



*Applause Series* CURRICULUM GUIDE  
CIVIC CENTER OF GREATER DES MOINES

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March 28, 2011

# WELCOME



## Dear Teachers,

Welcome to *Mad Science presents STAR TREK LIVE*, presented as part of the 15th anniversary season of the Applause Series. The *STAR TREK* franchise has inspired generations of Americans to dream about the realm of science and the new, uncharted territory where it can take us. The stage show, *STAR TREK LIVE*, capitalizes on this impulse, using the franchise's hallmark characters and sense of adventure to guide students' exploration of real, science-based principles related to living and working in space.

We thank you for sharing this very special experience with your students and hope that this study guide helps you connect the performance to your in-classroom curriculum in ways that you find valuable. In the following pages, you will find information about the performance and related subjects, as well as a wide variety of science-based experiments— each developed by the creators of the stage production. Some pages are appropriate to reproduce for your students; others are designed more specifically with you, their teacher, in mind. As such, please feel free to “pick and choose” material and ideas from the study guide to meet your class's unique needs. A complete table of contents for the experiments and other resources can be found on pages 2-3 of the guide.

See you at the theater,

Civic Center Education Team

**Support for Civic Center education programs and the Applause Series  
is provided by:**

Alliant Energy, American Republic Insurance Company, Bank of the West, Bradford and Sally Austin, Bank of America, EMC Insurance Companies, Jules and Judy Gray, Greater Des Moines Community Foundation, Hy-Vee, John Deere Des Moines Operations, Iowa Department of Cultural Affairs, Richard and Deborah McConnell, Pioneer Hi-Bred - a DuPont business, Polk County, Prairie Meadows Community Betterment Grant, Sargent Family Foundation, U.S. Bank, Wells Fargo & Co., Willis Auto Campus, and more than 200 individual donors.

## NOTES ABOUT THE GUIDE

This guide consists of two parts.

Part 1, pages ii-v, consists of **Civic Center Information**. Please consult these pages for the following:

- About the Civic Center
- Theater Etiquette
- Field Trip Information for Teachers

Part 2, pages 1-57, consists of the *STAR TREK LIVE* **Teacher's Resource Manual**. Please consult these pages for the following:

- Activities & Demonstrations
- Experiments
- Glossaries
- Scientific Method
- Worksheets
- Answer Key

A complete table of contents for the *Teacher's Resource Manual* can be found on pages 2-3.

# ABOUT THE CIVIC CENTER



The Civic Center of Greater Des Moines is a cultural landmark of central Iowa and is committed to engaging the Midwest in world-class entertainment, education, and cultural activities. The Civic Center has achieved a national reputation for excellence as a performing arts center and belongs to several national organizations, including The Broadway League, the Independent Presenters Network, International Performing Arts for Youth, and Theater for Young Audiences/USA.

Five performing arts series currently comprise the season— the Willis Broadway Series, Prairie Meadows Temple Theater Series, Wellmark Blue Cross and Blue Shield Family Series, the Dance Series, and the Applause Series. The Civic Center is also the performance home for the Des Moines Symphony and Stage West.

The Civic Center is a private, nonprofit organization and is an important part of central Iowa's cultural community. Through its education programs, the Civic Center strives to engage patrons in arts experiences that extend beyond the stage. Master classes bring professional and local artists together to share their art form and craft, while pre-performance lectures and post-performance Q&A sessions with company members offer ticket holders the opportunity to explore each show as a living, evolving piece of art.

Through the Applause Series— curriculum-connected performances for school audiences— students are encouraged to discover the rich, diverse world of performing arts. During the 2010-2011 season, the Civic Center will welcome more than 37,000 students and educators to 12 professional productions for young audiences.

.....  
**Want an inside look? Request a tour.**  
.....

.....  
Group tours can be arranged for performance and non-performance dates for groups grades 3 and above.  
.....

.....  
Call 515-246-2355 or visit [civiccenter.org/education](http://civiccenter.org/education) to check on availability or book your visit.  
.....

## DID YOU KNOW?

More than 250,000 patrons visit the Civic Center each year.

The Civic Center opened in 1979.

The Civic Center has three theater spaces:

- *Main Hall, 2745 seats*
- *Stoner Studio, 200 seats*
- *Temple Theater, 299 seats (located in the Temple for the Performing Arts)*

No seat is more than 155 feet from center stage in the Main Hall.

Nollen Plaza, situated just west of the Civic Center, is a park and amphitheater that is also part of the Civic Center complex. The space features the Brenton Waterfall and Reflection Pool and the Crusoe Umbrella sculpture.

The Applause Series started in 1996. You are joining us for the 15th anniversary season!

# GOING TO THE THEATER . . .



## YOUR ROLE AS AN AUDIENCE MEMBER

Attending a live performance is a unique and exciting opportunity. Unlike the passive experience of watching a movie, audience members play an important role in every live performance. As they act, sing, dance, or play instruments, the performers on stage are very aware of the audience's mood and level of engagement. Each performance calls for a different response from audience members. Lively bands, musicians, and dancers may desire the audience to focus silently on the stage and applaud only during natural breaks in the performance. Audience members can often take cues from performers on how to respond to the performance appropriately. For example, performers will often pause or bow for applause at a specific time.

As you experience the performance, consider the following questions:

- What kind of live performance is this (a play, a dance, a concert, etc.)?
- What is the mood of the performance? Is the subject matter serious or lighthearted?
- What is the mood of the performers? Are they happy and smiling or somber and reserved?
- Are the performers encouraging the audience to clap to the music or move to the beat?
- Are there natural breaks in the performance where applause seems appropriate?

## THEATER ETIQUETTE

Here is a checklist of general guidelines to follow when you visit the Civic Center:

- Leave all food, drinks, and chewing gum at school or on the bus.
- Cameras, recording devices, and personal listening devices are not permitted in the theater.
- Turn off cell phones, pagers, and all other electronic devices before the performance begins.
- When the house lights dim, the performance is about to begin. Please stop talking at this time.
- **Talk before and after the performance only.** Remember, the theater is designed to amplify sound, so the other audience members and the performers on stage can hear your voice!
- Appropriate responses such as laughing and applauding are appreciated. Pay attention to the artists on stage—they will let you know what is appropriate.
- Open your eyes, ears, mind, and heart to the entire experience. Enjoy yourself!

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\*GOING TO THE THEATER information is adapted from the Ordway Center for the Performing Arts study guide materials.

# CIVIC CENTER FIELD TRIP INFORMATION FOR TEACHERS



**Thank you for choosing the Applause Series at the Civic Center of Greater Des Moines. Below are tips for organizing a safe and successful field trip to the Civic Center.**

## ORGANIZING YOUR FIELD TRIP

- Please include all students, teachers, and chaperones in your ticket request.
- After you submit your ticket request, you will receive a confirmation e-mail within five business days. Your **invoice will be attached to the confirmation e-mail.**
- Payment policies and options are located at the top of the invoice. **Payment (or a purchase order) for your reservation is due four weeks** prior to the date of the performance.
- The Civic Center reserves the right to cancel unpaid reservations after the payment due date.
- Tickets are not printed for Applause Series shows. Your invoice will serve as the reservation confirmation for your group order.
- Schedule buses to arrive in downtown Des Moines at least 30 minutes prior to the start of the performance. This will allow time to park, walk to the Civic Center, and be seated in the theater.
- Performances are approximately 60 minutes unless otherwise noted on the website and printed materials.
- All school groups with reservations to the show will receive an e-mail notification when the study guide is posted. Please note that study guides are only printed and mailed upon request.

## DIRECTIONS AND PARKING

- Directions: From I-235, take Exit 8A (Downtown Exits) and the ramp toward 3<sup>rd</sup> Street and 2<sup>nd</sup> Avenue. Turn onto 3<sup>rd</sup> Street and head south.
- Police officers are stationed at the corner of 3<sup>rd</sup> and Locust Streets and will direct buses to parking areas with hooded meters near the Civic Center. Groups traveling in personal vehicles are responsible for locating their own parking in ramps or metered (non-hooded) spots downtown.
- Buses will remain parked for the duration of the show. At the conclusion, bus drivers must be available to move their bus if necessary, even if their students are staying at the Civic Center to eat lunch or take a tour.
- Buses are not generally permitted to drop off or pick up students near the Civic Center. If a bus must return to school during the performance, prior arrangements must be made with the Civic Center Education staff.

## ARRIVAL TO THE CIVIC CENTER

- When arriving at the Civic Center, please have an **adult lead your group** for identification and check-in purposes. You may enter the building through the East or West lobbies; a Civic Center staff member may be stationed outside the building to direct you.
- Civic Center staff will usher groups into the building as quickly as possible. Once inside, you will be directed to the check-in area.
- Seating in the theater is general admission. Ushers will escort groups to their seats; various seating factors including group size, grade levels, arrival time, and special needs seating requests may determine a group's specific location in the hall.
- We request that an **adult lead the group into the theater and other adults position themselves throughout the group**; we request this arrangement for supervision purposes, especially in the event that a group must be seated in multiple rows.
- Please allow ushers to seat your entire group before rearranging seat locations and taking groups to the restroom.

## IN THE THEATER

- In case of a medical emergency, please notify the nearest usher. A medical assistant is on duty for all Main Hall performances.
- We ask that adults handle any disruptive behavior in their groups. If the behavior persists, an usher may request your group to exit the theater.
- Following the performance groups may exit the theater and proceed to their bus(es).
- If an item is lost at the Civic Center, please see an usher or contact us after the performance at 515.246.2355.

### QUESTIONS?

Please contact the Education department at 515.246.2355 or [education@civiccenter.org](mailto:education@civiccenter.org). Thank you!



PRESENTS

**STAR TREK™**  
**LIVE**  
*STARFLEET ACADEMY*

**TEACHERS RESOURCE MANUAL**



**HANDS-ON  
EXPERIMENTS  
AND CLASSROOM  
DEMONSTRATIONS**

**VOLUME 1.0**



## Teachers Resource Manual: *Mad Science STAR TREK LIVE!*

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### **History and Mission of Mad Science®**

Established in Montreal, Canada, in 1985—The Mad Science Group performs live, interactive, and exciting science programs to students in over 25 countries through a network of more than 200 franchises. Mad Science presentations are designed specifically to be fun, entertaining, and educational. The *STAR TREK LIVE!* performance you attended with your group demonstrates Mad Science's commitment to both science education and sparking imaginative learning. Visit our website at [www.madscience.org](http://www.madscience.org) to discover how you can expand the experience and invite Mad Science into your community center or home.

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# Welcome to the *STAR TREK LIVE!* Teachers Resource Manual

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This manual provides demonstrations and activities to perform in the classroom to extend the Mad Science *STAR TREK LIVE!* experience. The activities designed for 1-30 students in grades 3-6 fulfill specific science learning standards to meet educators' needs.

This manual provides activities organized into four main space-science topics. There are 2-4 activities and/or demonstrations for each topic. *Star Trek* and space, fun facts are interspersed throughout the manual to complement the activities. A book list and glossary of related terms allows further space-science explorations. Extension activities are included in other subjects such as math, language arts, and art to expand the multi-disciplinary nature of space science. Wrap up your lesson—challenge your students' *Star Trek* and space-science knowledge with word and logic puzzles.

There is a scientific method worksheet available in the Worksheets & Answer Key section. This worksheet lets students note science experiment observations and reinforces the scientific method's important elements. Use the included scientific method definitions on page 43 to review these elements with the class before beginning any activities. This will help clarify the ideas and processes involved in conducting a scientific experiment.

This manual is also practical for scout leaders, camp directors, after-school program animators, and parents to conduct hands-on science activities with the concepts presented in *STAR TREK LIVE!*

# Mad Science Teachers Resource Manuals Meet National Science Education Standards

The National Research Council in the United States collaborated with many other organizations to develop the National Science Education Standards. The collaborators include teachers, school administrators, parents, curriculum developers, college faculties, scientists, engineers, and government officials. These standards outline what students need to know, understand, and apply to be scientifically literate.

	STAR TREK LIVE!	CSI: LIVE!	DON'T TRY THIS AT HOME	FUNKY FARMWORKS
<b>Science As Inquiry</b>				
Abilities necessary to do scientific inquiry	x	x	x	x
Understanding about scientific inquiry	x	x	x	x
<b>Physical Science</b>				
Properties of objects and materials	x	x		x
Position and motion of objects	x	x	x	
<b>Life Science</b>				
Characteristics of organisms	x	x		x
Life cycles of organisms				x
Organisms and environments	x	x		x
<b>Earth and Space Science</b>				
Properties of earth materials	x	x		x
Objects in the sky	x			
Changes in earth and sky	x			
<b>Science and Technology</b>				
Ability to distinguish between natural objects and objects made by humans	x	x		
Ability of technological design	x	x	x	
Understanding about science and technology	x	x	x	x
<b>Science in Personal and Social Perspectives</b>				
Personal health				x
Characteristics and changes in populations				
Types of resources				x
Changes in environments				x
Science and technology in local challenges				
<b>History and Nature of Science</b>				
Science as a human endeavor	x	x	x	x

# The Science of *STAR TREK LIVE!* and Space Exploration

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NASA and *Star Trek* have a long, parallel history together. *Star Trek's* final, original series episode aired in June 1969. One month later, NASA's *Apollo 11* astronauts Neil Armstrong and Edwin Aldrin (Buzz) landed on the Moon while their fellow crewmate Michael Collins remained in lunar orbit. NASA's missions are to gain a better understanding of our planet to explore our solar system and the universe. *Star Trek's* missions have similar objectives to explore strange new worlds, and seek out new life and civilizations. The effect of *Star Trek* has transformed science fiction into science reality. One of NASA's first space shuttles was named the *Enterprise* in honor of the show's premier starship. Numerous real-life astronauts have played cameo roles on the television series.

The original *Star Trek* show is set in the twenty-third century. Their technology outstrips our twenty-first century abilities and sparks our interest in developing such possibilities. The *Star Trek* world introduced science fiction devices that are now true science; *combades* and *tricorders* are precursors to cell phones and medical scanners. The show's writers had science consultants review each episode to make the show's futuristic science believable and factually aligned with present-day science.

Space science follows in *Star Trek's* fictional footsteps. NASA and other international space agencies have sent humans into orbit, collaborated to live and work in harmony in space, developed tools to observe space phenomena, and evolved technology for use in space and on Earth. *Star Trek* has successfully given a sense of science to science-fiction, and NASA makes it happen!

# Activities and Demonstrations

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This manual has four topics that make up the class activities. There are 2-4 activities and/or demonstrations for each topic with some challenging extension activities for advanced classes. Each activity is rated with one of the following difficulty levels: basic (grades 3-4), moderate (grades 4-5), and advanced (grades 5-6). There are worksheets, puzzles, and answer keys at the end of the manual.

## ***TOPIC 1: GETTING INTO SPACE***

Students learn how Newton's third law allows rockets to overcome the force of gravity and achieve liftoff.

## ***TOPIC 2: LIVING IN SPACE***

Students explore the challenges of orbital debris and living in microgravity.

## ***TOPIC 3: SPACE TECHNOLOGY***

Students perform the tasks normally programmed into devices used in space exploration.

## ***TOPIC 4: SPACE PHENOMENA***

Students discover the science knowledge required to gather information in space.

# Experiment: Rocket Launch

## TIME

10 min

## TOPIC

Getting into space

## SUMMARY

Students see Newton's third law of motion spin into action.

## DIFFICULTY LEVEL

Moderate

## SAFETY

None

## TIPS

You may also perform this activity as a demonstration for younger students or as a group activity for older students.

## MATERIALS

- Soda can (empty and clean, with tab still attached)
- Nail
- Nylon fishing line 50cm (20")
- Bucket
- Water 1L (34fl.oz.)
- Paper towel
- Scissors

## PROCEDURE

- 1 Before class begins: Lay the can on its side, and use the nail to punch a hole in the side 1cm (0.5") from the bottom.



- 2 Push the nail to one side so that the hole slants in one direction. Repeat three more times, rotating the can 90 degrees each time to create four holes all slanting in the same direction around the can's bottom.
- 3 Bend up the tab and tie a 50cm (20") fishing line length to it. Fill the bucket with water.
- 4 In class, dip the can in the water to fill it completely.
- 5 Hold the string end above the bucket. Have students observe the direction the can spins and the direction of the water as it pours out.
- 6 Discuss how the results could apply to rocket propulsion (see explanation on following page).

## EXTENSION

- 1 Change variables such as the number and size of holes to observe how they affect the number of spins. I.e., Does adding more holes to a can make it spin faster?

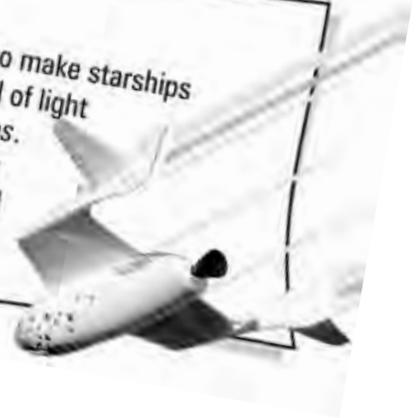
# Experiment: Rocket Launch

## *EXPLANATION*

Newton's third law of motion states that for every action there is an equal and opposite reaction. In this activity, the water pours out of the can in one direction and the can spins in the opposite direction. This action-reaction event is similar to what happens during a rocket launch. A rocket exerts a force in the opposite direction to overcome the force of gravity and achieve liftoff. The action in this case is the engine at the bottom of the rocket pushing out gas. The reaction is the gas pushing back on the rocket. This leads to the rocket's movement in the opposite direction. In *Star Trek*, starships use a fictional technology called *warp drive* to achieve high speeds in space. *Warp drives* are capable of traveling faster than the speed of light!

### **Fun Fact:**

*Star Trek* writers needed to make starships travel faster than the speed of light so they invented *warp drives*. They did this to explain how starships could travel around the galaxy quickly inside a 1-hour show.



### **Fun Fact:**

A NASA rocket motor during testing in Utah got so hot that it melted the nearby ground and turned the sand into glass.



# Experiment: Planet Pull

## TIME

15 min

## TOPIC

Getting into space

## SUMMARY

Students launch balloon rockets with different masses.

## DIFFICULTY LEVEL

Basic

## SAFETY

None

## TIPS

Stick the launch pad string with tape if the ceiling untiled

## MATERIALS

- 10 binder clips



- 10 long balloons
- 5 thick straws
- 5 large paper clips
- 5 small metal washers
- 5 masking tape rolls
- 5 balloon pumps
- Kite string
- Scissors

## PROCEDURE

- 1 Before class begins, cut and discard  $\frac{3}{4}$  of a straw's length. Bend the longer arm of the paperclip to form a hook. Tape the paperclip to the straw's center, leaving the hook free.



- Repeat with the remaining straws. Prepare a launch pad for each group in different areas of the room: Tie a string end to a binder clip. Clip the binder clip to a ceiling tile, metal frame. Cut the string so that its end just touches the floor.
- 2 Divide the class into groups of five. Assign each group to a launch pad. Give each group a prepared straw, two balloons, a balloon pump, binder clip, tape roll, and small washer.
  - 3 Have each group prepare a balloon for launch. They should inflate one balloon while keeping track of the number of pumps. Instruct to close the end with the binder clip to prevent the air from escaping. Have them tape the prepared straw around the balloon's center, ensuring that the hook is right side up and angled out.
  - 4 Instruct to feed the launch pad string through the straw on the balloon. Have one group member hold down the string taut to the floor with the balloon positioned close to the floor. On the count of three, have one group member unclip the balloon end. Ask the groups to describe what happens. The balloon moves up to the ceiling.

# Experiment: Planet Pull

- 5 Have the groups repeat step 3 with their second balloon. They should use the same number of pumps (the same amount of air) as the first balloon. Instruct them to add a metal washer to the paper clip hook.
- 6 Have the groups repeat step 4. Ask them to describe what happens. The balloon will not travel as far up the string.

## EXTENSION

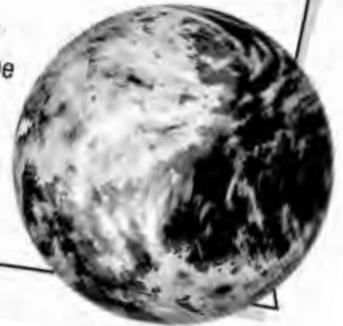
- 1 Have the students determine the amount of air pumps needed to lift the weighted balloon to the ceiling.

## EXPLANATION

The balloon moves according to Newton's third law. This law states that for every action there is an equal and opposite reaction. The balloon's contracting walls push air out of the balloon in one direction. The balloon moves in the opposite direction. The balloon moves in a straight line because it is attached to the straw, which is guided along a string. Weighting the balloon keeps it from moving as far up the string. The balloon's thrust needs to be greater than the washer's weight in order to move further up the string. In *Star Trek*, the gravity on planet *Vulcan* is stronger than the gravity on Earth. A rocket would need more force to escape *Vulcan's* gravity than Earth's gravity.

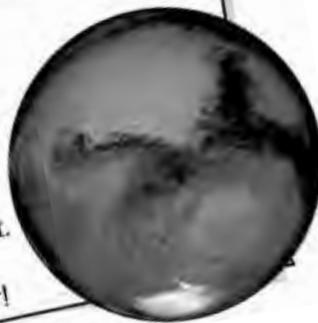
### Fun Fact:

*Star Trek* created the term *Class-M planets* to describe worlds where atmospheres are Earth-like enough for humans to visit without wearing a space suit.



### Fun Fact:

Evidence suggests that Mars once contained water. Scientists believe that this water reacted with iron compounds in the planet's soil to form rust. They believe that the rust is what gives Mars its red color!



# Experiment: Space Station Spin

## TIME

20 min

## TOPIC

Living in space

## SUMMARY

Students create artificial gravity in a space station model.

## DIFFICULTY LEVEL

Moderate

## SAFETY

None

## TIPS

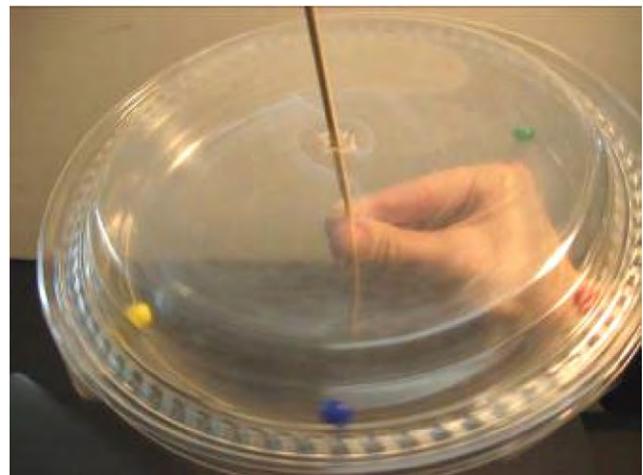
None

## MATERIALS

- 1 ruler
- 1 utility knife (X-Acto™)
- 30 clear plastic disposable plates
- 60 different-colored beads
- 15 dowels ½cm (¼") in diameter
- 15 tape rolls

## PROCEDURE

- 1 Before class begins, use a ruler to find a plate's center. Use a utility knife to cut an X in the center. Fold back the cuts to make a hole. Repeat with the other plates.
- 2 Instruct the students to jump. Ask them to describe what happens. They fall to the ground because of gravity. Gravity is the force that pulls us down to Earth.
- 3 Divide the class into pairs. Give each pair two plastic plates, four colored beads, a dowel, and tape roll.
- 4 Instruct each pair to match the paper plates' edges and to tape them together at several spots.
- 5 Instruct each pair to insert the dowels through their plates' holes. Tell them they have built a model space station.
- 6 Explain that the beads are like astronauts. Ask them to push the beads through their plates' top hole. Instruct each pair to shift the plate so that the beads are close to the plate's center.
- 7 Instruct one partner to hold the dowel while the other partner spins the space station plates on the dowel. Ask the students to describe what happens to the astronaut beads.

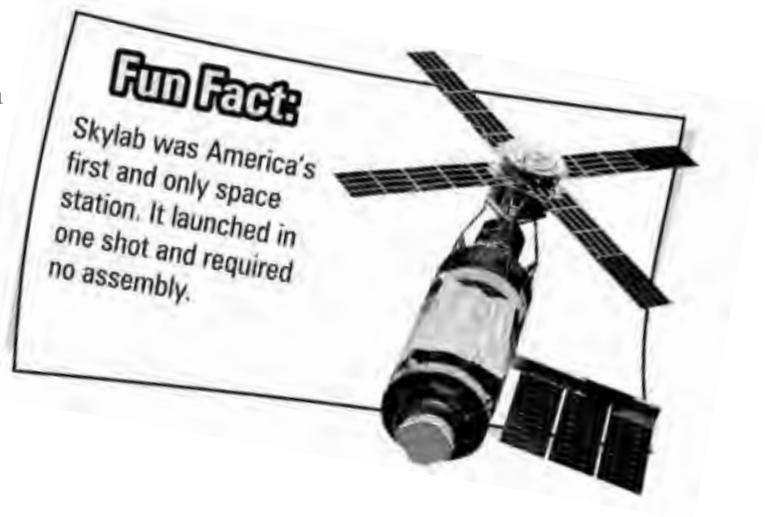


# Experiment: Space Station Spin

## *EXPLANATION*

Spinning the plates quickly makes the beads move towards the edge. The beads keep moving because objects in motion tend to stay in motion (Newton's first law of motion). Objects travel in a straight line if there is no other force on them. The centripetal force of the plate walls continuously forces the bead in a curved path.

Gravity on Earth pulls down on us when we walk, run, and play. This makes our muscles work hard and keeps them strong. Astronauts in space do not have to work against gravity so their muscles can weaken and waste away. *Star Trek* presents a future in which artificial gravity technology exists. Today, scientists are studying how artificial gravity could be used to extend space flights and to prevent astronauts' muscle wasting in space. NASA had tested a centrifuge that creates an effect similar to standing against a force two and half times that of Earth's gravity. Astronauts were strapped to beds inside the centrifuge and spun around. One hour daily on the centrifuge was enough to restore muscle loss.



# Experiment: Space Junk

## TIME

10 min

## TOPIC

Living in space

## SUMMARY

Students strike a potato with a plastic straw to investigate the effect of space debris.

## DIFFICULTY LEVEL

Moderate

## SAFETY

Students should be careful about hand placement during this activity.

## TIPS

None

## MATERIALS

- 60 thick straws
- 15 potatoes
- 30 plastic plates
- materials (tissue paper, rubber bands, napkins, aluminum foil, wax paper, plastic wrap, etc.)

## PROCEDURE

- 1 Before class, cut the potatoes in half. Place a halved potato on each plate, cut side down.
- 2 Give each student a plate with a potato half and two straws. Tell them the potato half is like a spacecraft.
- 3 Instruct the students to grip the straw and cover the top hole with their thumb. Instruct them to hold it about 30cm (1') above the potato. Have them stab the potato with a straw in slow motion. Ask them to describe what happens.



The straw collapses and barely penetrates the potato. Tell them this is like a screwdriver falling on a spacecraft being built on Earth.

- 4 Have the students repeat step 3 using a new straw and a quick motion.



Ask them to compare a quick and slow motion's penetration difference. The quick motion allows the straw to penetrate the potato without collapsing. Tell them this is like what happens when a small space debris piece, like a paint flake, hits spacecraft at a fast speed in space.

# Experiment: Space Junk

## EXTENSION

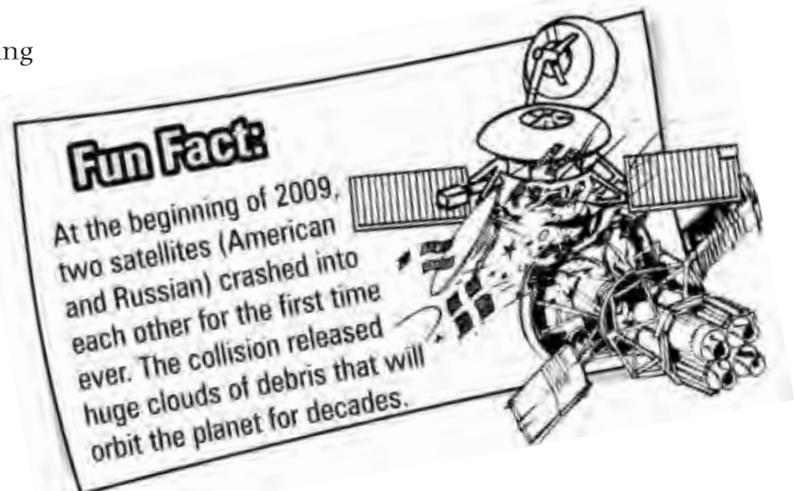
- 1 Have students choose from a variety of materials to create a protective shield for their potato spacecraft. Have them conduct an impact resistance test to evaluate their shield's effectiveness.

## EXPLANATION

Orbital debris (or space trash) are human-made objects remaining in space that are no longer useful. We call this orbital debris because it follows an orbital path around our planet like a satellite. This debris comes from nose cone shrouds, lenses, hatch covers, rocket bodies, and payloads that have disintegrated or exploded, and even objects that have escaped from manned spacecraft during operations.

Orbital debris is constantly moving. It has kinetic energy. The object's kinetic energy is proportional to its mass times its velocity (how fast it is moving). A paint chip does not have much mass, but it has enough kinetic energy at very high speeds to damage substantially a spacecraft. On average, space debris moves at 8km (5mi.) per second.

The NASA Orbital Debris Program Office is the lead NASA center for orbital debris research. Researchers at this office develop special shielding to protect spacecraft from small space debris. In *Star Trek*, the *Enterprise* uses a navigational deflector to avoid space debris damage.



# Experiment: Space Spine Stretch

## TIME

10 min

## TOPIC

Living in space

## SUMMARY

Students see how a human spine reacts in microgravity.

## DIFFICULTY LEVEL

Basic

## SAFETY

None

## TIPS

None

## MATERIALS

- 15 soft rectangular sponges
- 20 pocket-sized books
- 6 large rubber bands to fit around a stack of books
- 6 rulers

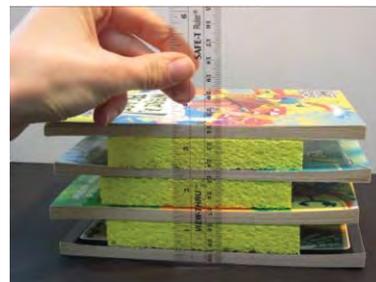
## PROCEDURE

- 1 Ask the students to hypothesize why astronauts in space might grow taller.
- 2 Divide the class into groups of five. Give each group three sponges, four books, one rubber band, and ruler.

- 3 Have the groups layer the books and sponges alternately to make a stack. Explain that the stack represents our spines. Our hard vertebrae, the bones in our backbone, are the books. The intervertebral disks, the soft material between them, are the sponges.
- 4 Instruct a group member to press down and compress the stack, while another student fits the rubber band around the stack. Inform that the rubber band illustrates the force of gravity compressing the disks in the spinal column when the astronaut is on Earth.
- 5 Have the groups measure the height of the book and sponge “spine” when gravity is present.



- 6 Instruct to remove the rubber band while keeping the stack upright. Explain that this represents an astronaut’s spine in space that is not affected by gravitational force. We call this environment-type microgravity. Have the groups use a ruler to measure the stack.



# Experiment: Space Spine Stretch

- 7 Ask for observations and conclusions. Have students list other ways microgravity would affect astronaut life.

## EXTENSION

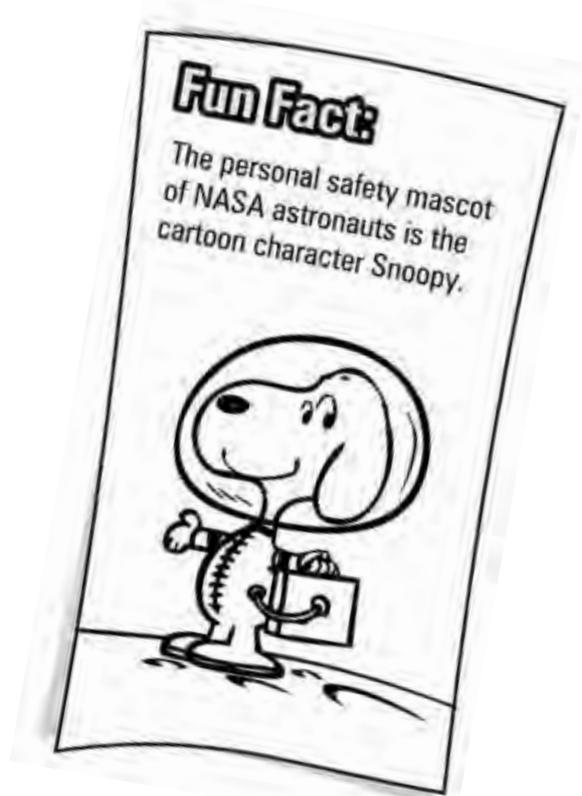
- 1 Measure students in the morning and at the end of day. They are taller in the morning. Our spines lengthen at night while we sleep, and they compress when we are upright all day.

## EXPLANATION

*Star Trek* takes place in the future when artificial gravity technology exists. Modern day astronauts' bodies are not affected by gravity when living in space. This environment is called microgravity. Microgravity environments affect an astronaut's weight and height.

This activity demonstrates how an astronaut's height changes in space. The book and sponge "spine" is taller without the rubber band's compression. Removing the rubber band allows the books and sponges to expand. Gravity's downward force on Earth compresses the soft material between our vertebrae. This pulling force is what makes us a certain height on Earth.

We say that astronauts in orbit are in free-fall. Earth's gravity pulls on the astronauts. Earth's gravity also pulls on their spacecraft. The astronauts and the spacecraft fall at the same rate continuously around Earth. This continuous "falling" is their orbit. An environment in free fall is a microgravity environment. Astronauts in free fall do not feel gravity. This allows the soft material between the vertebrae to expand, making astronauts temporarily taller.



# Experiment: Your Body in Space

## TIME

45 min

## TOPIC

Living in space

## SUMMARY

Students will learn how astronauts' bodies react to living in space.

## DIFFICULTY LEVEL

Basic

## SAFETY

None

## TIPS

None

## MATERIALS

- 4 Your body in Space learning center card sets (see Worksheets and Answer Key section)
- 8 cooked chicken bones
- Vinegar (to fill glass jar)
- 2 large resealable bags
- 4 pencils
- Glass jar
- Pot of white rice
- Paper towel

## PROCEDURE

- 1 A week before running the experiment:
  - Place four thoroughly cleaned, cooked chicken bones in a vinegar-filled glass jar.
  - Place the other four chicken bones in a large plastic bag in the fridge.
- 2 The day before you are going to run the experiment:
  - Cook a pot of white rice according to the package directions, allow cooling, and place the rice in a large resealable bag.
- 3 Before the class begins:
  - Photocopy four Your body in Space Learning Center Card sets (see Worksheets and Answer Key section), and cut them out.
  - Designate four stations in the classroom as working centers. Place the four Learning center #1—Balance cards at a designated learning station. Do the same with the remaining cards.
  - Place the bag and jar of chicken bones and paper towels at the Learning center #2—Bones station.
  - Place the bag of rice and paper towels at the Learning center #3—Health station.
  - Write the following questions on the board: What is balance? How may living in space affect balance? What happens to your bones in a low-gravity environment? Why may it be easier to catch a cold in space? Why is it especially important to exercise in space?
- 4 When the students arrive, discuss possible answers to the questions written on the board. Explain to the class that they will do a variety of activities to find the answers.
- 5 Divide the class into four groups. Inform them that they will rotate through the learning centers around the classroom with approximately 8 minutes at each center.

# Experiment: Your Body in Space

- 6 Instructions for learning centers: Have group members take a learning center card and read the “did you know” fact, discuss the “discussion question,” perform the “try it out” experiment, and then read the “discuss findings” questions. Groups may elect a member to take notes on the learning center card. Advise that class will reconvene to discuss their findings after all groups visit the four learning centers.
- 7 Assign each group to a learning center to begin the activities. Circulate to ensure that the groups are on-task and to answer any questions. Have the groups rotate after approximately 8 minutes.
- 8 After the groups have explored each learning center, reconvene the class to discuss their findings (see explanation section for more details).

## EXPLANATION

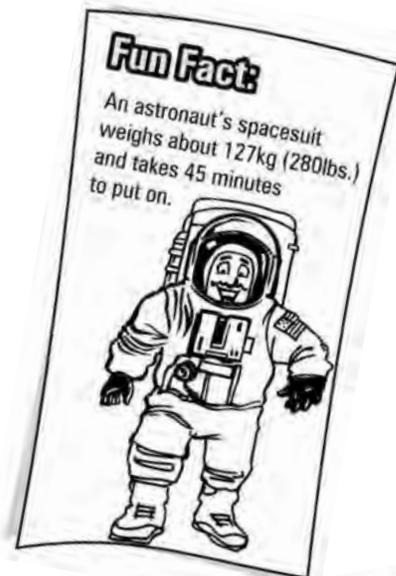
**Balance:** Your brain uses information from the eyes, special parts of the inner ear, and sensors in the joints and skin to help you stay oriented and balanced. These touch and balance systems in space, unable to feel gravity’s effects, become temporarily confused. Astronauts often feel dizzy and even experience motion sickness at the beginning of the space mission until they adjust to their new environment.

**Bones:** Astronauts’ bones in space become weak and porous, like the chicken bones in the vinegar, because they are not working against Earth’s gravity. Astronauts must be sure to eat foods that contain plenty of calcium and to do a lot of exercise to keep their bodies healthy and bones strong.

**Health:** Living and working in space may make it easier for astronauts to become sick or develop diseases. Classrooms like spaceships are enclosed spaces where germs spread easily like the rice

spreading among group members. You can wash your hands before and after visiting the restroom, and cover your mouth and nose with a tissue when you cough or sneeze to keep germs from spreading.

**Muscles:** Gravity on Earth pulls against us when we walk, run, and play. This makes our muscles work hard and keeps them strong. However, astronauts in space are affected by Earth’s gravity, so their muscles can weaken and waste away. This is why it is especially important for astronauts in space to exercise at least two hours daily. Astronauts in space do stretching and running exercises while strapped to a treadmill machine. Even if they workout in space, astronauts still experience muscle and bone loss and have to build them back when they return to Earth.



# Experiment: Computer User Recognition

## TIME

30-45 min

## TOPIC

Space technology

## SUMMARY

Students act out a “computer security system.”

## DIFFICULTY LEVEL

Moderate

## SAFETY

None

## TIPS

None

## MATERIALS

- 6 pens
- 7 paper sheets
- Utility knife (X-acto™)
- Scissors
- Tape roll
- 4 bristol boards
- 6 Computer Recognition learning center card sets (see Worksheet and Answer Key section)

## PROCEDURE

- 1 Prepare the centers before the class begins:



- Place two pens and two sheets of paper at learning center #1.
- Prepare and place two bristol boards at learning center #2: Use a utility knife to cut a small 2.5cm (1”) square hole in the bristol board’s center. Cut in half a paper sheet and tape them on each bristol board over the hole. Make side flaps: Bend a quarter on each side of the bristol boards so they can stand on their own. Place two pens and two sheets of paper at the center.
- Prepare and place two screens at learning center #3: Use a utility knife to cut a 10cm (4”) square near the bottom of the paper. Make side flaps: Bend a quarter on each side of the bristol boards so they can stand on their own. Place two pens and two sheets of paper at the center.
- Photocopy six Computer User Recognition Learning Center Card sets (see Worksheets and Answer Key section), and cut them out.
- Designate three stations in the classroom as working centers. Place the six Learning center #1—Voice Recognition cards at a designated learning station. Do the same with the remaining cards.

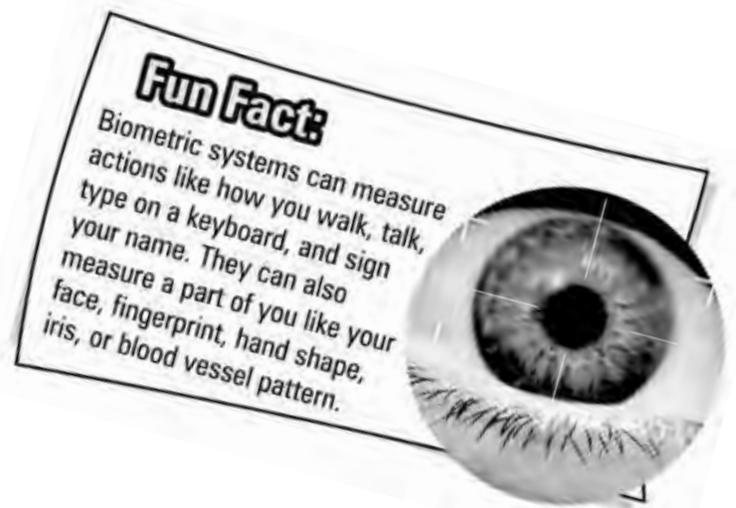
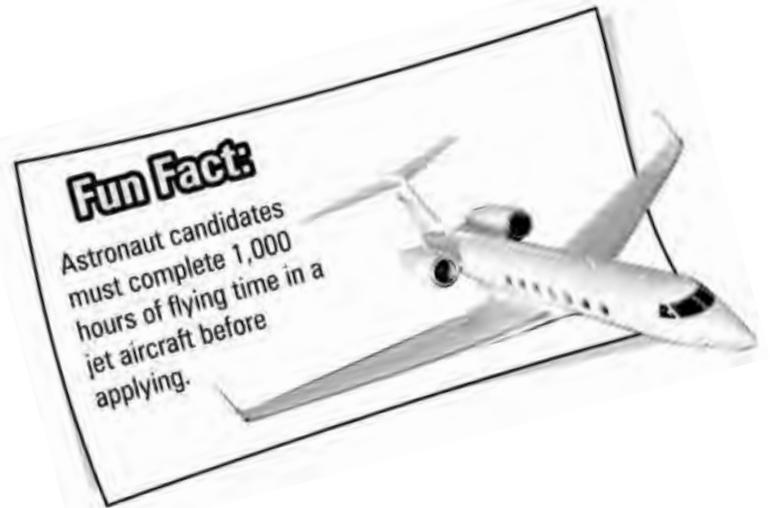
# Experiment: Computer User Recognition

- 2 Divide the class into three groups. Divide each group into two teams. Tell the groups they will circulate three learning centers.
- 3 Instructions for learning centers: Have group members from each team take a learning center card and read the “did you know” fact, discuss the “discussion question,” perform the “try it out” experiment, and then read the “discuss findings” questions. Groups may elect a member to take notes on the learning center card. Advise that class will reconvene to discuss their findings after all groups visit the three learning centers.
- 4 Assign each group to a learning center to begin the activities. Circulate to ensure that the groups are on-task and to answer any questions. Have the groups rotate after approximately 10-15 minutes.
- 5 After the groups have explored each learning center, reconvene the class to discuss their findings (see explanation section for more details). Tally the teams’ points and congratulate the winning team.

## EXPLANATION

Locks and safes protect our money and objects. Computers are machines that contain files. We need to protect these files. We use codes to keep our files safe. The codes can be something we type or something the machine scans. The three codes that we tried out are biometric scans.

Biometric comes from two Greek words. The word bio means life and the word metric means measure. These types of scans use your body as the code. It uses any part of your body as long as it doesn’t change. One of the most common scans is for your fingerprints. Other types of scans are eye color, voice patterns, and DNA. *Star Trek* uses a password and voiceprint scan to identify a crew member. NASA is a leader in using biometrics.



# Experiment: Satellite Sight

## TIME

15 min

## TOPIC

Space technology

## SUMMARY

Students draw the image according to a satellite's information relayed to ground stations.

## DIFFICULTY LEVEL

Advanced

## SAFETY

None

## TIPS

Perform the activity with one group as a demonstration.

## MATERIALS

- 15 file folders
- 30 graph paper sheets
- 30 pencils
- 15 simple photographs (i.e., house or animal against a plain background)

## PROCEDURE

- 1 Before class, find pictures of objects with a sharp, contrasting background. Draw a 10x10 square grid over each picture (The squares on the image can be a different size from the graph paper squares.) Place one picture in each file folder.
- 2 Ask students to predict how satellites collect information about Earth. Explain that they will model how satellites transmit their data to the computers on Earth.
- 3 Have the students pair up, and assign one child the sender role and the other the receiver role. Give out the pencils.
- 4 Tell the senders to hide the image from their receivers before distributing the file folders! Give the senders the images and the receivers one sheet of graph paper each.
- 5 Instruct the students to label the columns of their graphs (paper and picture) from left to right with the letters A to J. Instruct the students to number the rows on the far left column from top to bottom with the numbers 1 to 10. Explain how grid locations work (i.e., A1 is the square located in column A and row 1).
- 6 Explain that scientists use the word data instead of information. Explain how a satellite (sender) relays data to a computer (receiver) with binary code: When receivers call out a square location on the grid such as A1, the senders locate it on their image grid and say "zero" if the square is just the background or "one" if the square contains part of the object in the image.
- 7 Instruct the pairs to receive and send all the squares in their grid. Challenge the receivers to determine what object the senders see, and then compare the sent and received data.

# Experiment: Satellite Sight

- 8 Have the pairs switch roles, and instruct the new senders to switch images with each other. Advise them to hide the picture from their partners. Give the receiver a new sheet of graph paper, and repeat steps 5-6 for the new image.

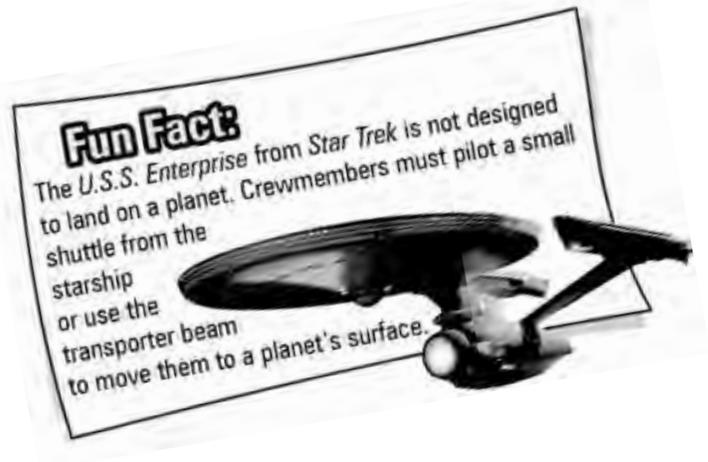
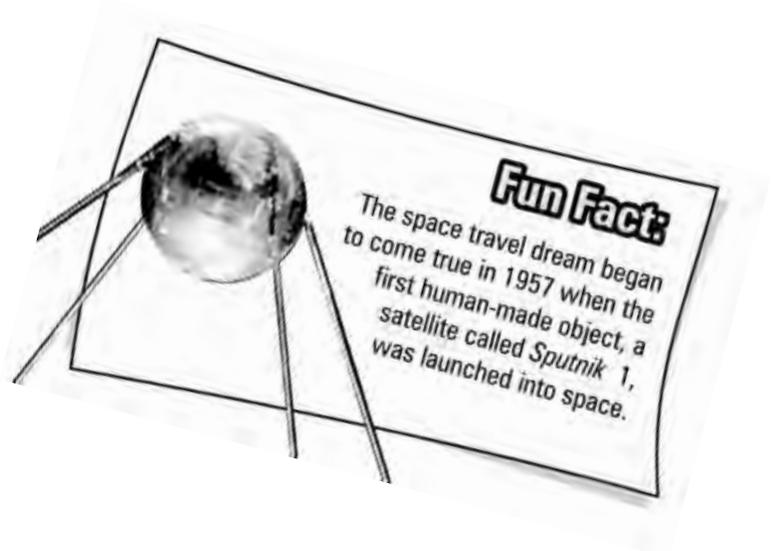
## EXTENSION

- 1 Instruct the senders to use a ruler to draw an extra line down the middle of each column and across each row to make 20 columns and 20 rows to split each cell in half.
- 2 Have the pairs switch images with one another. Instruct the students to label the columns from left to right A to T and the rows from top to bottom 1 to 20.
- 3 Challenge the pairs to receive and send the new data, and then to compare the resulting image with the previous 10x10 grid images.

## EXPLANATION

Radio signals relay space technology data to Earth. The ground stations receive and relay these signals in a numbered computer code called the binary code. The word binary means two numbers, and the code consists of two values, one and zero. One code value is a bit. Eight linked bits is a byte. A bit is on if its code value is one. A bit is off if its code value is zero. When a satellite sends binary coded images, the resulting image reflects gray shades ranging from white to black. Each pixel in the image uses one byte of information. This means all eight bits in the byte can be on or off, and this determines the pixel's gray shade. Each pixel can be one of 256 possible gray shades! In our experiment, each pixel or square uses only one bit. This means that each pixel could only be black if the bit is on, or white if the bit is off. Increasing the pixels and bits per pixel improves the detail of an image sent from space. Radio signals can be audio, visual, or both.

This science is *Star Trek's* main means of communication. The show's characters use radio signals to send communications from one planet or starship to another.



# Experiment: Space Radio

## TIME

15 min

## TOPIC

Space technology

## SUMMARY

Students perform experiments to enhance/obscure radio waves.

## DIFFICULTY LEVEL

Moderate

## SAFETY

Do not allow young children to handle the chicken wire.

## TIPS

Perform the activity with one group as a demonstration.

## MATERIALS

- 6 AM/FM radios
- 1 piece of chicken wire large enough to cover a radio
- 5 25cm (8") aluminum foil squares
- 5 cloth bags
- 5 paper sheets

## PROCEDURE

- 1 Before class begins, mold the chicken wire to form a cage around the radio. Leave an opening to remove the radio.
- 2 Discuss the electromagnetic spectrum. Explain how the spectrum consists of different wavelengths of light that we can or cannot see (see explanation for details). Explain that radio waves are very big. They are big enough to stop with a filter, the same way a kitchen sieve stops large food particles from going down the drain.
- 3 Adjust a portable radio to an FM station and play the music so that the class can hear it.
- 4 Put the radio inside the prepared cage. The radio sound becomes staticky, but you can still hear it.
- 5 Pull the radio out of the cage and change to an AM station. Adjust the volume so that the class can hear it.
- 6 Put the radio back inside the cage. The sound cuts out.
- 7 Pull the radio out of the cage. The radio plays again.

## EXTENSION

- 1 Divide the class into five groups.
- 2 Provide each group with a portable radio, aluminum foil, cloth bag, and paper sheet.
- 3 Challenge each group to find a means to (1) improve the reception, and (2) block the reception.

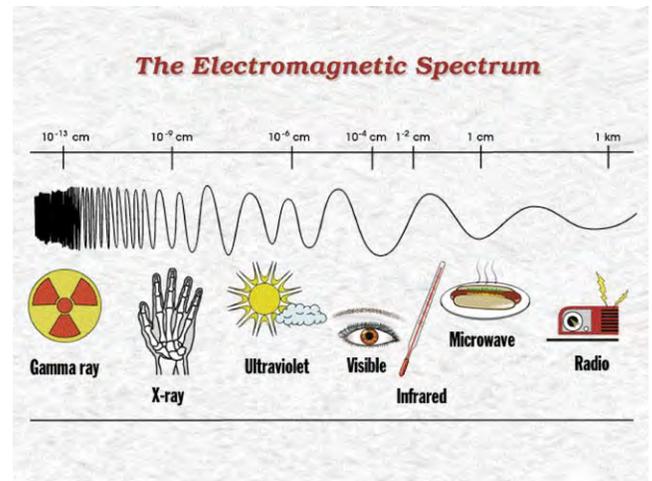
# Experiment: Space Radio

## EXPLANATION

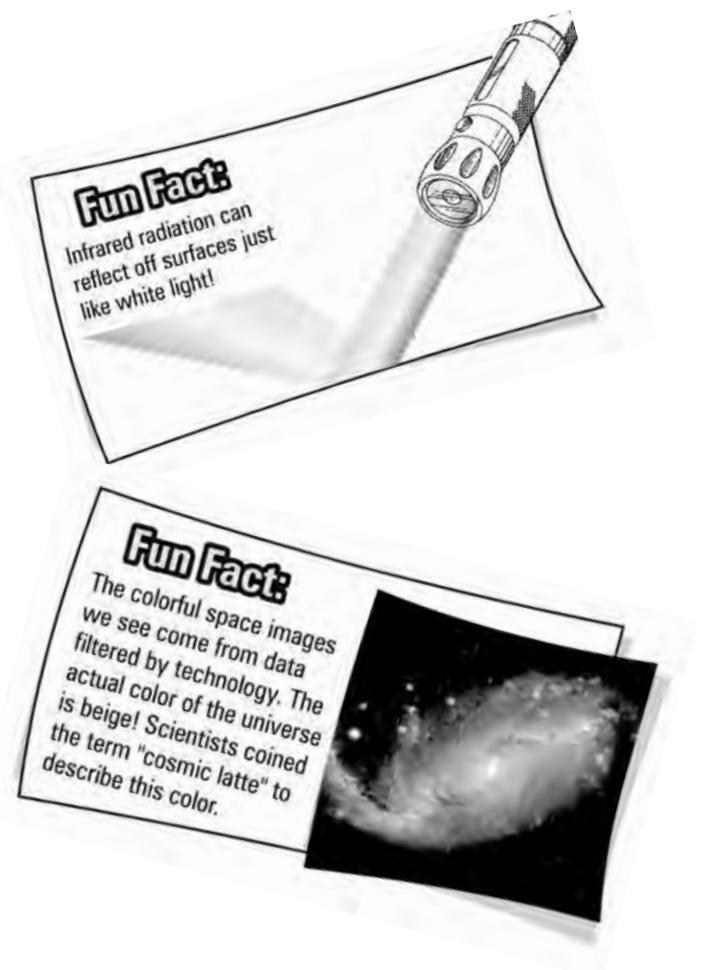
Energy in the electromagnetic spectrum travels in waves. The wavelengths define the type of electromagnetic radiation. The electromagnetic spectrum includes white light, infrared, ultraviolet light, gamma rays, X-rays, microwaves, and radio waves (see image). White light is part of the visible electromagnetic spectrum. Ultraviolet light, gamma rays, and X-rays have wavelengths too small for us to see, but they can affect us. UV light can give us sunburns. Infrared, microwaves, and radio waves are also part of this spectrum. Their wavelengths are too long for us to notice.

Radio waves can be longer than a football field or as short as a football. Radio waves carry signals to radios, televisions, and cellular phones. A radio station's numbers reflect its radio wave frequency (number of waves that cycle per second). AM radio waves are longer than FM radio waves. You know this when you look at a radio station numbers: a 690 AM news station compared to a 99.1 FM rock station. AM waves are much longer. This means they can be filtered out by larger holes than FM waves, just like pouring marbles and sand through a sieve.

Astronauts use radio waves to communicate with their coworkers on Earth and in space. Many astronomical objects also emit radio waves. Scientists built radio telescopes to capture the emissions and translate them into images. *Star Trek* takes radio signals one step further. The Enterprise captain would tell the communication officer to open hailing frequencies to communicate with other galactic vessels. Hailing frequencies encompass all the possible radio waves that another civilization may use for telecommunication. Saying "open frequencies" means the captain wishes to establish contact such as knocking on somebody's door.



Courtesy of NASA/JPL-Caltech



# Experiment:

## Space Technology Spin-offs

### TIME

20 min

### TOPIC

Space technology

### SUMMARY

Students learn how some space technology works on Earth.

### DIFFICULTY LEVEL

Moderate

### SAFETY

None

### TIPS

Replace the following materials with pictures as an alternative.

### MATERIALS

- Metal baseball bat
- Running shoes
- Computer mouse
- Ear thermometer
- Cordless telephone headset
- Emergency reflective blanket
- Cordless drill
- Bicycle helmet
- Bar code
- 9 index cards

### PROCEDURE

- 1 Before class begins, use the index cards to write the object's name on one side and its origin on the opposite side (see following table). Place the materials or pictures at the front, or around the room. Place the accompanying cards beside the materials with the names facing up.
- 2 Inform the students that these objects were initially created for use in space. Companies found a use for these objects on Earth and marketed them to the public.
- 3 Divide the class into groups of five and have each group pick a card. Challenge the group members to determine the object's technology, and use in space and Earth. Have the groups spend 5-10 minutes on each card. Designate the direction that the groups will rotate as they observe each object in the room.
- 4 Invite the students to read the explanation after making a hypothesis about the object's technology and uses.

### EXPLANATION

Some of *Star Trek's* science fiction technology is now available in our modern day world, from *combades* to cell phones, and *tricorders* to medical scanners. Some of NASA's technology has also become commonly used items. Earth-commercialized technology originally designed for space is a spin-off. NASA created the Technology Transfer Program in 1962 to promote the transfer of aerospace technology to the public sector. The idea of commercializing space technology was to offset the high costs involved with space research. You can look on NASA's website in the *NASAlife* section to find out more about space spin-offs. The following table defines spin-offs and their origins used for this activity.

# Experiment: Space Technology Spin-offs

Spin-off	Origin
<b>Metal baseball bat</b>	Metals used in space need to be strong. One type of strong metal that scientists made is liquid metal. It is strong, elastic, and durable. This metal replaces titanium. This metal can form baseball bats, golf clubs, and bicycle frames. It can also make airplanes, medical tools, and cellular phones.
<b>Running shoes Nike™ Air</b>	NASA used a special method to create space suits to walk on the Moon. The space suits need to absorb shocks from moving around. The process is "blow rubber molding." It fills the space inside a mold with shock-absorbing materials. A NASA engineer had an idea to use the same process on Earth. We use it to create shock-absorbing running shoes!
<b>Computer mouse</b>	A person working on an early version of computers had an idea. His idea was for a device that could make computers more useful. He proposed his idea to NASA. He got enough money to make this device. The device was first called a bug. Now, we call it the mouse!
<b>Ear thermometer</b>	NASA developed a technology using infrared. It measured the temperature of stars and planets. Infrared is the range of wavelengths found just past the color red on the light spectrum. It is a range of wavelengths that we cannot see. Any heat source gives off infrared. Even your body does! This space technology was made into a thermometer. It measures your body temperature through your ear!
<b>Cordless telephone headset</b>	Astronauts in space need to communicate with people on Earth. NASA helped create hands-free radio headsets. Police, fire, taxicab, and other radio dispatch centers use this technology. New products came from this. The Bluetooth™ headsets for phones and laptops were created!
<b>Emergency reflective blanket</b>	NASA spacecrafts are made with a metal insulation. It protects astronauts from the Sun. This metal can make film, fabric, paper, or foam. Emergency blankets that reflect body heat were created from this metal. They are thin and lightweight. These blankets help keep a person warm for hours in the cold outdoors.
<b>Cordless drill Black &amp; Decker™</b>	Astronauts gather samples from the Moon. We analyze the samples on Earth. They use drills to dig into the lunar rock. There are no power outlets on the Moon to plug their tools. NASA helped create small, lightweight, battery-powered drills. We now use these drills in construction work and in medical offices for surgery.
<b>Bicycle helmet</b>	NASA came up with a material that absorbs shock. They used this to make aircraft seats. It is called temper foam. This foam lines the inside of bicycle helmets. The bicycle helmet shape comes from airfoil research. Airfoil is the shape of a wing that improves how an aircraft flies.
<b>Bar codes</b>	A spacecraft consists of millions of parts. NASA developed a bar code system to keep track of all parts. Vendors now use bar codes to keep track of their products, from how much is sold to how much is in stock.

# Experiment: Seeing in Space

## TIME

20 min

## TOPIC

Space phenomena

## SUMMARY

Students position mirrors to create a light telescope.

## DIFFICULTY LEVEL

Moderate

## SAFETY

Emphasize handling the mirrors with care.

## TIPS

Each group requires a lot of room to perform this activity.

## MATERIALS

- 7 concave magnifying mirrors (i.e. for putting on make-up)
- 14 flashlights
- 7 measuring tapes
- 7 paper sheets
- 7 tape rolls

## PROCEDURE

- 1 Divide the class into groups of four. Give each group a magnifying mirror, measuring tape, paper sheet, tape roll, and two flashlights.
- 2 Have each group tape their paper to the wall about 30cm (1') from the floor and place the light source in front of it.
- 3 Instruct to place their mirrors about 30cm (1') in front of the light source and to adjust it so that the light source reflects on the paper. They should move the mirror back and forth until the reflection is in focus.
- 4 Have a group member move the mirror about 2m (6') away from the light source. Have them turn the mirror so that it reflects to one side instead of straight back at the light source.
- 5 Have another group member untape the paper and move it back and forth to focus the light source's reflection on the paper.



- 6 Instruct another group member to place another light source further away from the first one and move the mirror back another 1m (3'). Ask the groups to measure the distance between the first light source and the paper.

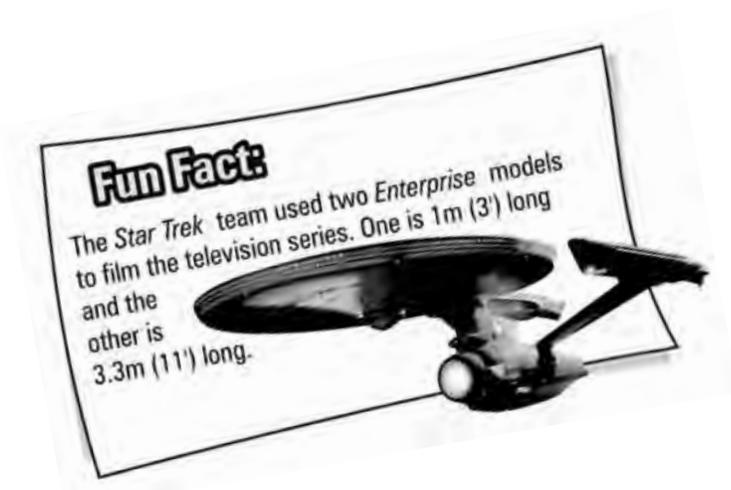
# Experiment: Seeing in Space

## *EXPLANATION*

The groups create basic reflector telescopes. A telescope is a device used to magnify distant objects. Astronomers use telescopes to look at space phenomena. There are various telescopes to collect frequencies across the electromagnetic spectrum. Specific telescopes collect infrared, X-rays, radio waves or microwaves.

Telescopes that collect white light are reflector telescopes: Mirrors have a surface that reflects light. Flat mirror surfaces reflect light at the same angle. Curved mirrors change the angle of reflected light. We can say it gathers light and reflects it at a focus. You can see the reflected image at the focus.

Isaac Newton invented this type of telescope. His design includes a secondary, small mirror to reflect the light from the curved mirror onto the screen. Modern telescopes link to computers. They often use large parabolic mirrors to focus the maximum amount of light or radiation. We see the image on the linked computer screen. Instead of telescopes, *Star Trek's* starships have hull sensors that collect electromagnetic data. The starship's sensors link to the main bridge's computer screen.



# Experiment:

## It's Dark Down There

### TIME

20 min

### TOPIC

Space phenomena

### SUMMARY

Students experiment with a black hole paper model.

### DIFFICULTY LEVEL

Advanced

### SAFETY

None

### TIPS

Add a geometry component to this activity. Have the students draw the circles with a compass instead of using the provided templates. The circle measurements are as follows:

- Sheet with universe surrounding black hole: 10cm (4") circle – 5cm (2") radius
- Circle to make black hole cone: 16cm (6") circle – 8cm (3") radius
- Circle to make event horizon inside black hole: 2cm (3/4") circle – 1cm (3/8") radius
- Circle to make actual black hole: 5mm (3/16") circle

### MATERIALS

- 15 Black Hole Template sets (see Worksheets and Answer Key section)
- 15 rulers
- 30 scissors
- 30 pencil crayons, different colors
- 15 erasers
- 15 pieces of tape

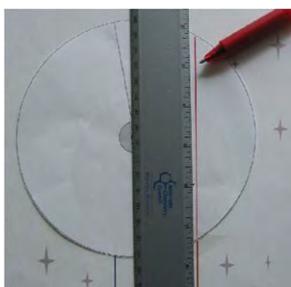
### PROCEDURE

- 1 Before class begins, photocopy fifteen Black Hole Template sets—sheet #1 and #2 (see Worksheets and Answer Key section).
- 2 Explain that astrophysicists have many theories about black holes. Astrophysicists gather theories from their observations of how things react when they come within a black hole's reach. Explain black hole parts (see explanation) and that they will make a paper model to see how black holes affect light.
- 3 Divide the students into pairs and give each pair one template set, two pencil crayons, one eraser, ruler, and two pairs of scissors.
- 4 Instruct the class to use the scissors to pierce a hole through the black hole circle from Sheet #1 in order to cut out the circle from the sheet.
- 5 Instruct the class to cut out the Sheet #2 circle and to cut a slit along the drawn line up to the black hole's center.
- 6 Instruct the class to place the Sheet #1 on a table. Tell the students this is the universe. In Sheet #1, instruct the pairs to use the ruler to draw two parallel lines from the bottom at least 7cm (2-3/4") apart towards the hole. Each line should be a different color.
- 7 Instruct the pairs to overlap and roll the slit into a cone shape that fits exactly inside the universe hole. Explain that the small circle near the tip is the black hole's event horizon and the black tip is the black hole. The rest of the cone is the part of the universe affected by the black hole.

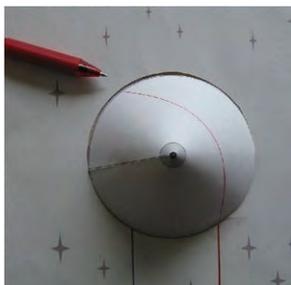


# Experiment: It's Dark Down There

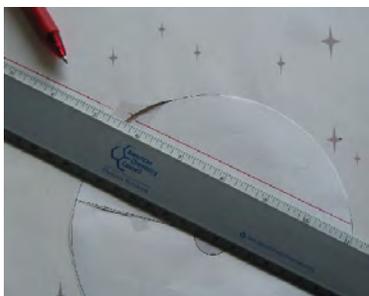
- 8 Give each pair one piece of tape. Instruct the pairs to place the piece of tape at one of the colored lines that meets the cone and to secure in place. Have the pair unroll their cone so that it lies flat against Sheet #1.
- 9 Instruct the class to use their rulers to continue the colored line onto the circle. Have them roll the circle back into a cone shape without disturbing the piece of tape.



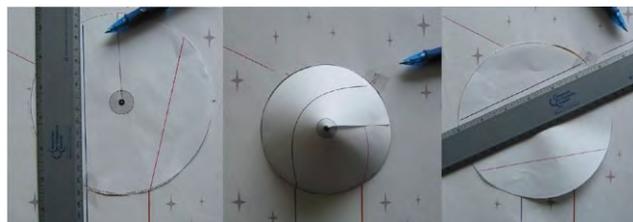
- 10 Instruct the students to look for the point on the cone's edge where the colored line touches the paper. Give the pairs a second piece of tape so that it connects the cone to the paper at this spot.



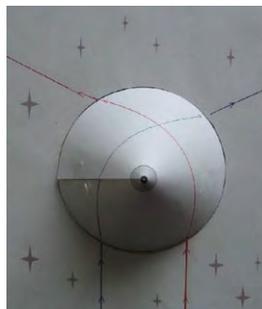
Instruct the students to unroll the cone and to use the ruler to continue the line from the cone onto the paper.



- 11 Instruct the pairs to repeat the line extension with the other colored line.



- 12 Discuss how the two parallel lines cross after passing through the black hole.



- 13 Encourage the students to experiment to see what happens to other parallel lines after they pass through the black hole. The black hole traps any lines that pass within the event horizon (the 2cm (3/4") circle). The students should roll the cone to spiral the lines' tips inwards until they touch the dark black hole circle in the center.



# Experiment: It's Dark Down There

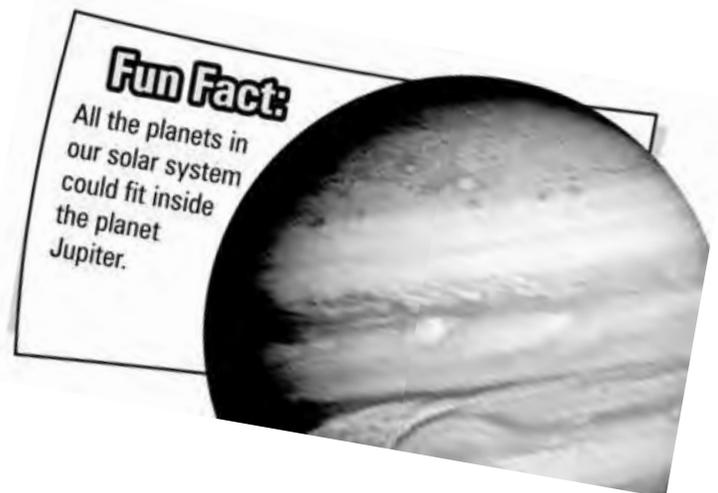
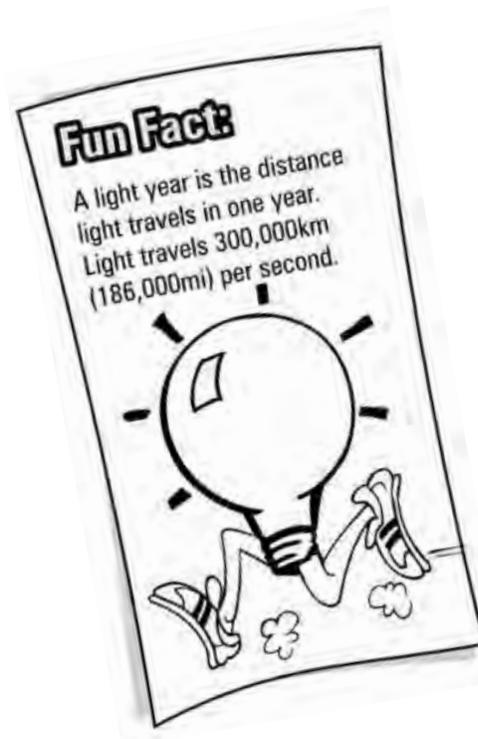
## EXPLANATION

Scientists have made theories about black holes, but no one has discovered one yet! A black hole is a region of space in the universe where the force of gravity is so strong that nothing entering can come out again. Black holes are even able to trap light! Black holes form from very large stars. The star's gravity pulls itself constantly towards its center. The star's nuclear reactions constantly push itself outwards. A black hole forms when the star runs out of fuel. Its force of gravity pulls in on itself until it is concentrated into the middle.

Physicists call this middle point a *singularity*. They think it can be smaller than an atom's nucleus! A black hole has a lot of mass inside a small point. This creates a big force of gravity. The black hole's pull of gravity gets stronger as you come nearer to it. The pull of gravity gets so strong at a certain point near the black hole that all objects are pulled inside. This is called the black hole's event horizon. Even light cannot move fast enough to escape the black hole's gravity past this point! The black hole may affect any object that comes near but remains outside its event horizon. The object's path changes but keeps moving. This is why light can be bent around a black hole.

Anything can become a black hole if compressed small enough. Our Earth can become a black hole if compressed smaller than the size of a 5mm (3/16") ball! Its event horizon would be 2cm (3/4") in diameter. Only a large star has enough mass to compress itself into a black hole. Our sun is not large enough! It would have to be 3 times its size to become a black hole at the end of its lifetime.

Some scientists say that black holes connected back-to-back form wormholes. *Star Trek* uses this idea to make various starships travel quickly over large distances across the universe and even across time.



# Additional Extension Ideas

## MATH

- Have students create a scaled version of the solar system across a wall in the classroom. They can use paper or any other materials so long as the planets and the distance between them is to scale. Divide the class into groups of three. Assign NASA space missions to each group. A space mission is a project to send a probe or other object into space. This probe collects data about a particular part of the universe and sends it back to Earth. Have each group research and plot their mission's space travels on the class solar system—trajectories, asteroids, and visited planets and moons.
- Use *Star Trek* characters and places to create math word games (See [www.startrek.com](http://www.startrek.com) library section in Characters and Places). For example, *Captain Kirk* beamed down to the planet *Deltazoid* with a landing party of four people. They met the planet's ruling council, and seven council members asked to visit his starship. How many people beamed up to the starship?
- Have students research reliable, space-related sites such as NASA and create a space phenomena calendar. For example, mark the days of the year when the next meteor shower happens.

## LANGUAGE ARTS

- *Star Trek* crews have the ability to travel from star to star. What if you could travel through space? Have students write a ballad that describes their experiences.
- Living on the *International Space Station* (ISS) is the closest experience we have to living aboard the *Enterprise*. Have students research life aboard the ISS and write a series of diary entries describing their findings.

- Have students write an advertisement to hire an astronaut for a new mission. They should list the qualifications required.
- Have the students imagine that they are world-famous astronauts who are about to participate in a rocket launch and go on a space mission. Have them write a newspaper article in which they are interviewed about their training and expectations for space travel.

## ART

- Have students design a spacecraft and build a three-dimensional (3-D) model using recycled objects.
- Have students act like clothing designers. Instruct them to design and draw a flight suit that is protective material, comfortable to wear, suitable for astronaut activities, and creative (tip: Velcro is helpful to keep things like pens and notepads from floating away).
- Astronauts on every space shuttle mission design their own patches. Have students work in small groups to design patches for their future space shuttle missions. Each patch should include a mission number, date, astronaut's name, and mission highlights.
- Have students research how astronomers add color to space phenomena images. Give them black-and-white images to colorize based on their theories.

# Additional Extension Ideas

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## *SOCIAL STUDIES*

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- Astronauts spend all their time in cramped conditions in space. Discuss tasks that astronauts perform on a space mission. Have the class design a set of tasks (a mission) to perform in the classroom. Divide the class into groups of five “astronauts.” Use masking tape to cordon off a small space in the classroom, and have each astronaut group spend 30 minutes everyday for a week inside the space to carry out the mission. Discuss how the astronauts feel as the week progresses.
- Invite the students to research the biography of an astronaut. Have them make comparisons between their interests and the interests of their chosen astronaut.
- Have the students watch a *Star Trek* episode and note all the elements in the show that are now used in everyday life. I.e, automatic sliding doors and cell phones.

## *FIELD TRIP IDEAS*

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- Visit a local swimming pool and instruct the students to perform specific tasks in the water. Before living in space, astronauts practice doing different jobs in a large pool called a Weightless Environment Test Facility to help them prepare for microgravity work challenges.
- Visit a planetarium.
- Visit a space museum.

# Space Science Glossary

<b>Astronomer</b>	A scientist who studies the stars, planets, and other aspects of space.
<b>Astronomy</b>	The science of studying objects in the universe.
<b>Binary numbers</b>	A system for coding data with only two digits: 1 and 0. This coding is based on the on and off signal principle where 1 means a signal is on and 0 means the signal is off.
<b>Biometric</b>	The science of measuring and identifying specific characteristics of living organisms.
<b>Black hole</b>	An object whose mass is concentrated into a small space. The mass still has a force of gravity. This force of gravity—the event horizon—is so great that it pulls in both matter and light at a certain distance.
<b>Concave lens</b>	Also mirror; a lens that curves inward like a cave.
<b>Convex lens</b>	Also mirror; a lens that curves outward like a ball.
<b>Electromagnetic radiation</b>	A type of energy that travels in waves. The wavelength determines its frequency. There is a continuous spectrum of radiation frequencies. Frequencies are grouped into radiation types. X-rays, gamma rays, ultraviolet rays, white light, infrared light, microwaves, and radio waves are all part of the electromagnetic spectrum.
<b>Event horizon</b>	The point of no return of a black hole. Objects that travel past this point cannot escape the black hole's force of gravity.
<b>Frequency</b>	The number of waves per second that an energy type emits. Radio signals are carried along certain frequencies within the electromagnetic spectrum's radio wavelength.
<b>Gravity</b>	The attraction that two masses exert on each other. All objects have a gravitational pull. The size of the object affects its strength. For example, Earth's gravity attracts planes toward its ground. The plane also attracts Earth towards it, but the Earth's gravitational force is stronger. Gravity on Earth is the downward force affecting flight.
<b>Lift</b>	The upward force affecting flight.
<b>Mass</b>	The amount of matter in an object.
<b>Matter</b>	Anything with mass that occupies space.
<b>Microgravity</b>	A very low gravity environment, which causes people and objects to be practically weightless. During the first few days in space, the effects of microgravity can cause some astronauts to feel nauseated.
<b>Orbit</b>	A specific path that a planet, satellite, or other space object follows.
<b>Pixels</b>	The smallest part of a picture. Pixels fit together to form a picture.
<b>Satellite</b>	An object that orbits a planet. The Moon is a natural satellite that orbits Earth. Geo-stationary satellites are artificial satellites that orbit Earth.

# Space Science Glossary

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<b>Speed of light</b>	The speed at which light travels—300,000km (186,000mi) per second.
<b>Spin-off</b>	A commercial product based on an item developed for use in space.
<b>Thrust</b>	The forward force affecting flight.
<b>Wavelength</b>	The length of one up and down movement of electromagnetic radiation. A wavelength size determines the electromagnetic radiation type.
<b>Weightlessness</b>	A condition when an object is not affected by any other object's force of gravity.

# Star Trek Glossary

<b>Hailing frequencies</b>	Radio frequencies sent out by the communications officer to make contact with another space faring vessel or planet.
<b>Prime Directive</b>	<i>Starfleet General Order #1</i> . This is the most important rule that all members of Starfleet must follow. The <i>Prime Directive</i> forbids any member of Starfleet to interfere with the development of any society they encounter. An example would be to give a less-developed planet the technology for building a warp drive engine.
<b>Romulan</b>	A race of humanoid beings derived from <i>Vulcans</i> . <i>Romulans</i> rejected the philosophy of logic that <i>Vulcans</i> follow. They are a warrior civilization. <i>Romulans</i> are considered passionate, aggressive, but honorable people.
<b>Stardate</b>	The <i>Star Trek</i> equivalent of calendar years. This timekeeping system standardizes time for travelers all across the galaxy.
<b>Starfleet</b>	The agency chartered by the <i>United Federation of Planets</i> to conduct missions in deep space. These missions involved seeking out new life, conducting science, exploration, and going where no one has gone before.
<b>Starship</b>	Space-going vessel that is capable of traveling faster than the speed of light.
<b>Tribble</b>	Fictional furry animals that breed very quickly. Tribbles will continuously multiply so long as food is available.
<b>U.S.S</b>	Designation given to all <i>Federation starships</i> . The initials stand for United Space Ship.
<b>Vulcan</b>	Race of humanoid beings from the planet <i>Vulcan</i> . Their pacifist society is based on logic. <i>Vulcans</i> in <i>Star Trek</i> were the first extraterrestrials to make contact with humans on Earth.
<b>Warp drive engine</b>	The <i>starship</i> engine that allows the vessel to travel faster than the speed of light.
<b>Wormhole</b>	A space anomaly that links two distant parts of the universe. <i>Wormholes</i> may also link two time periods together.

# Star Trek and Space Exploration Research Library

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There are numerous books available on space science. Below are some suggested resources for students in kindergarten to sixth grade.

## REFERENCE BOOKS

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**Title:** This Rocket  
**Author:** Paul Collicutt  
**Publisher:** Farrar, Straus and Giroux  
**ISBN#:** 0374374848  
**Description:** *This Rocket* introduces and compares all rocket types. Younger children can manage the simple text and pictures while older children can gather even more information from the detailed end pages, which feature rocket history and a description of the *Apollo 11* mission. This book is appropriate for students in kindergarten to 2<sup>nd</sup> grade.

**Title:** My Book of Space  
**Author:** Ian Graham  
**Publisher:** Kingfisher  
**ISBN#:** 0753453991  
**Description:** *My Book of Space* introduces young readers to the amazing world of space, space travel, and the vehicles we use to explore it. Large, colorful spreads with action-oriented text reveal the answers every young child wants to know, including why the moon seems to change shape, and how spaceships work. This book is appropriate for students in kindergarten to 3<sup>rd</sup> grade.

**Title:** All About Space  
**Author:** Sue Becklake  
**Publisher:** Scholastic  
**ISBN#:** 0590104713  
**Description:** *All About Space* covers the solar system, the study of space, and space travel with excellent photos, diagrams, drawings, and organized text appropriate for the primary grade student. This book is appropriate for students in kindergarten to 3<sup>rd</sup> grade.

**Title:** Space Station Science: life in free fall  
**Author:** Marianne J. Dyson  
**Publisher:** Scholastic  
**ISBN#:** 0590058894  
**Description:** Marianne J. Dyson gathers information from astronauts and other scientists to take readers through crew training and rocket launch. Her research includes physical necessities and hazards as well as the tasks and research that can be performed on a space station. She studies the effects of an extended stay off-planet to conclude the book. This book is appropriate for students in kindergarten to 3<sup>rd</sup> grade.

**Title:** Orbit: NASA astronauts photograph the Earth  
**Author:** Jay Apt, Michael Helfert, and Justin Wilkinson  
**Publisher:** The National Geographic Society  
**ISBN#:** 0792237145  
**Description:** Astronaut Jay Apt together with scientists Michael Helfert and Justin Wilkinson compiled astonishing photographs taken by astronauts from the space shuttle while in orbit. This book is appropriate for students in kindergarten to 3<sup>rd</sup> grade.

## EXPERIMENT & ACTIVITY BOOKS

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**Title:** Rocket-powered Science  
**Author:** Edwin J. C. Sobey  
**Publisher:** Good Year Books  
**ISBN#:** 1596470550  
**Description:** Rocket-building activities challenge students to work in teams like NASA engineers. Students make and test models, measure and record data as well as graph and report results. There are 25 demonstrations and 16 models, all with clear guidelines and science standards to meet. They require only inexpensive or free recycled materials. This book is appropriate for students in 3<sup>rd</sup> to 6<sup>th</sup> grade.

# Star Trek and Space Exploration Research Library

**Title:** Toys in Space: exploring science with the astronauts

**Author:** Carolyn Sumners

**Publisher:** McGraw Hill

**ISBN#:** 0070694893

**Description:** *Toys in Space: exploring science with the astronauts* helps children develop a hands-on appreciation of physics through toy-based activities. It features ready-to-use activities and more than 40 experiments comparing how toys move on Earth and how they move in space. NASA astronauts have performed similar experiments on space shuttle missions. Activities based on these NASA simulations are included here. This book is appropriate for students in 5<sup>th</sup> to 6<sup>th</sup> grade.

## FICTION

**Title:** The Magic School Bus Book #4: space explorers

**Author:** Eva Moore, Joanna Cole

**Publisher:** Scholastic

**ISBN#:** 9780439114936

**Description:** Join Carlos and Ms. Frizzle's class on a far-out adventure in outer space! Follow them as they become real space explorers, and learn all about the awesome solar system. This book is appropriate for students in 2<sup>nd</sup> to 4<sup>th</sup> grade.

**Title:** The Firebird Rocket

**Author:** Franklin W. Dixon

**Publisher:** Grosset & Dunlap

**ISBN#:** 0448089572

**Description:** Two teenage sleuths help their detective father search for a famous rocket scientist whose disappearance endangers the *Firebird* rocket launch. This book is appropriate for students in 3<sup>rd</sup> to 6<sup>th</sup> grade.

**Title:** Tom Swift and His Megascope Space Prober

**Author:** Victor Appleton

**Publisher:** Grosset & Dunlap

**ISBN#:** NA

**Description:** Tom Swift is a young scientist inventor whose inventions propel him into battles against sinister enemies. Tom works to complete his megascope space prober, designed to “keep an eye on the universe.” His megascope space prober is a radio telescope that sends a special radio wave to scan different objects' surfaces and thus create a picture. This book is appropriate for students in 3<sup>rd</sup> to 6<sup>th</sup> grade.

**Title:** The Space Hotel

**Author:** Victor Appleton

**Publisher:** Aladdin Paperbacks

**ISBN#:** 9781416917519

**Description:** When Tom arrives to the world's first space hotel, he experiences weightlessness, learns about the hotel's high-tech nature including the robotic cleaning staff, and plays a game of zero gravity badminton. He begins to notice some strange happenings as he explores the ship. This book is appropriate for students in 3<sup>rd</sup> to 6<sup>th</sup> grade.

**Title:** On the Shuttle: eight days in space

**Author:** Barbara Bondar

**Publisher:** Maple Tree Press

**ISBN#:** 1895688124

**Description:** *On the Shuttle: eight days in space* takes you aboard! Barbara Bondar accompanied *Discovery* crewmember and sister, Dr. Roberta Bondar, for several weeks during the training procedures prior to the International Microgravity Laboratory-1 (IML-1) shuttle mission. This book provides readers with a detailed look into the first IML-1. This book contains countless interesting facts—from detailed space shuttle components to maintaining daily hygiene aboard. This book is appropriate for students in kindergarten to 6<sup>th</sup> grade.

# *Star Trek* and Space Exploration Research Library

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**Title:** The Space Shuttle

**Author:** Christopher Maynard

**Publisher:** Kingfisher Books

**ISBN#:** 1856975142

**Description:** The *Space Shuttle* tells the story of a rescue mission in space, from liftoff to landing. Information behind the folded flaps offers opportunities for thoughtful discussions. The combination of story and fascinating facts makes this a comprehensive read! This book is appropriate for students in 1<sup>st</sup> to 3<sup>rd</sup> grade.

# Student's Guide to the Scientific Method

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## **HYPOTHESIZE**

A hypothesis is a guess as to what will happen when you do an experiment. Look for books or information on the internet to learn about your experiment before you start. Write down what you think will be the result of your experiment.

## **MATERIALS AND PROCEDURES**

You should be able to follow instructions to repeat a science experiment. Materials are the items you need to do the experiment. Procedures are the steps you follow. Write the materials you use and steps you follow.

## **OBSERVE**

Observations provide an idea of how your experiment turns out. Record whatever you see during an experiment. Observe using your sense of sight, sound, touch, smell, and taste to gather the most information as possible. Remember to never smell, taste, or touch anything that your teacher does not approve. You can both write and draw what you see.

## **DRAW CONCLUSIONS**

Conclusions are your ideas about why the experiment works—or does not work. Think about the steps taken and observations. Write what happened and why you think you came to your result.

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# Worksheets and Answer Keys

# Experiment Log

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**Name:**

***Hypothesis***

Guess what might happen.

***Materials***

Be sure to include measurements!

***Procedure***

Make sure to write down all the steps.

***Observations***

Record what you noticed. You can draw a diagram on this paper.

***Conclusions***

What happened and why?

# Your Body in Space Learning Center Cards

## Learning center #1 — Balance

**Did you know:**

Tiny hairs cover your inner ear? Their tips float in liquid and tell your brain the position of your head. Your brain then controls the muscles to help keep you balanced.

**Discussion question:**

What is balance, and how may living in space affect it?

**Try it out:**

- 1 Stand on one leg with your eyes OPEN.
- 2 Stand on one leg with your eyes CLOSED.

**Discuss findings:**

Is it easier to keep your balance when your eyes are open or closed? Which body parts help keep your balance?

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## Learning center #2 — Bones

**Did you know:**

On Earth our bones are strong enough to help us stand up against the force of gravity?

**Discussion question:**

What happens to your bones in a low-gravity environment?

**Try it out:**

- 1 Take one chicken bone from the resealable bag. Try to bend it.
- 2 Take one chicken bone from the jar of vinegar. Wipe it with paper towel. Try to bend it.

**Discuss findings:**

How does the bone from the resealable bag feel? How does the bone from the jar feel? Why do your bones need to grow and stay strong? Why may an astronaut's bones weaken in space?

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## Learning center #3 — Health

**Did you know:**

Sneezing, coughing, and breathing spreads germs through the air?

**Discussion question:**

Why may it be easier to catch a cold in space?

**Try it out:**

- 1 One group member sticks their hand in the bag of rice. The rice should stick to the hand.
- 2 The group member uses the hand that touched the rice to shake a group member's hand. That person shakes another group member's hand until everyone has shaken hands.

**Discuss findings:**

How is a classroom like a spaceship? What does the rice show in this experiment? How do we keep germs from spreading?

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## Learning center #4 — Muscles

**Did you know:**

Some muscles develop when you push against the force of gravity?

**Discussion question:**

Why is it especially important to exercise in space?

**Try it out:**

- 1 Grasp your right hand with your left hand with your palms facing up. Pull and push in opposite directions for ten seconds.
- 2 Place your hands against a wall or stationary object. Run in place for 10 seconds.

**Discuss findings:**

Why may exercises similar to these be important for astronauts to do daily in space?

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# Computer User Recognition Learning Center Cards

## Learning center #1— Voice Recognition

### Did you know:

A voiceprint is like a fingerprint? We can identify a person by the way they sound when they speak. Some computer security systems use voiceprint scans.

### Discussion question:

Can you use voiceprint scans to identify your group members?

### Try it out:

- 1 One member from each team sits facing away from the other team members. These people each hold a sheet of paper and pen and are their team's computer security system, or "security." The security members must identify the voices of their team members.
- 2 The remaining team members take a turn saying their own name twice and the phrase "Access Computer" as the security listens and records their names.
- 3 Switch three members between both teams without letting the security member see.
- 4 Each person says "Access Computer." The security members have to determine if the person speaking is on their team. The security members say either the person's name and "access cleared" or "access denied." The team with the highest voice recognitions gets a point.

### Discuss findings:

Which voices are easiest and most difficult to recognize?

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## Learning center #2— Eye Recognition

### Did you know:

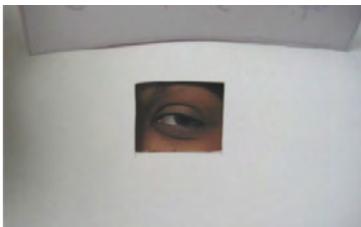
The iris is the colored part of the eye? The plural for iris is irides or irises. Your iris controls the amount of light that enters the eye. An iris scan is like a fingerprint. We can identify a person by the color pattern in their irides. Some computer security systems use iris scans.

### Discussion question:

Can you use iris scans to identify your group members?

### Try it out:

- 1 One member from each team sits behind a bristol board on the side without the paper flap. These members each hold a sheet of paper and pen and are their team's computer security system, or "security." The security members must identify the eyes of team members.
- 2 There is a small peephole covered under the sheet of paper in the bristol board's center. Each member puts their eye against the hole, and taps on the bristol board.
  - 3 The security members lift the flap and looks at the eye while the member says their name. The security members memorize the eyes and record their name. The security members must lower the flap between group members.
  - 4 Switch three members between both teams without letting the security members see them.
  - 5 Repeat step 2 without speaking. This time the security members have to determine whether the person is on their team. They say either the person's name and "access cleared" or "access denied." The team with the highest eye recognitions gets a point.



### Discuss findings:

Which eyes were easiest and most difficult to recognize?

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# Computer User Recognition Learning Center Cards

## Learning center #3— Hand Recognition

### Did you know:

The blood vessel pattern in our hands is different in every person? It is like a fingerprint, but inside the body. Special cameras can pick up the blood vessel or palm vein prints. Some computer security systems use palm vein scanners.

You cannot see the blood vessels, but you can see the lines on the palm of your hand. Can you use palm line scans to identify your group members?

### Try it out:

- 1 One member from each team sits behind a bristol board. There is a hole large enough for a hand to fit through the screen. These members hold a sheet of paper and a pen and are their team's computer security system, or "security." The security members must identify the palms of team members.
- 2 Each member rolls up their sleeve, fits their hand palm-up through the hole up to the wrist, and says their name twice. The security members memorize the palms and record the name.
- 3 Switch three members between both teams without letting the security members see them.
- 4 Repeat step 2 without speaking. The security members have to determine whether the person's palm is on their team. The security members say either the person's name and "access cleared" or "access denied." The team with the highest hand recognitions gets a point.

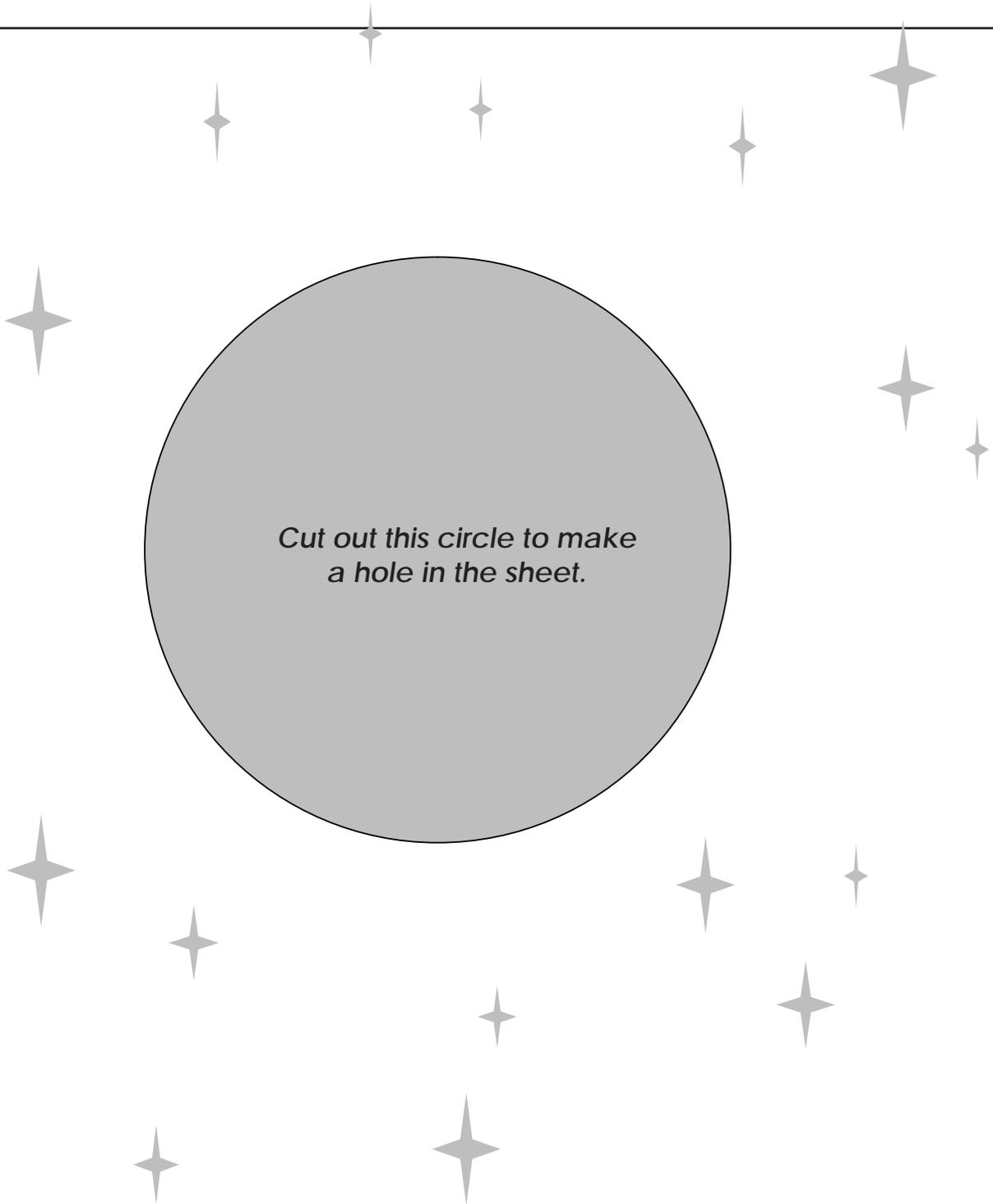
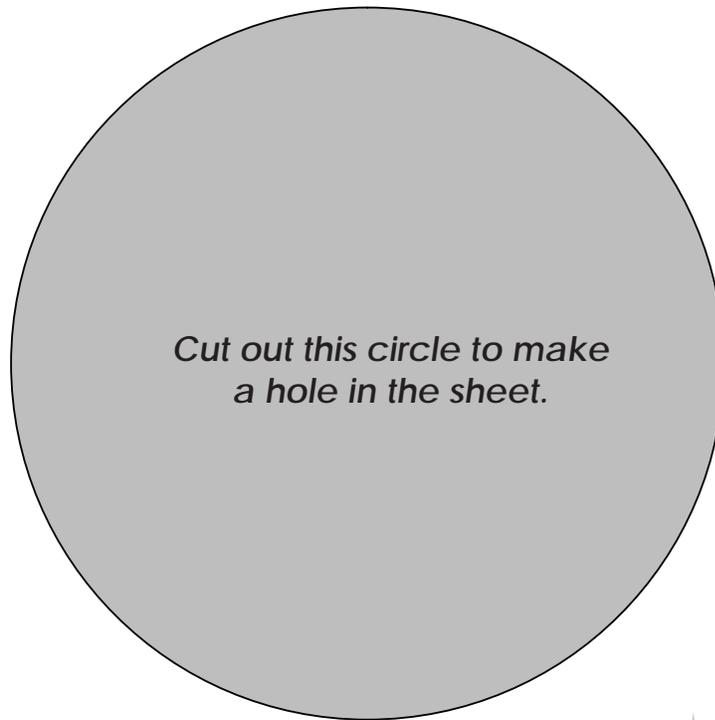


### Discuss findings:

Which palms were easiest and most difficult to recognize?

# Black Hole Template

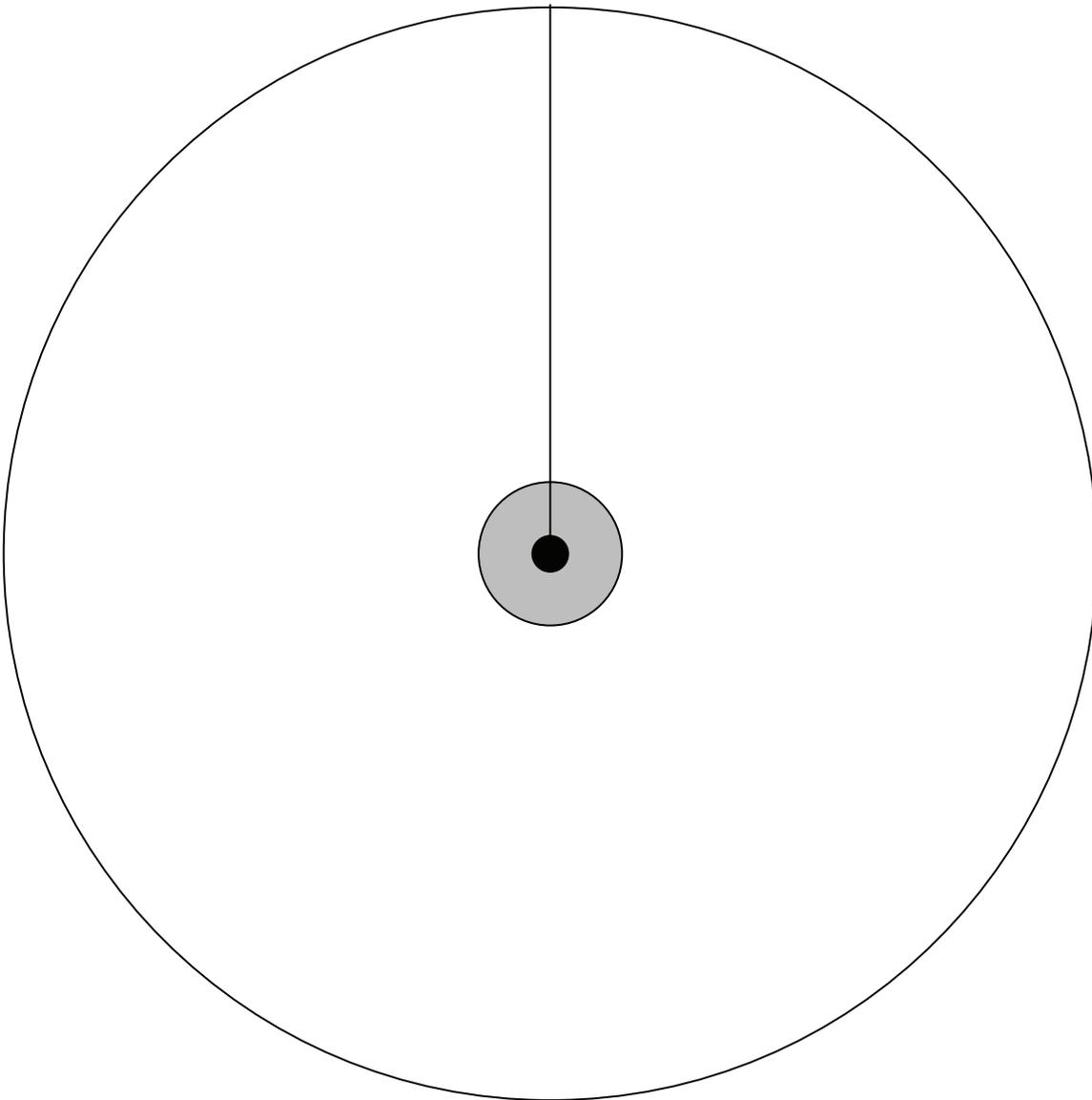
Sheet #1 - universe surrounding the black hole



# Black Hole Template

Sheet #2 -black hole cone

*Cut out the circle and then cut along the slit on the circle.*



# Star Trek and Space Science Word Search

Name:

## Difficulty level:

- Moderate

## Directions:

- Find and circle the words from the list below. Words can be forwards, backwards, diagonal, or vertical.

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

## Word list

ASTRONAUT  
BLACK HOLE  
COMMUNICATION  
CURIOSITY  
DISCOVERY  
EXPLORE  
GALAXY

LOGIC  
NEW WORLDS  
ORBIT  
PLANET  
PRIME DIRECTIVE  
ROMULAN  
SATELLITE

SCIENCE  
SOLAR SYSTEM  
STARSHIP  
TELESCOPE  
VULCAN  
WARP DRIVE

# Star Trek and Space Science Crossword Puzzle

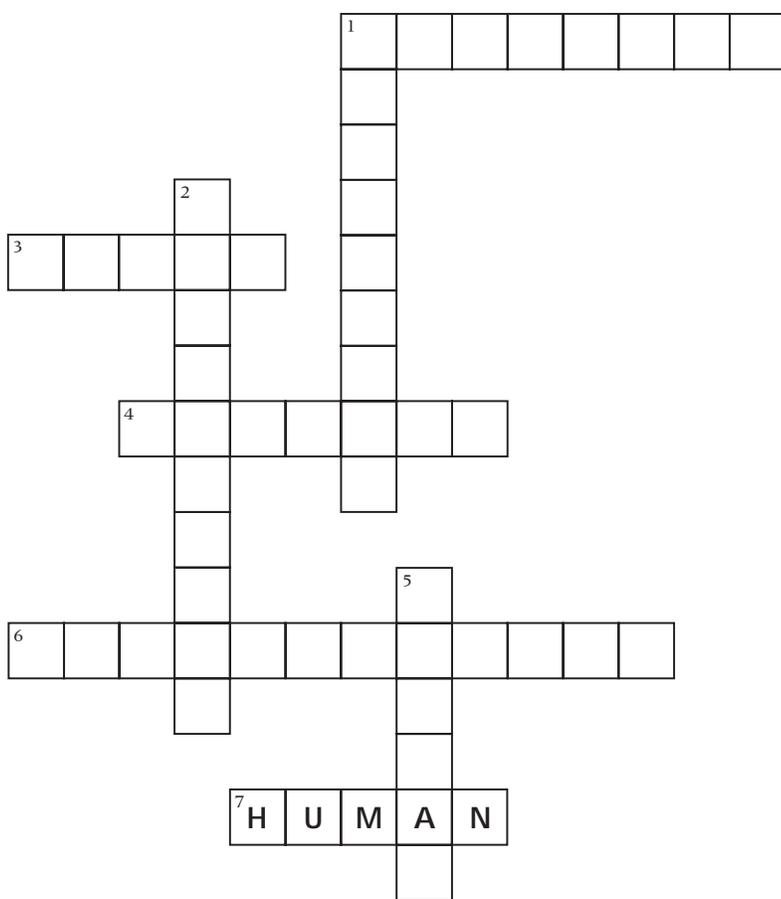
Name:

**Difficulty level:**

- Moderate

**Directions:**

- Read the clues and fill in the blank squares on the grid. One word has been filled in for you.



**Across**

1. Invasive alien species in *Star Trek*.
3. The path an object follows as it moves around a planet or other large body in space.
4. The \_\_\_\_\_ Space Center is the launch site for every U.S. human space flight since 1968.
6. NASA spacecraft that transports crew to and from space.
7. \_\_\_\_\_ blood is iron-based.

**Down**

1. Scientific instrument used for scanning in *Star Trek*.
2. Science that uses a living person's measurements to identify them.
5. \_\_\_\_\_ blood is copper-based.

**Word list**

BIOMETRICS  
HUMAN  
KENNEDY

ORBIT  
SPACE SHUTTLE  
TRIBBLES

TRICORDER  
VULCAN

# Star Trek and Space Science Double Puzzle

Name:

**Difficulty level:**

- Moderate

**Directions:**

- Fill in the boxes using the clues below. Copy the letters from the numbered boxes into the matching boxes to find the hidden sentence. The first word is filled in for you.

a.   
1

b.   
8

c.   
4 13

d.    
14 5 11

e.   
3

f.   
15 18 6 10

g.   
9 12

h.     
17 2 16

i.   
7

- a. Spock's fictional race
- b. \_\_\_\_\_ is the downward force that keeps us on Earth.
- c. *Star Trek* starship name
- d. Another name for space junk
- e. Lack of downward force in space
- f. Person who works in space
- g. The *Enterprise* uses the \_\_\_\_\_ drive to move quickly in space.
- h. Research facility in space
- i. Aggressive race of aliens in *Star Trek*

**Word list**

ASTRONAUT  
ENTERPRISE  
GRAVITY

INTERNATIONAL  
MICROGRAVITY  
ORBITAL DEBRIS  
ROMULANS

SPACE STATION  
VULCAN  
WARP

L 1 2 3 4

5 6 7 8

9 10 11

12 13 14 15 16 17 18

# Star Trek Logic Puzzle

Name:

## Difficulty Level

- Advanced

## Puzzle

Five Starfleet Academy crewmembers and their families have come aboard the first intergalactic space station to work together. Each family has one child and comes from a different planet. Each family has one parent with a role on the station: engineer, medical staff, shuttle pilot, science officer, and assistant commander. Use the clues to figure out each child's name, home planet, and parent's space station role.

## Directions

- 1 Read each fact to connect the correct answer with an O in the grid. Place an X in a box for results that do not match. There are three grids. There should be four X's and one O in each row and column of each grid.
- 2 The first fact states that Eelen Akaar's home planet is Capella IV. Place an O in the box linking Eelen Akaar and Capella IV. Place an X in the rest of the row and column.

## Tips

- Place an O in the fifth box where four X's in a row or column are showing.
- If there is an O in a box, place X's in the other boxes of that row and column.
- Use your logic to match up the results!  
Here is an example:  
A child's name and a parent's role link in one grid. The parent's role and home planet link in another grid. This means you can link the child's name to that planet in the last grid.

## Facts

- 1 Eelen Akaar and her family visit their home planet Capella IV every year.
- 2 The Denevan child and Zera Cochrane are best friends. Zera's mother is an engineer. The other child thinks that his parent is the best pilot on the station.
- 3 The Vulcan child wants to follow in his father's footsteps and be a science officer.
- 4 The parent from Alpha Centauri is one of the top engineers at Starfleet Academy.
- 5 James Pike and Sutak are the only male children on the station. Vulcan male names always begin with the letter S.
- 6 The family with the parent who is Assistant Commander has never visited the planet Betazed.
- 7 Eelen Akaar's parent is good friends with the Science Officer.
- 8 Marina Troi's parent is not the pilot.
- 9 James Pike's home planet starts with the letter "D".
- 10 Sutak and Eelen Akaar are not the pilot's children.
- 11 Zera Cochrane has a poster of her home planet, Alpha Centauri in her room.
- 12 The daughter of the Medical Staff is Marina Troi.

If you completed the puzzle with:  
 Facts 1-3, you're using intuition more than logic!  
 Facts 1-6, you have great logic abilities!  
 Facts 1-9, congratulations for thinking logically!  
 Facts 1-12, keep practicing your logic!

# Logic Puzzle Grid

Name: \_\_\_\_\_

The links from facts #1 is already marked in the grid.

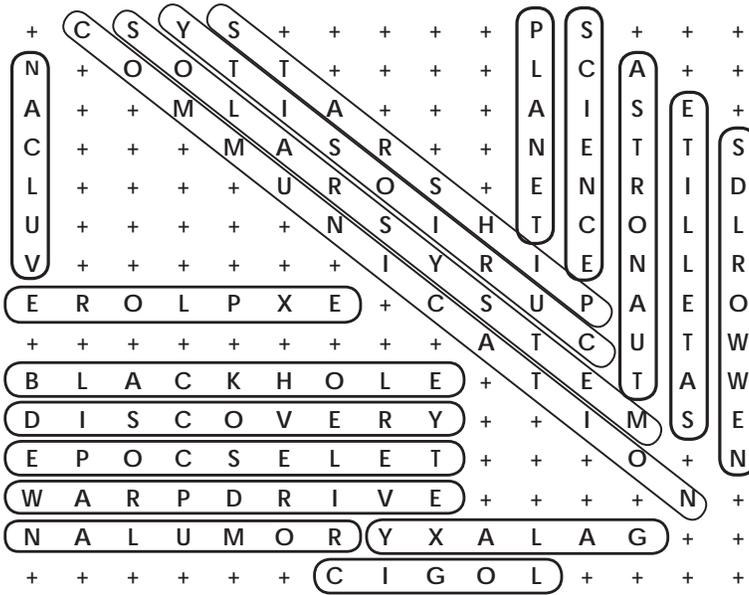
		HOME PLANET					PARENT'S SPACE STATION ROLE				
		ALPHA CENTAURI	BETAZED	CAPELLA IV	DENEVA	VULCAN	ASSISTANT COMMANDER	ENGINEER	MEDICAL STAFF	PILOT	SCIENCE OFFICER
CHILD'S NAME	ELEEN AKAAR	X	X	O	X	X					
	JAMES PIKE			X							
	MARINA TROI			X							
	SUTAK			X							
	ZERA COCHRANE			X							
SPACE STATION ROLE	ASSISTANT COMMANDER										
	ENGINEER										
	MEDICAL STAFF										
	PILOT										
	SCIENCE OFFICER										

Summary from the grid (write down the results as you find them):

NAME	HOME PLANET	PARENT'S SPACE STATION ROLE
Eleen Akaar		
James Pike		
Marina Troi		
Sutak		
Zera Cochrane		

# Worksheet Answer Keys

## Star Trek and Space Science Word Search



### Double Puzzle

- VULCAN
- GRAVITY
- ENTERPRISE
- ORBITAL DEBRIS
- MICROGRAVITY
- ASTRONAUT
- WARP
- INTERNATIONAL SPACE STATION
- ROMULANS

**Answer:** LIVE LONG AND PROSPER

### Crossword Puzzle

#### Across

- TRIBBLES
- ORBIT
- KENNEDY
- SPACE SHUTTLE
- HUMAN

#### Down

- TRICORDER
- BIOMETRICS
- VULCAN

# Worksheet Answer Keys

## Star Trek Logic Puzzle

		Home Planet					Parent's Space Station Role				
		Alpha Centauri	Betazed	Capella IV	Deneva	Vulcan	Assistant Commander	Engineer	Medical Staff	Pilot	Science Officer
Child's Name	Eleen Akaar	X	X	O	X	X	O	X	X	X	X
	James Pike	X	X	X	O	X	X	X	X	O	X
	Marina Troi	X	O	X	X	X	X	X	O	X	X
	Sutak	X	X	X	X	O	X	X	X	X	O
	Zera Cochrane	O	X	X	X	X	X	O	X	X	X
Parent's Space Station Role	Assistant Commander	X	X	O	X	X					
	Engineer	O	X	X	X	X					
	Medical Staff	X	O	X	X	X					
	Pilot	X	X	X	O	X					
	Science Officer	X	X	X	X	O					

Child's Name	Home Planet	Parent's Space Station Role
Eleen Akaar	Capella IV	Assistant commander
James Pike	Deneva	Pilot
Marina Troi	Betazed	Medical assistant
Sutak	Vulcan	Science officer
Zera Cochrane	Alpha Centauri	Engineer

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In March 1985, brothers Ariel and Ron Shlien, teenagers at the time, began launching rockets at birthday parties in their neighborhood. They quickly realized that their means of extra income was very appealing to educators, parents, after-school programs, and community centers. Fun, cool, hands-on science experiments were in demand. As a result, the first franchise opened in 1994, and the network has grown to include over 200 locations worldwide.

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# Welcome to the World of Mad Science®

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Mad Science Productions currently has a variety of show inventory: *Star Trek Live!*, *CSI: LIVE!*, *Movie Magic: The Science behind the Movies*, and *Newton's Revenge 2*.

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