the place where your finger is touching the straw when it balances), push the straight pen through the straw.
7. Push the straight pen into the center of the eraser and finally into the wood of the pencil. See diagram 3.
8. Spin the straw a few times to loosen up the hole the pen made in the straw.
9. Put on safety goggles.
10. Once it spins freely, blow up the balloon and hold your finger over the end of the straw to keep the air from escaping.
11. Hold the pencil away from your body and then release the straw.

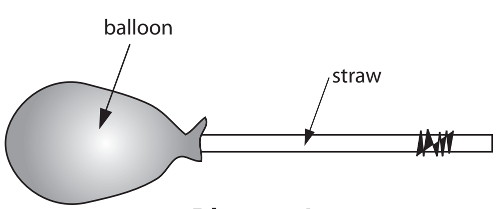


Diagram 1

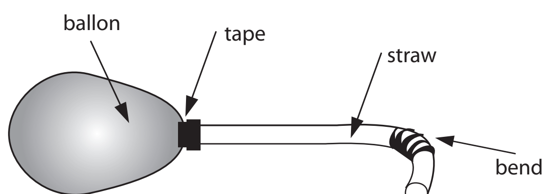


Diagram 2

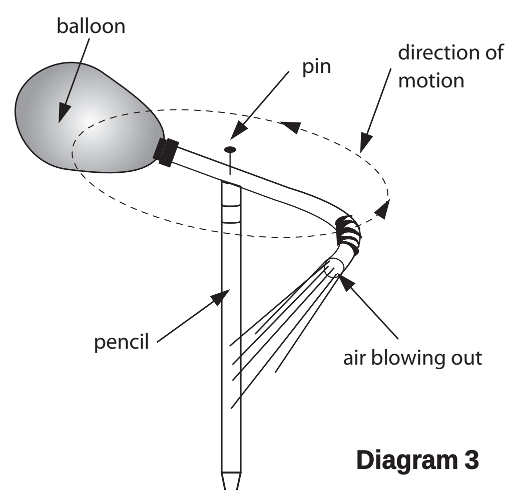


Diagram 3

Conclusion

1. In which direction did the straw and balloon spin? Why?
2. Use Newton's Third Law to explain what happened in this experiment.

Rocket Racer

Purpose

To observe Newton's Third Law of Motion to understand the principles behind rockets

Materials

foam meat tray
tape
flexible straw
scissors
4 pins
marker
rounded balloon
metric ruler
pencil
wheel pattern (p. 52)
masking tape

Procedure

1. Using scissors cut out the wheel patterns.
2. Place the patterns on the foam meat tray and trace around the edges.
3. Use the metric ruler to draw a rectangle 7.5 cm by 18 cm on the foam meat tray. See diagram 1.
4. Blow up the balloon a few times to stretch it out.
5. Place the end of the straw with the bend inside the open neck of the balloon.
6. Use a small piece of tape to seal the balloon to the straw. The balloon should inflate when you blow through the straw.
7. Lay the straw in the center of the rectangle, having the end without the balloon hanging 1 cm over the front edge. Bend the straw upward at the bendable section and tape the entire straw into place. See diagram 2.
8. Push the pins through the hubcaps into the wheels and then into the edges of the rectangle. See diagram 3.
9. Make a starting line by placing a piece of masking tape on the floor.
10. Blow up the balloon and pinch the end of the straw to hold in the air.
11. Place the racer on the floor at the starting line and release. See diagram 4.
12. Measure the distance that your racer traveled and record in your science journal.
13. Discuss how you could improve your Rocket Racer so that it might go farther.
14. Make any changes decided upon and repeat steps 10-13.
15. Repeat for two more trials.
16. Find the average distance your Rocket Racer traveled in all four trials.

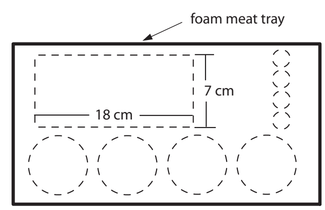


Diagram 1

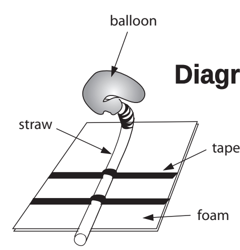


Diagram 2

Diagram 3

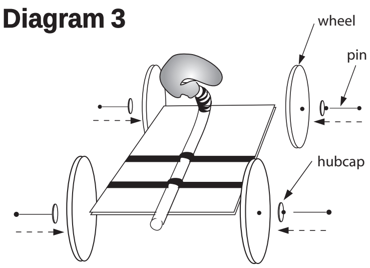
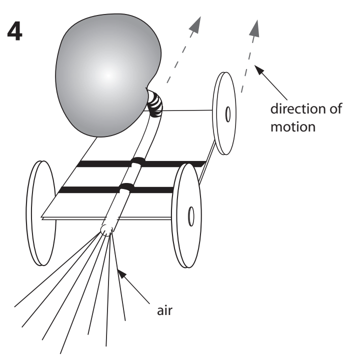


Diagram 4



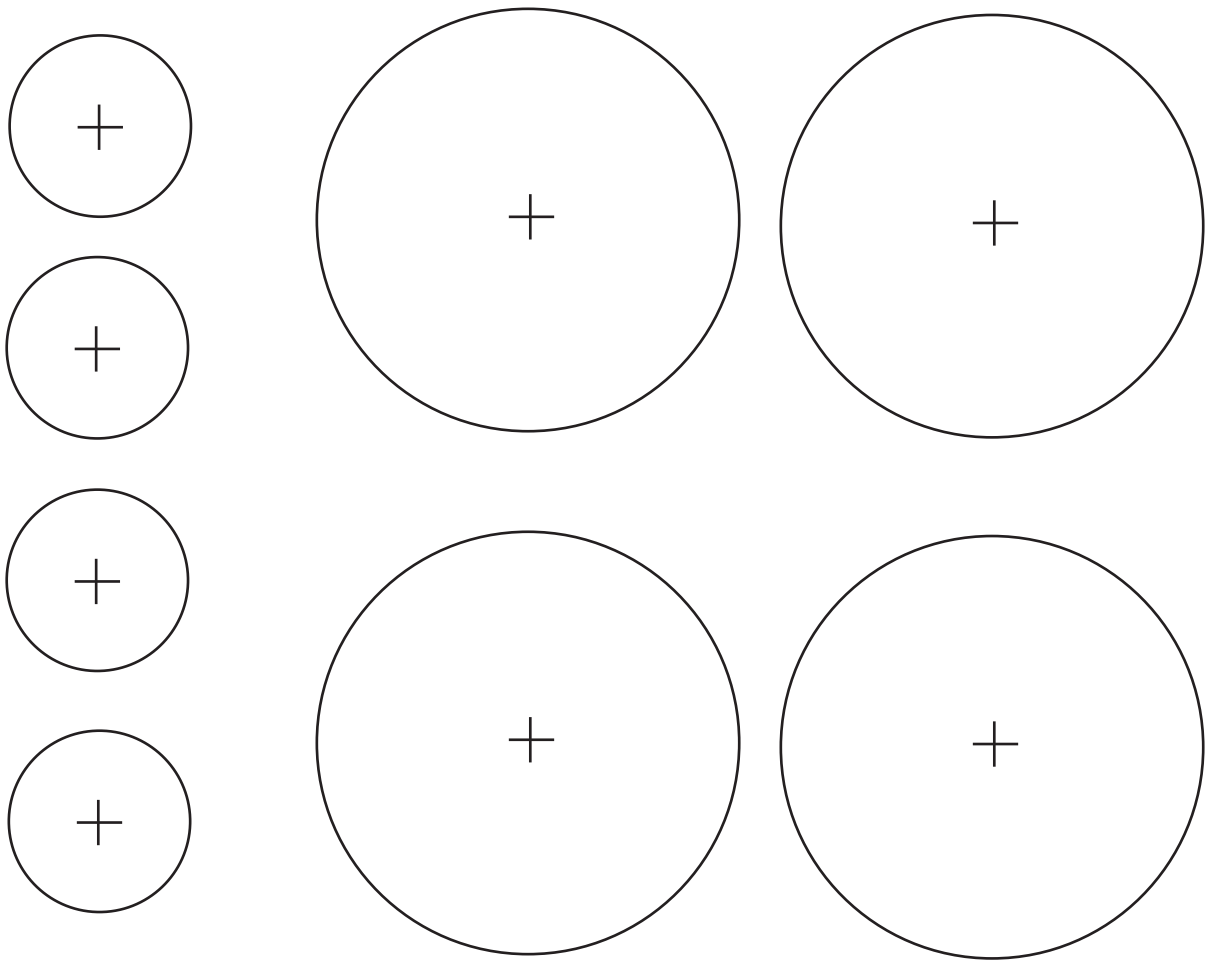
Conclusion

1. Did your Rocket Racer travel the same distance each time? Why or why not?
2. Explain how the Rocket Racer got its power to travel.
3. What could you do to improve your Rocket Racer?

Rocket Racer (concluded)

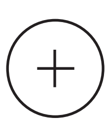
Wheel Patterns

Crosses mark the centers



Hubcap Patterns

Crosses mark the centers



There's an Ant In Your Acid

Materials

effervescent antacid tablets (4 per group)
2 glass jars (same size)
tweezers or forceps
scrap paper
watch or clock with second hand
thermometer
goggles
water (warm and cold)
metric-measuring cup
wooden block

Problem

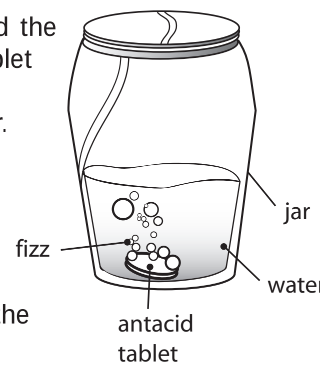
To investigate methods of increasing the power of rocket fuels by manipulating surface area and temperature

Background

When rocket propellants (fuel) burn faster, the amount (mass) of exhaust gases expelled increases and so does the speed at which gases accelerate out of the rocket nozzle. Newton's Second Law of Motion states that the force of a rocket engine is directly proportional to the mass expelled times its acceleration.

Procedure

1. Fill each jar with 50 ml of tap water.
2. Put on your goggles.
3. Predict how long it will take for the tablet to dissolve in the water. Record your prediction in the chart below.
4. Drop one of the tablets into the first jar and using a clock with a second hand, time how long it takes for the tablet to dissolve. Record in the chart below.
5. Place a second tablet on a piece of paper and wrap it around the tablet. Use a wooden block or other heavy item to crush the tablet into small pieces.
6. Predict how long it will take for the tablet to dissolve in the water. Record your prediction.
7. Drop the crushed tablet into the second jar and time how long it takes to dissolve. Record.
8. Empty both jars and rinse thoroughly.
9. Fill the first jar with 50 ml of very warm water.
10. Place a thermometer in the jar and wait a minute or two. Record the temperature reading on the thermometer in the chart below.
11. Predict how long it will take for the tablet to dissolve and record.



	Prediction	Actual Dissolving Time	Observation Notes
Tap Water Whole Tablet			
Tap Water Crushed Tablet			
Warm Water			
Cold Water			

12. Drop the tablet into the warm water and time how long it takes to dissolve. Record.
13. Add 50 ml of very cold water to the second jar and repeat steps 10-12.

Conclusion

1. Which tablet dissolved faster, the whole tablet or the crushed tablet? Why?
2. Which tablet dissolved faster, the one in warm water or the one in cold water? Why?
3. Using what you learned from this experiment, how could you make the tablet dissolve even faster?
4. How would this information help scientists make rockets go faster?

Answer Key

There's a Micro in My Gravity?

A Drop of a Cup

1. When you removed your thumb, the water poured out of the hole in the cup because the force of gravity pulled the water down toward the Earth.
2. When you dropped the cup, the water did not come out the hole because the water was in a state of freefalling. Even though the water stayed in the cup, it was still attracted to the Earth by gravity and ended up in the same place that the water did in the first experiment!

The Weight is Falling

1. When you dropped the book and the scale together, the weight went to zero because both the book and the scale were falling toward the Earth at the same time, creating microgravity.
2. Astronauts in space and the space shuttle are both falling toward Earth at the same rate of speed. The freefall creates microgravity and allows the astronauts to "float."
3. Answers will vary but might include roller coaster rides, springboard (diving), and elevators.

Rocket Go Round

1. The balloon spun in the opposite direction of the air coming out the end of the straw.
2. The balloon produces an action by squeezing on the air inside, causing it to rush out the straw. The air, traveling around the bend in the straw creates a reaction force at a right angle to the straw. The result is that the balloon and straw spin around the pin.

Rocket Racer

1. Answers will vary, but most likely the Rocket Racer did not travel the same distance each time. The difference in distance could have been due to different amounts of air being used to blow up the balloons or variances in the wheels (roundness, smooth edges, and so on).
2. The Rocket Racer is propelled along the floor according to the principle stated in Newton's Third Law of Motion, "For every action there is an opposite and equal reaction." Because the balloon is attached to the car, the force of the air expelling from the balloon pulls the car along.
3. Answers will vary but might include smoothing out the edges of the wheels, blowing the balloon up with more air, using different materials, and so on.

There's an Ant In Your Acid

1. The crushed tablet dissolved faster because when you crushed the tablet, you increased the surface area. Increasing the surface area increases its reaction rate with the water.
2. The tablet in warm water dissolved faster because tablets in warm water react more quickly than tablets in cold water. The heat helps to speed up the reaction.
3. A combination of a crushed tablet and warm water would provide the faster way to dissolve the tablet.
4. In a rocket, scientists can make the rocket's thrust greater by increasing the burning surface area of its propellant and by adding heat or preheating the propellant.

Segment 4

As the tree house detectives wind up their investigation, they call on Bianca to learn more about the stars and galaxies. Bianca is beginning her internship at the Arecibo Observatory in Puerto Rico. Arecibo is the home of the largest radio telescope in the world. Dr. D, who just happens to be at Arecibo, gives Bianca a tour of the night sky and helps her understand the differences among stars. The next day, Bianca meets with Dr. Daniel Altschuler, Dr. Tapasi Ghosh, and Dr. Jose Alonso, who help her understand how a radio telescope works and how it is used to study the stars, planets, and other objects in the universe. After a successful internship and a great time in Puerto Rico, Bianca heads home to help the rest of the detectives wrap up their project and create an "out-of-this-world" vacation.

Objectives

The students will

- understand how a telescope works.
- understand the conditions necessary for life on planets outside our solar system.
- be able to identify two types of stars.
- be able to identify constellations.
- understand that stars are various colors.
- identify three types of galaxies.
- learn how a radio telescope works.
- learn the importance for searching for life in the universe.

Vocabulary

constellation—a grouping of stars that has a shape resembling an animal, mythological character, or other object and thus is named for it

dwarf star—a star that in comparison to other stars gives off an ordinary or small amount of energy and has small mass and size

extraterrestrial—coming from or existing outside the Earth or its atmosphere

galaxy—a massive grouping of gas, dust, and stars in space held together by gravity

giant star—a late stage in a star's life cycle in which the core has contracted and grown hotter, causing its outer layers to expand

nebula—a large cloud of gas and dust in space that is the beginning of a star

radio telescope—an instrument that uses a large antenna to gather radio waves from space for use in studying space objects and communicating with artificial satellites and probes

radio waves—electromagnetic waves having long wavelengths; we use them to transmit voice, music, video, and data over distances

reflecting telescope—an optical instrument that uses a concave mirror, a flat mirror, and a convex lens to magnify distant objects

star—a ball-shaped gaseous celestial body (such as the Sun) of great mass that shines by its own light

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich the 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. Prior to viewing Segment 4 of *The Case of the Galactic Vacation*, discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site in the tree house section and have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 3 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 3. Use tools located on the Web, as was previously mentioned in Segment 3.
4. Focus Questions–Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program to answer the questions. An icon will appear when the answer is near.

View Segment 4 of the Video

For optimal educational benefit, view *The Case of the Galactic Vacation* in 15-minute segments and not in its entirety. If you are viewing 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. At the end of Segment 4, lead students in a discussion of the focus questions for Segment 4.
2. Have students discuss and reflect upon the process that the tree house detectives used to design their "out-of-this-world" vacation. The following instructional tools located in the educator's area of the web site may aid in the discussion: Experimental Inquiry Process Flowchart and/or Scientific Method Flowchart.
3. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
4. Wrap up the featured online Problem-Based Learning investigation. Evaluate the students' or teams' final product, generated to represent the online PBL investigation. Sample evaluation tools can be found in the educator area of the web site under the main menu topic "Tools" by clicking on the "Instructional Tools."
5. Have students write in their journals what they have learned about our solar system, the Moon, Mars, stars, galaxies, and/or the problem-solving process and share their entry with a partner or the class.

Careers

telescope operator
atomic scientist
biomedical engineer
technician
payload specialist

Resources

Books

Berger, Melvin and Gilda Berger: *Do Stars Have Points?: Questions and Answers About Stars and Planets (Scholastic Question-And-Answer).* Scholastic, 1999, ISBN: 0439085705.

Berger, Melvin and Gilda Berger: *Can You hear a Shout in Space?: Questions and Answers About Space Exploration (Scholastic Question-And-Answer).* Scholastic, 2001, ISBN: 0439148790.

Dickinson, Terrence: *Exploring the Night Sky: The Equinox Astronomy Guide for Beginners*. Firefly Books, 1988, ISBN: 092065668.

Gribbin, John R. and Mary Gribbin: *Eyewitness: Time & Space*. DK Publishing, 2000, ISBN: 0789455781.

Jackson, Ellen: *Looking for Life in the Universe*. Houghton Mifflin Company, 2002, ISBN: 0618128948.

Lippincott, Kristen: *Eyewitness: Astronomy*. DK Publishing, 2000, ISBN: 0789448882.

McDonald, Kim: *Life in Outer Space: The Search for Extraterrestrials (Space Explorer)*. Raintree/Steck-Vaughn, 2000, ISBN: 0739822233.

Simon, Seymour: *Galaxies*. William Morrow & Company Library, 1988, ASIN: 0688080049.

Simon, Seymour: *The Universe.* Harper Trophy, 2000, ISBN: 0064437523.

Stott, Carole and Clint Twist: *Backpack Books: 1001 Facts About Space*. DK Publishing, 2002, ISBN: 0789484501.

Thompson, C. E.: *Glow-In-The-Dark Constellations: A Field Guide for Young Stargazers*. Grosset & Dunlap, 1999, ISBN: 0448412535.

Resources (concluded)

Web Sites

NASA Star Child
This web site is a learning center for young astronomers written on two levels. Explore the solar system, universe, and other space stuff. This site is also offered in Spanish.
http://kids.msfc.nasa.gov/Sites/ExternSite.asp?url=http%3A%2F%2Fstarchild%2Egsfc%2Enasa%2Egov%2F

NASA's Observatorium
This web site is full of Earth and space data with pictures of the Earth, planets, stars, and other cool stuff, as well as the stories behind the images. Students can play games and teachers can find a wealth of lesson plans and information.
http://kids.msfc.nasa.gov/Sites/ExternSite.asp?url=http%3A%2F%2Fobserve%2Earc%2Enasa%2Egov%2F

NASA's Astro-Venture
Transport yourself to the future and work for NASA as you search for and build a planet with the necessary characteristics for human habitation. Also available are student fact sheets, trading cards, classroom lessons, and much more.
http://kids.msfc.nasa.gov/Sites/ExternSite.asp?url=http%3A%2F%2Fastroventure%2Earc%2Enasa%2Egov%2F

NASA SpaceKids™
Visit this site to send your name to Mars, organize a star gazing party, learn about Solar Max, and much more. There is also a junior astronomer club, a teacher corner, and web cast of meteor showers to view.
http://spacekids.hq.nasa.gov/

Amazing Space: Galaxies
Visit this site to learn about galaxies. Click on "Galaxies Galore, Games and More" and learn about our Milky Way galaxy, play games, count galaxies in deep space, and much more.
http://amazing-space.stsci.edu/capture/galaxies/

New Views of the Universe
The companion site to Hubble Space Telescope: New Views of the Universe, a Smithsonian traveling exhibition. This web site takes visitors on a journey into Hubble's amazing universe through cool pictures, interactives, and movies.
http://hstexhibit.stsci.edu

The Hubble Telescope
Share in Hubble's remarkable discoveries with the latest in Hubble news, pictures, information, and resources.
http://hubble.stsci.edu/

Activities and Worksheets

In the Guide

On the Web

Galaxies Galore
Create mini galaxies to learn the three basic shapes of galaxies.

Signals from Space
Look for radio waves to understand how astronomers search for intelligent extraterrestrial life.

Counting Your Lucky Stars

Problem

To understand how astronomers use sampling to estimate the number of stars in the universe

Materials

Star Field Sheet (p. 61)
pencils
scissors
science journal

Background

There are two principal ways of gathering data: using census (counting) or sampling. Sometimes it is impractical to count every single item such as each character on a classified ad page in the newspaper. Instead, you can count the number of characters in a small area and then mathematically calculate an estimate of the total number on the page. This method is called sampling. Astronomers use sampling to estimate the number of stars in a galaxy and even in the universe.

Procedure

1. Observe the Star Field Sheet and estimate the number of stars it contains. Record your estimate in the chart below.
2. On the Star Field Sheet, cut out the sampling window along the solid lines.
3. Fold the window in half, with the pattern lines on the outside, and cut along the dashed lines. Unfold the window.
4. Hold the window about 30 cm above the Star Field Sheet and drop. Make sure the window lands completely within the boundaries of the star field. If not, drop the window again.
5. Count the number of stars within the window, being careful not to bump or move the window. Count any stars that have at least 50% of their area in the window. Record the number of stars in the chart below.
6. Repeat steps 3-5 for two more trials.
7. Average the number of stars sampled and record.
8. Look at the Star Field Sheet and count the number of squares that make up the star field.
9. Multiply the number of squares in the star field by the average number of stars you counted in your samplings.
10. To find out how close your sampling is to the actual number of stars, divide the squares among your classmates and have each person count the stars in his/her square. Record in a class chart and find the sum of all the squares.

	Prediction	Average	Number of squares in the Star Field	Approximate Number of Stars in Star Field	Actual Number of Stars
Trial 1					
Trial 2					
Trial 3					
Total:					

Multiply average number of stars by number of squares.

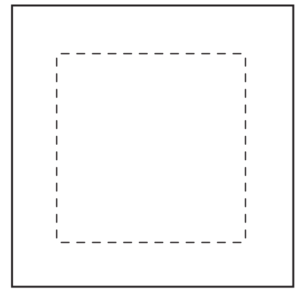
Conclusion

1. How did your prediction compare to the approximate number of stars determined by sampling?
2. How did the approximate number of stars determined by sampling compare to the actual number of stars?
3. Why would astronomers use sampling to estimate the number of stars in the night sky?
4. What could you do to improve the accuracy of the sampling?
5. How else could sampling be used?

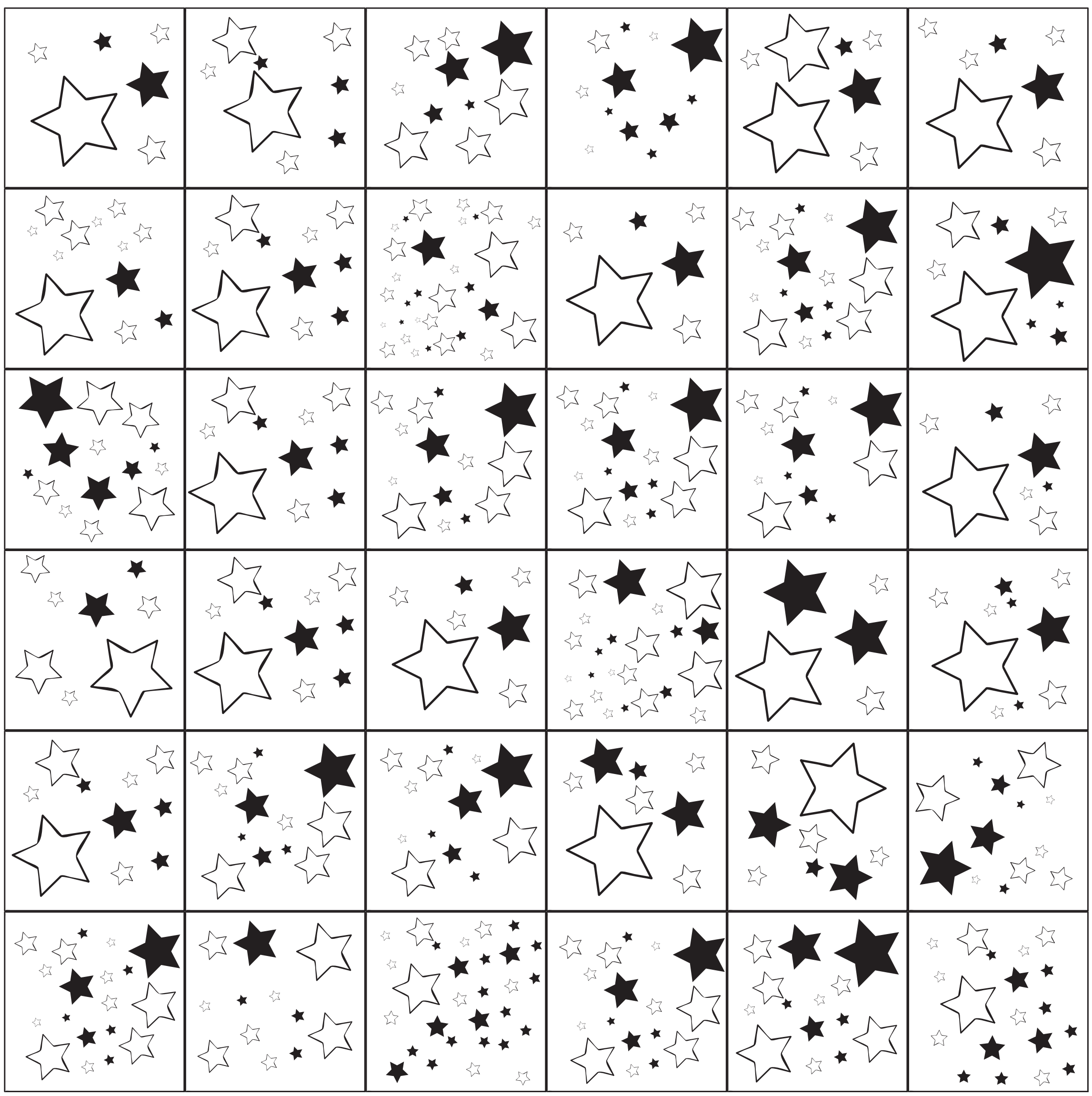
Counting Your Lucky Stars (concluded)

Extension

Conduct this experiment using the classified ad section of a local newspaper. Instead of stars, the students will be determining the number of characters on a page. Spaces don't count. To determine the actual number of characters on the page, cut the page into enough pieces for all students to have one and have them count the characters in their own sections.



Star Field Sheet



Just a Wobble Away

Problem

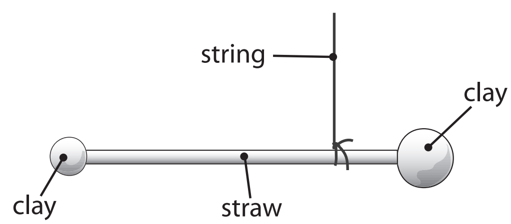
To learn how astronomers locate planets in other star systems

Materials

40-cm string
2 plastic straws
clay
science journal

Procedure

1. Loosely tie one end of the string around a drinking straw so that the knot slides back and forth along the straw.
2. Roll the clay to form a ball the size of a golf ball (represents a star).
3. Place the ball of clay on the end of the straw.
4. Roll the clay to form a ball the size of a marble (represents a planet).
5. Place the ball on the other end of the straw.
6. Due to the difference in the amount of clay, one side of the straw is heavier than the other side. Therefore, you will need to find the balance point for the string. Hold the free end of the string in one hand and move the knotted end of the string toward the outer edge until the straw with the clay balances.
7. Working with your partner, hold the string by the free end and let the straw spin freely. Have your partner at eye level to observe the spinning straw. Record observations.
8. Repeat, but this time have your partner stand approximately 3-4 meters away and observe the straw as it spins. Record observations.
9. Have your partner hold a second drinking straw vertically at arm's length between his/her eye and the spinning straw. Observe and record.
10. Repeat, having your partner hold the string while you observe.



Conclusion

1. What do the straw and clay represent?
2. What did you observe at eye level? From across the room? With the second straw?
3. If a planet is near a star, will it be easy to detect? Why or why not?

Pictures in the Sky

Purpose

To learn to recognize star patterns called constellations

Teacher Note

Number of canisters will vary, depending on how the activity is completed. It can be completed either in groups of four, with each student constructing four constellation finders, or each student can construct one.

Materials

16 black 35-mm film canisters
Constellation patterns (p. 64)
scissors
tape
pushpin
dot stickers (optional)
science journal

Procedure

1. In your group divide the constellation patterns among you.
2. Using scissors, cut out the constellation patterns on the dotted line.
3. Place a pattern over the bottom of the film canister to align the solid circle with the outside rim of the canister.
4. Tape into place.
5. Using a pushpin, punch a small hole through the paper and the canister for each star in the pattern.
6. Hold the film canister to the light and look through it to make sure that you have punched the holes completely and light is seen through each.
7. Using a dot sticker, create a label for the canister with the name of the constellation and place it on the side of the canister.
8. Remove the paper from the canister.
9. Repeat steps 3-8 for any remaining constellation patterns.
10. Choose one of the canisters, read the name, and look through it to try to memorize the pattern. Slowly turn the canister counterclockwise and observe.
11. Exchange canisters within your group. Practice identifying the constellations.

Conclusion

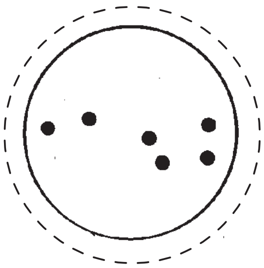
1. How did turning the canister affect the appearance of the constellation?
2. Why would constellations look different at different times of the night?

Extension

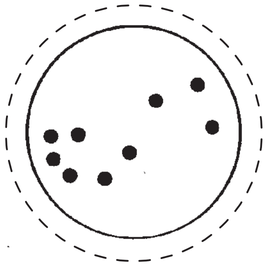
1. To have a larger viewing area, make a constellation viewfinder out of a shoe box and punch the constellations in black card stock paper that can be inserted in one end of the box (cut out a small section on one end of the box).
2. Organize a star party and observe the night sky to see how many constellations you can identify.
3. Contact your local astronomy club and arrange for volunteers to help students observe the sky with the use of telescopes.

Pictures in the Sky (concluded)

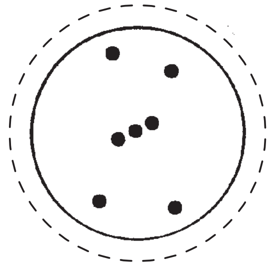
Constellation Patterns



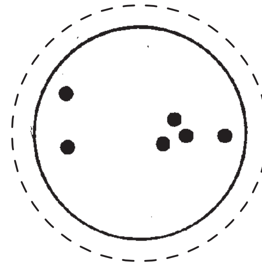
URSA MAJOR,
the Great Bear



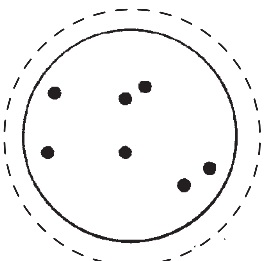
SCORPIUS,
the Scorpion



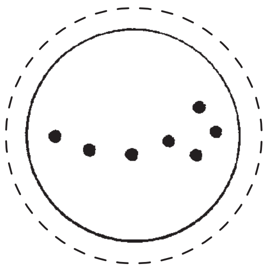
ORION,
the Hunter



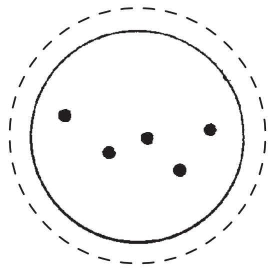
TAURUS,
the Bull



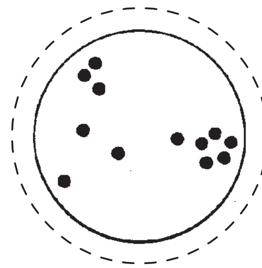
PEGASUS,
the Flying Horse



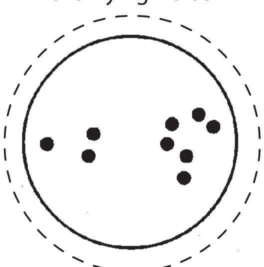
URSA MINOR,
the Little Bear



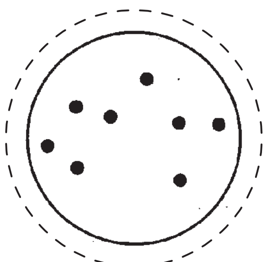
CASSIOPEIA,
the Queen



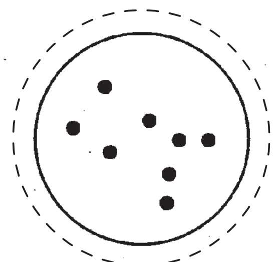
PISCES,
the Fishes



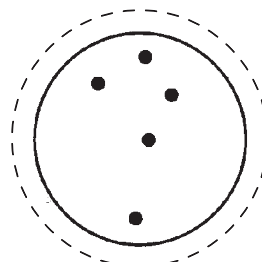
LEO,
the Lion



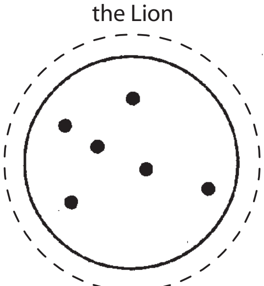
SAGITTARIUS,
the Archer



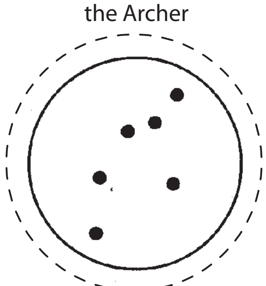
GEMINI,
the Twins



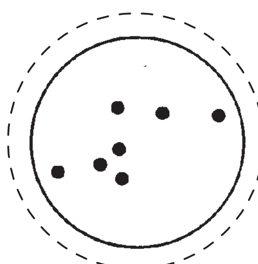
BOOTES,
the Herdsman



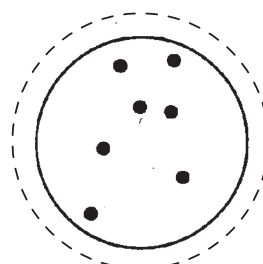
CYGNUS,
the Swan



PERSEUS



CANIS MAJOR,
the Big Dog



HERCULES

No Planets in the Planetarium

Problem

To create a classroom planetarium for students to observe a "night sky"

Materials

large, black, thick, plastic tarp
strong tape
box fan
star chart
marker
pushpin

Procedure

1. Fold tarp in half, lining up the sides as evenly as possible.
2. Using strong tape, such as duct tape, tape the two pieces of tarp together on both of the shorter sides of the tarp. See diagram 1.
3. On the longer side of the tarp, tape the edges together, leaving an opening large enough to fit a box fan plus 1 meter. See diagram 2.
4. Using a star chart, choose a portion of a night sky that you would like for the students to observe in the planetarium. You will not be able to create all of the constellations, so you might want to pick those that are more easily identified and recognized by students.
5. Use a permanent marker to draw the constellations on the outside of the top layer of the planetarium. Place the name of the constellation next to it.
6. With a pushpin, punch a hole through the top layer of the tarp at each star in the constellations.
7. If needed for better viewing, use a sharpened pencil to enlarge the holes slightly.
8. Once the constellations are completed, place a box fan at the far left of the opening in the tarp so that the air from the fan is blowing in to create a bubble. See diagram 3.
9. Secure the tarp by taping the top layer of the tarp to the top of the box fan.
10. Crawl into the tarp bubble and view the stars. Widen holes as necessary.
11. Provide star charts for the students and invite them to observe a night sky in the planetarium. This activity is best if a limited number of students go in at one time.

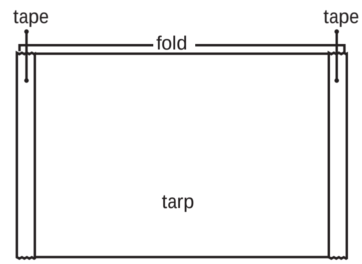


Diagram 1

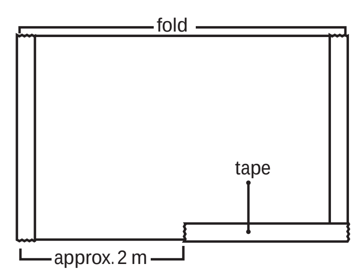


Diagram 2

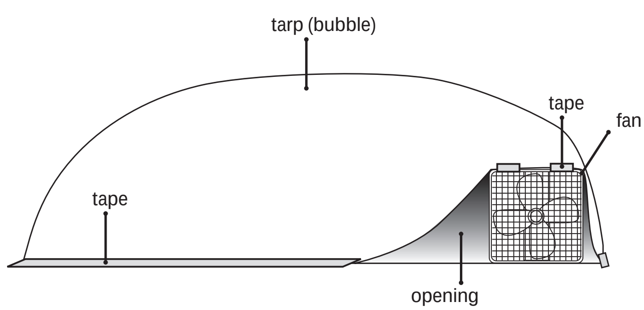


Diagram 3

Extension

1. Invite parents to a "Star Party" and have the students give tours of the night sky.
2. Have the students research the constellations and identify the stars within each grouping.
3. Have students research various folklore related to the constellations and create reports, posters, plays, or songs explaining the myths.

Galaxy Go Round

Problem

To demonstrate the movement of the Milky Way Galaxy

Materials

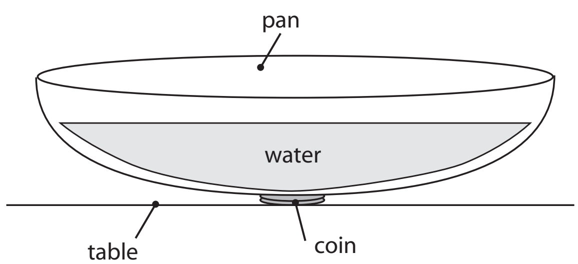
round pan
coin
water
paper holes from hole punch

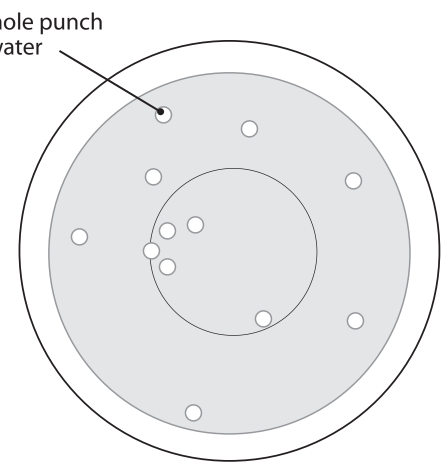
Background

A galaxy is a cluster of stars, dust, and gas held together by gravity. Galaxies range in diameter from a few thousand to a half million light years. Large galaxies have more than a trillion stars, and small galaxies have fewer than a billion. Astronomers believe that there are billions of galaxies in the universe. Astronomers classify galaxies into three basic patterns: spiral, elliptical, and irregular. Elliptical galaxies contain mostly older stars and little or no gas to make new stars. They are ball or oval shaped and may have formed early in the universe's history. Irregular galaxies are small and shapeless, but many are still actively making new stars. Spiral galaxies are easy to identify with sweeping "arms" that contain gas and dust that make new stars. Our galaxy, the Milky Way, is a spiral galaxy.

Procedure

1. Place the pan on a table and put a coin under the center of the pan. Make sure the pan can spin easily.
2. Pour about 2 cm of water into the pan.
3. Carefully sprinkle the paper holes in the center of the pan.
4. Spin the pan slowly. Observe the dots and draw your observations in your science journal.





Conclusion

1. What forms new stars?
2. What is the name of our galaxy?
3. Why are galaxies so hard to see in the night sky?

Hello! Anyone Out There?

Problem

To create a message to be sent into space and to understand the difficulty in creating and interpreting the message

Materials

magazines with lots of pictures
scissors
glue or tape
large construction paper
pencil
notebook paper
science journal

Teacher Prep

Have the students bring in magazines about a week before the project. The magazines should have pictures that show all aspects of life on Earth such as landscapes, people (different cultures), wildlife, technology, and so on. Scan the magazines for appropriate content

Background

In 1977, NASA launched two Voyager spacecraft to fly by the outer planets in our solar system. Because scientists and engineers knew that Voyagers' paths would carry them beyond our solar system and hopefully, eventually among the stars, they placed an audio-video record onboard the craft with the "sights and sounds of Earth." The disk contained 118 photographs, 90 minutes of music from all around the world, and greetings in almost 60 languages. The disk is like a "message in a bottle" set to drift in space as a token of humanity's existence. As you might imagine, the committee given the task of selecting the images and music had lots of discussions on what to include, and they only had six weeks!

Throughout the history of man, we have tried to leave messages saying that "we were here." You can see evidence in cave drawings and ancient stone tablets. It is often difficult to understand these messages and sometimes we never know what they mean. But when we decipher the messages, we are very excited to have another piece of our past unlocked.

Procedure

1. Your mission is to use 10 pictures from magazines to create a "we were here" message to be sent into space to any intelligent extraterrestrial life. This message needs to let other intelligent life know that we exist and what our world is like. Discuss the matter with your group members and come to an agreement on a message. You have 10 minutes.
2. Use scissors and cut out the chosen pictures. Decide how to arrange them on the large construction paper and glue them into place. You may not write any words on your message, only pictures. You have 10 minutes.
3. Decide upon a team name and write it on the back of the message.
4. On a sheet of notebook paper, write a paragraph summarizing the message you are trying to convey with your pictures. Put your team's name at the top of the paper, then date and sign it, being sure to include all team members' names. You have 10 minutes.
5. On the same day or a different day, imagine that you are intelligent extraterrestrial life. Your group will "intercept" a message by choosing one of the messages that have been completed.
6. As a group, try to make sense of the message and reach a consensus on what it says. Write a brief paragraph explaining what you think it is telling you. Remember that you know nothing about Earth and you can only use the pictures.
7. Once you are finished, share your findings with the class and then have the group who sent the message read its description. Compare the two messages.

Conclusion

1. How difficult was it to interpret the message?
2. What would have made it easier?
3. Would it be harder for a true extraterrestrial to understand a message sent from Earth than for an Earthling to understand a message sent by another Earthling? Why or why not?
4. What things might we have in common with other intelligent extraterrestrials?

Lost in Space

Word Bank

inner planet
light year
parallax
solar system
Apollo
Moon
axis
gravity
propulsion
satellite
star
telescope
radio waves
galaxy

P	N	C	R	U	S	T	X	A	L	L	A	R	A	P	P	A	R	A	T	U	M
U	R	M	O	S	P	S	M	G	P	S	A	B	E	H	A	G	U	Y	I	O	A
T	A	O	E	A	O	R	P	S	W	V	C	A	C	X	N	R	O	L	O	D	N
E	B	F	P	T	P	E	R	O	A	K	M	E	I	C	G	I	P	N	E	C	T
R	N	S	A	E	E	O	M	L	V	H	T	I	H	B	A	L	C	H	T	O	L
C	H	E	D	L	T	O	U	A	E	R	A	U	X	S	E	L	I	S	E	N	E
O	K	A	I	L	O	I	R	R	S	I	N	E	T	I	A	I	I	I	O	V	E
A	J	I	L	I	E	S	N	S	D	C	J	A	L	P	L	L	E	U	R	E	N
P	L	S	T	T	I	D	J	Y	I	B	R	S	T	R	E	T	O	R	I	R	T
O	R	N	T	E	C	I	R	S	N	D	A	I	E	S	I	E	V	A	T	G	I
L	E	O	N	E	C	I	P	T	I	T	E	E	T	H	S	L	A	R	E	E	A
L	Z	I	U	I	C	K	I	E	T	H	A	X	I	S	R	E	E	P	U	N	L
O	N	S	D	S	H	I	N	M	P	R	I	L	T	I	S	S	I	T	I	T	L
Y	G	L	A	R	S	Z	A	A	O	V	U	O	D	R	O	C	C	Y	A	I	I
K	I	U	N	R	T	S	R	T	R	A	I	D	N	R	N	O	N	H	J	K	R
J	S	P	Y	K	O	G	A	L	A	X	Y	Y	I	I	I	P	N	B	O	N	A
H	F	O	T	J	O	E	R	R	E	O	P	E	L	L	C	E	I	I	D	A	E
P	E	R	E	M	G	Y	A	A	R	T	C	K	C	I	B	A	T	S	T	R	Y
U	E	P	S	R	G	S	I	D	V	Z	U	U	A	E	O	I	S	H	I	C	T
Y	K	I	E	I	I	T	G	A	D	I	B	I	S	B	O	L	L	I	I	I	H
T	E	V	E	S	B	E	K	I	S	R	T	H	Y	O	M	J	A	C	O	N	G
S	I	E	M	A	I	M	O	S	C	I	N	Y	T	C	E	T	E	T	A	L	I
D	G	W	I	N	R	A	D	I	O	W	A	V	E	S	I	N	Y	I	R	P	L
I	N	N	E	R	P	L	A	N	E	T	K	E	L	F	U	R	O	E	T	E	M

Crossing Space Puzzle

Create a crossword puzzle with the following terms and the grid below.

Vocabulary

inner planets
outer planets
light year
parallax
solar system
Moon phases
axis
gravity
propulsion
satellite
star
radio telescope
galaxy

Add your own:

____
____
____
____

Across

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

Down

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

Answer Key

Counting Your Lucky Stars

1. Answers will vary.
2. Answers will vary.
3. Astronomers would use sampling to estimate the number of stars in the night sky because with billions of stars, it would be impossible to count them all in a person's lifetime.
4. Answers will vary but might include that the number of trials could be increased. The more trials, the better the estimate. Securing the window to the paper so that it does not move would also help to increase the accuracy of the sampling.
6. Sampling can be used in many ways, and some include counting populations of insects, estimating the number of people at a sporting event, and so on.

Just a Wobble Away

1. The straw and clay represent a solar system (star and planet).
2. At eye level there was very little movement. From across the room, the wobble was very difficult to see. The second straw makes it easier to see.
3. A planet near a star is difficult to detect because as a planet orbits a star, there is very little motion seen. It appears as only a slight wobble.

Pictures in the Sky

1. Turning the canister made the constellations appear upside down and sideways.
2. Even though the stars remain in the same relative position, the Earth is turning; therefore, to an observer on Earth, constellations appear to move around the sky throughout the night.

Galaxy Go Round

1. Gas and dust make new stars.
2. Our galaxy is the Milky Way Galaxy.
3. Galaxies are difficult to see in the night sky because they are so far away.

Hello! Anyone Out There?

1. Answers will vary.
2. Answers will vary but might include that it would have been easier if there were words that could be read and understood.
3. Yes. People who live on Earth have a good understanding of humans and our world. If we were to interpret a message from our own planet, we would at least have a background of information to build upon. Extraterrestrials would not have any information from which they could begin to understand the message. They might not know what a car is or even a cloud.
4. Answers will vary but might include things such as mathematical operations, prime numbers, the structure of atoms, engineering principals, knowledge of the universe, and so on.

Lost in Space Answers

P	N	C	R	U	S	T	X	A	L	L	A	R	A	P	P	A	R	A	T	U	M
U	R	M	O	S	P	S	M	G	P	S	A	B	E	H	A	G	U	Y	I	O	A
T	A	O	E	A	O	R	P	S	W	V	C	A	C	X	N	R	O	L	O	D	N
E	B	F	P	T	P	E	R	O	A	K	M	E	I	C	G	I	P	N	E	C	T
R	N	S	A	E	E	O	M	L	V	H	T	I	H	B	A	L	C	H	T	O	L
C	H	E	D	L	T	O	U	A	E	R	A	U	X	S	E	L	I	S	E	N	E
O	K	A	I	L	O	I	R	R	S	I	N	E	T	I	A	I	I	I	O	V	E
A	J	I	L	I	E	S	N	S	D	C	J	A	L	P	L	L	E	U	R	E	N
P	L	S	T	T	I	D	J	Y	I	B	R	S	T	R	E	T	O	R	I	R	T
O	R	N	T	E	C	I	R	S	N	D	A	I	E	S	I	E	V	A	T	G	I
L	E	O	N	E	C	I	P	T	I	T	E	E	T	H	S	L	A	R	E	E	A
L	Z	I	U	I	C	K	I	E	T	H	A	X	I	S	R	E	E	P	U	N	L
O	N	S	D	S	H	I	N	M	P	R	I	L	T	I	S	S	I	T	I	T	L
Y	G	L	A	R	S	Z	A	A	O	V	U	O	D	R	O	C	C	Y	A	I	I
K	I	U	N	R	T	S	R	T	R	A	I	D	N	R	N	O	N	H	J	K	R
J	S	P	Y	K	O	G	A	L	A	X	Y	Y	I	I	I	P	N	B	O	N	A
H	F	O	T	J	O	E	R	R	E	O	P	E	L	L	C	E	I	I	D	A	E
P	E	R	E	M	G	Y	A	A	R	T	C	K	C	I	B	A	T	S	T	R	Y
U	E	P	S	R	G	S	I	D	V	Z	U	U	A	E	O	I	S	H	I	C	T
Y	K	I	E	I	I	T	G	A	D	I	B	I	S	B	O	L	L	I	I	I	H
T	E	V	E	S	B	E	K	I	S	R	T	H	Y	O	M	J	A	C	O	N	G
S	I	E	M	A	I	M	O	S	C	I	N	Y	T	C	E	T	E	T	A	L	I
D	G	W	I	N	R	A	D	I	O	W	A	V	E	S	I	N	Y	I	R	P	L
I	N	N	E	R	P	L	A	N	E	T	K	E	L	F	U	R	O	E	T	E	M

On the Web

Signals from Space

1. Some reasons for static while listening to a radio when riding in a car are other electrical devices, power plants, lightning, power lines, poor connection, and so on.
2. Some sources of interference for astronomers are other space matter, television and radio broadcasting, microwave communications, the radio receiver itself, satellites, and so on.
3. Answers will vary.