MISSION X!

Lesson SPI Guidelines:

Use the activities in the lesson materials to help students practice the following grade-level appropriate SPI related skills, among many others. As you read the activities, keep in mind the specifics skills your students need to practice and master in the different grade levels and use them to guide your approach in how you present the activities and what you have the students do. You can add additional SPIs in your plans that are outside the specific ones listed below

2nd Grade:

Math SPIs:

- 6.5.1 Read, interpret, and analyze data shown in tables, bar graphs and picture graphs.
- 6.5.2 Read, interpret, and create tables using tally marks.
- 6.5.3 Explain whether a real world event is likely or unlikely.
- 6.5.4 Predict outcomes of events based on data gathered and displayed.
- 6.4.4 Estimate, measure, and calculate length to the nearest unit: meter, centimeter, yard, foot, and inch.
- 6.1.3 Use strategies to make estimates of time.
- 6.1.4 Solve problems involving elapsed time in hour and half-hour intervals.

RLA SPIs:

Writing

- 1.3.1 Write to describe, entertain, and inform.
- 1.3.6 Use temporary/creative spelling to spell independently while transitioning to standard spelling in first drafts.
- 1.3.7 Arrange events in a logical and sequential order when writing.
- 1.3.8 Continue to add descriptive words and details to writing.
- 1.3.11 Incorporate suggestions from teachers and peers.

Logic:

- 1.5.4 Compare and contrast information and ideas.

3rd Grade:

Math SPIs:

- CU 6.4.10 Use reasonable units of length (i.e. kilometer, meter, centimeter; mile, yard, foot, inch) in estimates and measures.
- 0306.1.7 Select appropriate units and tools to solve problems involving measures.
- 0306.4.5 Choose reasonable units of measure, estimate common measurements using benchmarks, and use appropriate tools to make measurements.
- 0306.4.6 Measure length to the nearest centimeter or half inch.
- 0306.4.7 Solve problems requiring the addition and subtraction of lengths.
- 0306.5.2 Solve problems in which data is represented in tables or graphs.
- 0306.5.3 Make predictions based on various representations.

RLA SPIs:

Writing & Research:

- 0301.3.1 Identify the purpose for writing (i.e., to entertain, to inform, to respond to a picture, story, or art).

Logic

- 0401.5.1 Locate information to support opinions, predictions, and conclusions.

4th Grade:

Science SPIs:

- CU 7.11.1 Identify the position of objects relative to fixed reference points.
- SPI 7.11.1 Describe the position of an object relative to fixed reference points.

Math SPIs:

- 0406.2.10 Solve contextual problems using whole numbers, fractions, and decimals.
- 0406.4.6 Determine situations in which a highly accurate measurement is important [or is not].
- 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.
- 0406.4.8 Convert measurements within a single system that are common in daily life (e.g., hours and minutes, inches and feet, centimeters and meters, quarts and gallons, liters and milliliters).
- 0406.5.1 Depict data using various representations (e.g., tables, pictographs, line graphs, bar graphs).
- 0406.5.2 Solve problems using estimation and comparison within a single set of data.

- CU 6.4.12 Estimate the size of an object with respect to a given measurement attribute (length, perimeter, area, or capacity).
- CU 6.4.13 Compare objects with respect to a given attribute such as length, area, and capacity.

RLA SPIs:

Writing and Research:

- 0401.3.1 Identify the purpose for writing (i.e., to entertain, to inform, to share experiences).

Logic:

- 0401.5.1 Locate information to support opinions, predictions, and conclusions.

Informational Text:

- 0401.6.1 Select questions used to focus and clarify thinking before, during, and after reading text.

5th Grade:

- SPI 7.12.1 Explain and give examples of how forces act at a distance.

Math SPIs:

- 0506.1.1 Given a series of geometric statements, draw a conclusion about the figure described.
- 0506.4.3 Identify a three-dimensional object from two-dimensional representations of that object and vice versa.
- 0506.4.6 Record measurements in context to reasonable degree of accuracy using decimals and/or fractions.
- 0506.4.8 Convert measurements
- 0506.2.1 Read and write numbers from millions to millionths in various contexts.
- 0506.5.1 Depict data using various representations, including decimal and/or fractional data.
- 0506.5.2 Make predictions based on various data representations.

RLA Standards:

Writing and Research

- 0501.3.2 Identify the purpose for writing (i.e., to entertain, to inform, to share experiences, to persuade, to report).
- 0501.3.8 Select vivid and active words for a writing sample.

Logic:

- 0501.5.1 Locate information to support opinions, predictions, and conclusions.

Informational Text:

- 0501.6.1 Select questions used to focus and clarify thinking before, during, and after reading text.

6th Grade:

Math SPIs:

- 0606.1.1 Make conjectures and predictions based on data.
- 0606.1.3 Use concrete, pictorial, and symbolic representation for integers.
- 0606.2.5 Transform numbers from one form to another (fractions, decimals, percents, and mixed numbers).
- 0606.4.4 Calculate with circumferences and areas of circles.
- 6.3.4 Generate data and graph relationships concerning measurement of length, area, volume, weight, time, temperature, money, and information.

RLA SPIs:

Writing and Research

- 0601.3.1 Identify the purpose for writing (i.e., to inform, to describe, to explain, to persuade).

Logic:

- 0601.5.7 Make inferences and draw conclusions based on evidence in text.

7th Grade:

Math SPIs:

- 0706.1.3 Recognize whether information given in a table, graph, or formula suggests a directly proportional, linear, inversely proportional, or other nonlinear relationship.
- 6.2.8 Apply ratios, rates, proportions and percents (such as discounts, interest, taxes, tips, distance/rate/time, and percent increase or decrease).
- 0706.5.1 Interpret and employ various graphs and charts to represent data.
- 0706.2.7 Use ratios and proportions to solve problems.
- 0706.1.4 Use scales, ex. to read maps.
- 0706.4.3 Apply scale factor to solve problems involving area and volume.

RLA SPIs:

Writing and Research

- 0701.3.1Identify the purpose for writing (i.e., to inform, to describe, to explain, to persuade, to entertain).

Informational Text:

- 0701.6.1 Formulate clarifying questions before, during, or after reading.
- 0701.6.4 Interpret factual, quantitative, technical, or mathematical information presented in text features (e.g., maps, charts, graphs, time lines, tables, and diagrams).

8th Grade:

Math SPIs:

- 0806.1.1 Solve problems involving rate/time/distance (i.e., d = rt).
- 0806.1.2 Interpret a qualitative graph representing a contextual situation.
- 0806.4.4 Convert between and within the U.S. Customary System and the metric system.

RLA SPIs:

Writing & Research:

- 0801.3.1 Identify the purpose for writing (i.e., to inform, to describe, to explain, to persuade, to entertain).

Informational Text:

- 0801.6.1 Formulate appropriate questions before, during, and after reading.
- 0801.6.4 Interpret factual, quantitative, technical, or mathematical information presented in text features (e.g., maps, charts, graphs, time lines, tables, and diagrams).

MISSION X!

Use the following activities, aka, "missions" to help students train like an astronaut, learn why astronauts need to be physically fit, and gain a better understanding of what astronauts do to keep in shape on Earth and in space!

THINKING IT THROUGH:

Use open-ended questions **before, during, and after** practicing the following physical activities to help students make observations about their own physical fitness level and their progress in each physical activity.

Image Credit: http://porcelanita.deviantart.com/art/astronaut-thinking-114708843.

Sample Questions:

- How do you feel?
- What muscles do you feel you are working?
- Which part of the physical activity seems most difficult? Why?
- Did it get harder or easier as you practiced? Why?
- Did you ever lose your balance? Why?
- What organs do you use to help you gain your balance?
- What might happen if you get really dizzy?
- Do you think astronauts get dizzy in space?
- How come astronauts who stay in space a long time can't "practice"

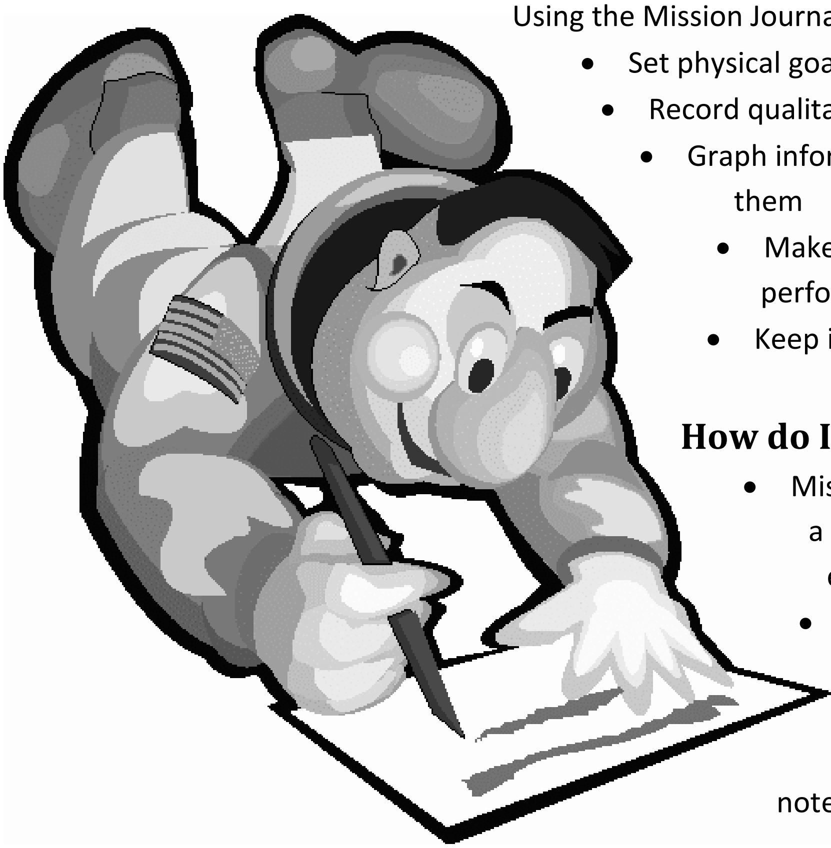
their balance until they return to Earth?

- Which of the following do you think is more difficult? Why?
- Are you getting more tired each time you complete the course?
- Are you getting better each time you practice the course?
- How do you know you are getting better?
- What do you think would be more difficult for an astronaut: completing this course after a 14-day mission or a six-month mission? Why?
- Do you think an astronaut could successfully complete this course the day they landed from a 6-month mission? A week later? A month later?
- Are your trial scores improving as you are practicing?
- Was your first and last trial different?
- If they were, what do you think played a factor in making both trials different?
- If your reaction time did not increase, what can you do to make your reaction time faster?

MISSION JOURNALS:

What is a Mission Journal?

The Mission X Journal is a "mission notebook" for students to organize their physical activity practice time, document research and reflections, and collect data on their progress.



Using the Mission Journal, students will be able to:

- Set physical goals and make predictions
- Record qualitative and quantitative data
- Graph information, make hypotheses, and test them
- Make observations about their physical performance and improvement
- Keep individual team scores

How do I make a mission journal?

- Mission journals could be space set aside in a student's science notebook or other existing class notebook.
- There is a sample cover included if you want to have students make their own, stapling blank paper, decorating the cover, and adding notes for each activity completed.

Collect, Record, and Analyze Data

- Students should record observations about their physical experience in skill with movement, coordination, and speed in their Mission Journal before and after each physical activity. They should also record their physical activity goals and enter qualitative data for drawing conclusions.
- As a group, or have students individually, graph the data collected in the Mission Journal on graph paper, letting students interpret the data individually and as a group. Share graphs with the group.
- Have students find a mean, median, and mode of their reaction times.
- Apply mathematics! Convert the centimeters to millimeters, feet to yards, yards to inches, etc. http://www.onlineconversion.com/length_common.htmStudents

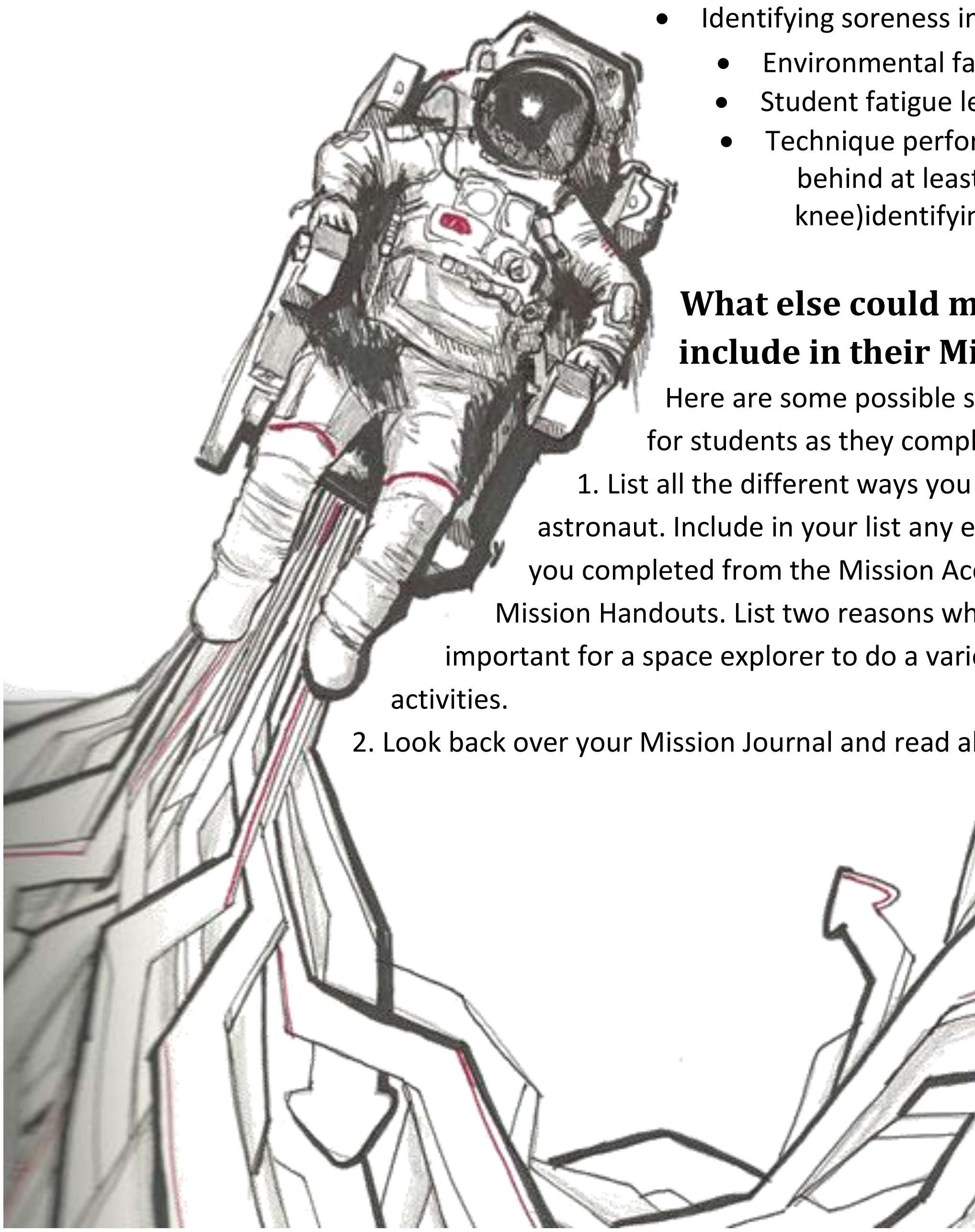
Some quantitative [measured by the quantity of something] data for each physical activity may include things like:

- Length of time to complete the course
- Number of penalties (knocked-over cones)length of rest period
- Number of times the course was completed rate of perceived exertion (on a scale of 1-10)
- Practice how many tries it took to balance 60 seconds the improvement (in seconds) for each try.
- Game: how many times the student was able to pass the ball
- Changes in trial scores
- How many trials were performed over the course of the class
- Rate of perceived exertion (on a scale of 1-10)
- Length of time activity was performed without rest
- Distance traveled
- Length of rest period.

- Respirations (breaths per minute)
- Number of crunches performed
- Amount of time the plank is held

Some qualitative [measured by the quality of something rather than its quantity] data for each physical activity may include things like:

- Identifying environmental impacts
- Identifying physical readiness (stretched out, warmed up, alertness, diet, adequate rest)
- Identifying soreness in specific body parts
- Environmental factors
- Student fatigue level
- Technique performance (foot raised behind at least level with knee)identifying amount of stability



What else could my students include in their Mission Journals?

Here are some possible suggested questions for students as they complete each challenge.

1. List all the different ways you trained like an astronaut. Include in your list any extra physical activities you completed from the Mission Accelerations on the Mission Handouts. List two reasons why it might be important for a space explorer to do a variety of physical activities.
2. Look back over your Mission Journal and read about how you felt as you completed the activities. List one type of physical activity that became easier to do over time. What body parts or systems did it strengthen? List some notes you recorded that helped you realize the physical activity was becoming easier. Why do you think it became

Image Credit: Michael Weinstein Designs from the sketchbook. 8/29/2010 http://www.michael-weinstein.com/tags/astronaut/. Accessed 1/12/12.

easier? What daily tasks might become easier to do if you continue to do this physical activity? How might astronauts benefit from this physical activity?

3. Astronauts learn about their bodies and space exploration before training for a mission. In the research you conducted relating to each physical activity, which two topics did you research the most? List three things you learned while researching these topics. How did this research help you to better understand the importance of physical fitness and good health in space exploration?

4. Sometimes, your environment can affect how well you perform physical activity. List an environmental challenge you faced during a physical activity and how it affected your performance. What are some similar environmental challenges astronauts may face in space?

Just as astronauts must make time in their busy schedule to be physically active, so should you! List three ways you could add more physical activity throughout your day.

6. List some questions about space exploration and fitness that you would like to learn more about. Share your questions with others. Do they have the same questions? If you would like to learn more, use these questions as additional research topics.

7. Now that you have seen how astronauts need to stay healthy and fit on Earth, what ideas do you have for space agencies that might help astronauts and cosmonauts stay healthy and fit on the Moon and Mars?


TOP SECRET
AUTHORIZED

MISSION

X!


CONFIDENTIAL
TOP SECRET
CONFIDENTIAL

Your Mission: Mission Control

Explain to students: On Earth, we use a variety of cues to sense the position of our bodies, while stationary or moving. We use touch and pressure cues (such as weight on our feet) and visual cues (such as location of ceiling and floors) to determine orientation (what direction we are facing). On Earth, our sense of upright is determined by the pull of gravity as sensed by the balance organs of the inner ear. Our brains use all this sensory information to tell us which way is up and which way is down. However, in an environment with less gravity, the brain needs to relearn how to use these sensory signals. In space, astronauts free-float, so there are no pressure cues to the bottom of the feet. Their visual system can be fooled because there may be no distinct floor or ceiling in a spacecraft. As the brain relearns how to interpret sensory information in space, astronauts sometimes experience disorientation (confusion) and nausea (sickness) at least for the first few days in space. Even though crew members eventually adapt to their weightless environment, at some point they must return to Earth. This means they have to readjust to Earth. Until they do, they can't drive a car, or fly a plane until their balance and spatial orientation is restored.

It's a Space Fact!

During the first few days of space flight and after returning to Earth, astronauts experience a change in spatial awareness and may lose some sense of balance when they return to Earth. Research scientists from NASA's Neurosciences Laboratory closely monitor the crew members, who often report difficulty walking around corners and feeling like they are "tumbling" when they move their heads from side-to-side. Their brain has to relearn how to use information from their eyes, tiny balance organs in their inner ear, and their muscles to help control body movement. These problems are usually corrected after several weeks have passed and balance exercises are added to their fitness routine. Until then, they have to be extra careful; which means they may not be able to do some physical activities like fly a plane or drive a car.

- Spatial Awareness: Knowing where you are in your space compared to your surroundings.
- Agile: Being ready and able to move quickly and easily.
- Coordination: Using your muscles together to move your body the way you want it to.

Students will perform throwing and catching techniques on one foot to improve balance and spatial awareness. Students will also record observations about improvements in balance and spatial awareness during this physical experience in their Mission Journal.

Equipment:

- Mission Journal and pencil
- tennis ball (one per student)
- watch or stopwatch
- gym ball or similar sized/weighted ball (at least one per group)

MISSION ASSIGNMENT: Balance Training

Practice:

Choose a smooth-surfaced solid wall and have students bounce a tennis ball off the wall and try to catch it while balancing on one foot. Raise their foot up behind you, level with their knee. Count how many seconds they can stand on one foot while throwing the tennis ball against the wall.

Have them try not to let the ball or their foot touch the floor. Try to balance for at least 30 seconds without falling. Continue to practice this activity over time until they can keep their balance for 60 seconds without having to start over.

Increasing the Challenge:

- Have students bounce a tennis ball off a wall while balancing on one foot. Do this for60 seconds. Without taking a break, have them change legs and balance on the opposite foot for 60 second. Take a 30 second break and repeat this routine five times.
- While standing still, have students stand on a soft surface and balance on one foot. Examples: towel, pillow, or cushion.
- Students should use a balance beam by using a 2x4.
- Students should balance on one foot by taking off their shoes.
- Students should balance on the ball of their foot.
- Time students while they try to balance on two feet with their eyes closed.
- Tell them to open their eyes if they start to lose their balance.
- While practicing simple balance activities, you can also have students lift one foot to increase the difficulty.

Game:

Divide students into groups, each forming a circle. Each circle should contain at least 6 players. In each circle: Students should space a distance more than arms length apart. Try to balance on one foot while gently tossing a gym ball to a player across from you. If a player loses balance and both feet touch the floor, he or she must hop on one foot, around the outside of the circle before rejoining the game.

YOUR MISSION: AGILITY ASTRO-COURSE

Anyone who wants to improve their quickness and speed should try agility training like an astronaut. Agility is the ability to rapidly change directions without the loss of speed, balance, or body control. Agility training is at the core of any astronaut's endurance level. If you want to last longer on the dance floor, field, or the court without getting winded agility is the key. Proper agility training will give you more flexibility and let your body take on the challenges that can come in any physical activity.

Just like an athlete, it is necessary for an astronaut to do strength and agility training. The healthier and stronger the astronaut is, the better they will perform during a space mission and when they return to Earth. Astronauts go through vigorous physical fitness training before each mission to prepare their bodies for space flight. Astronauts lose agility while spending time in space.

Students will complete an agility course as quickly and as accurately as possible to improve agility, coordination and speed. After they have completed the Astro-Course and recorded their times, they will comment on their agility during this physical experience in their Mission Journal.

Agility requires quickness, strength, and good balance and coordination. Walking up and down stairs, hiking outdoors and playing tag are some daily activities that require agility.

- Agility: The ability to quickly and easily move your body.
- Coordination: Using your muscles together to move your body.

It's a Space Fact!

Astronauts practice strength and agility through training exercises designed by NASA Astronaut Strength, Conditioning & Rehabilitation Specialists (ASCR). These fitness specialists conduct an annual fitness test, design individual exercise programs, and provide one-on-one pre-flight and post-flight conditioning activities for the astronauts. The agility we use every day on Earth is different from the agility used in space. Being in space over a period of time can affect astronaut's agility. This is observed once the astronauts return to Earth. Due to the astronauts living in microgravity environment and not using their muscles as they do on Earth, their muscles weaken. After they return from a long duration mission, astronauts work with ASCRs to restore and maintain agility as before their spaceflight mission.

Equipment

Educator:

- Eight marking cones, or other small, steady objects.
- Measuring tape or meter stick
- Paper and pencil
- Watch or stopwatch

Student:

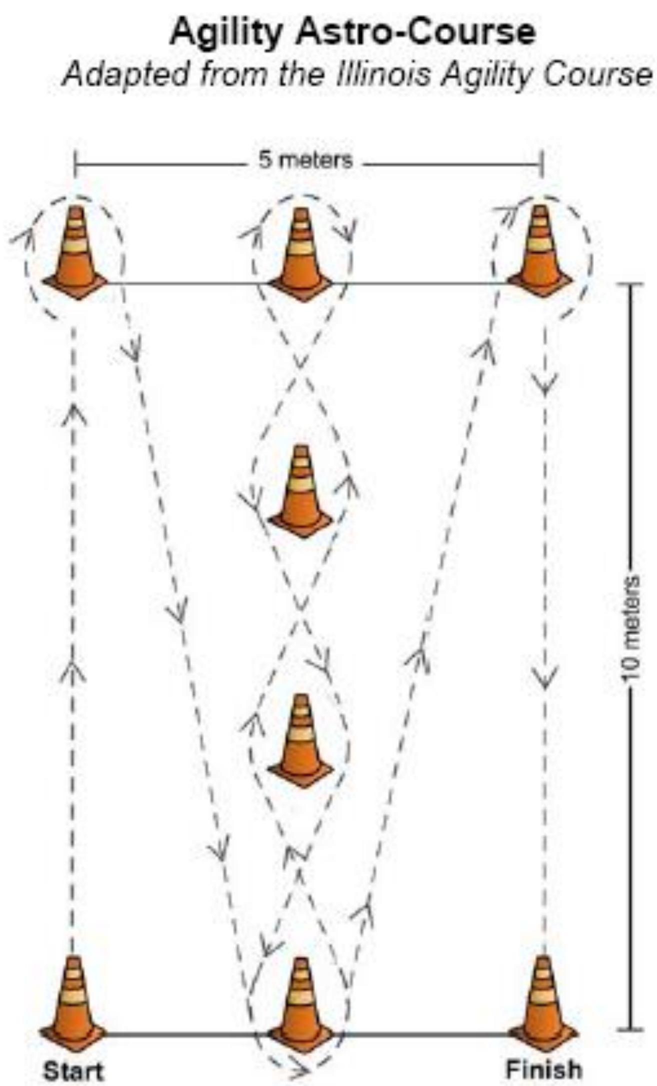
- Mission Journal and pencil

Optional Equipment:

- Swimming noodles placed on the cones to create a more challenging course.

MISSION ASSIGNMENT: Agility Training

Course Description: The length of the course is 10 meters (33 feet) and the width (distance between the start and finish points) is 5 meters (16.5 feet). Four cones are used to mark the start, finish, and the two turning points. Another four cones are placed down the center an equal distance apart 3.3 meters (11 feet) apart between each cone.



Using a stopwatch or clock with a second hand, time the students as they complete one lap through the course. Run the course to demonstrate to the students the proper path to take in the course. Have students form one line and complete the course one at a time. Students should lie on their front (similar to starting a push up) with hands by their shoulders. The stopwatch starts on the 'Go' instruction. The student gets up quickly and runs around the course in the direction indicated without knocking the cones over. Time is stopped when the student crosses the finish line.

Have students follow the directions listed below to complete the Agility Astro-Course. A warm-up/stretching and cool-down period is always recommended.

Have students:

- Lie face-down on the ground at the starting point. When time starts, jump to their feet and run the course to the finish following these criteria.
    - Complete the course as quickly as possible.

    - Do not touch or knock over any cones.
    - Touching or knocking over a cone is a 2 second penalty added to your completed time for each cone infraction.
- Record their final time in their Mission Journal.
- Record any penalties that occurred in their Mission Journal. Return to the end of the line. Rest at least one minute, wait in line, repeat the Astro-Course at least three times, following the same directions as the first time. Continue to practice improving their movements, accuracy and time. Record observations about this activity before and after this physical experience in their Mission Journal.

Increasing the Challenge:

- Using the same set up as the Agility Astro-Course, move the cones to make the agility course larger. You may also add more cones to increase the agility factor or reduce the area of the Agility Astro-Course by using less cones.
- Ask students: Is this course more difficult to complete?
- Have students: Immediately before engaging in the Agility Astro-Course, do jumping jacks for 30 seconds. Then have them compare this time to the times for the first three trials. Did their time increase or decrease? Explain.
- Change the environment in which the Agility Astro-Course is performed (i.e. inside to outside).Decrease the rest time between trials.

YOUR MISSION: THE SPEED OF LIGHT

Have you ever played a quick moving sport such as basketball, tennis, or racquetball? As in most sports, these physical activities require you to be quick on your feet and stay focused. Thinking quickly about your next move takes a lot of practice and dedication to improve your game. Each time you practice a sport or engage in physical activity, you are improving your reaction time. Reaction time is how fast you can respond to a stimulus. A stimulus can be a noise or something you feel or see. Astronauts practice their mission duties on Earth to improve reaction time and concentration and be prepared for their mission. NASA has a variety of environments where astronauts train for their missions. They often simulate unforeseen situations and events to help the astronauts practice reaction time and concentration in space. In space, up and down are not recognized and even a minor tweaks with a thruster can send someone spinning off into space. Practicing their reaction time here on Earth will help the EVA astronauts have successful EVAs in space.

Space shuttle pilots know the importance of reaction time and concentration, because they are required to land the space shuttle safely. Pilots practice on Earth in space shuttle simulators for many hours. They are presented various landing situations and they must practice to be able to land the space shuttle successfully. Therefore, astronauts must depend on their reaction time and concentration in order to have a successful shuttle landing.

Students will perform a time reaction activity using a ruler to practice their hand-eye reaction time and improve their concentration. They will collect, record, and analyze data during the skill-based experience in their Mission Journal.

It's a Space Fact!

In preparation for space travel, astronauts invest many hours with NASA ASCR's and instructors to practice their hand-eye reaction time. Operating the robotic arm on the International Space Station (ISS) or landing the space shuttle requires crew members to have quick reaction times. Crew members must also be prepared for environmental hazards such as lighting and solar winds which could have a negative impact on reaction times. Fatigue, physical stamina and noise levels can also have a detrimental effect on an astronaut's reaction time. One responsibility of space shuttle pilots is to safely land the shuttle at the end of the mission. Pilots must practice landing techniques before they go into space. They use simulators on Earth to improve hand-eye coordination and sharpen concentration skills. Experience has shown that shuttle pilots with better hand-eye coordination and sharper concentration skills have more success landing the shuttle after a 12 to 14 day mission.

- Dominant: A part of the body that instinctively takes the lead over another.
- Robotic arm: A programmable, robot manipulator, that has functions similar to a human arm.
- Fatigue: A lack of energy.

- Trials: The act or process of trying and testing.
- ASCR: Astronaut Strength, Conditioning, and Rehabilitation Specialists; a fitness specialist that provides training pre- and post-flight for NASA astronauts.

Equipment

- Mission Journal and pencil
- Metric rulers – wood, hard plastic, or metal
- Distance/Time Chart Print outs

MISSION ASSIGNMENT: Hand-eye Reaction Training

Students will complete this mission with a partner.

One will be the crew member the other the trainer. You will sit or stand directly across from each other. If sitting, position two chairs directly across from each other. One chair for each student in a team of two.

The crew member will do the following:

- Extend their dominant arm out in front of their body.
- Make a fist with their hand, thumb side up.
- Point their thumb and index finger forward, keeping them about 2 cm apart.
- Use their index finger and thumb to catch the ruler immediately after it has been released by the trainer.

The trainer will do the following:

- Hold the ruler between the outstretched index finger and thumb of the crew member's dominant hand.
- Line the top of the crew member's thumb level with the zero centimeter line on the ruler. Without warning, release the ruler letting it fall between the crew member's thumb and index finger.
- When the crew member catches the ruler, determine the distance between the bottom of the ruler and the top of the crew member's thumb.

Record the measurement in centimeters in the Mission Journal.

Repeat and record for a total of ten times. Switch roles and repeat the procedure above for a total of ten trials.

Measure each time score using the Distance and Time chart.

Note: There are 1,000 milliseconds (ms) in 1 second.

Have students record their best time in the Mission Journal and record observations before and after this skill-based experience in their Mission Journal.

Increasing the Challenge:

Have students:

- Squeeze a stress relief ball 15 times and then try the Speed of Light activity. Did this affect their time? Have them explain.
- Do twenty jumping jacks and then try the Speed of Light activity. Did this affect their reaction time? Have them explain.

Distance	Time
5 cm (2 in)	100 ms (0.10 sec)
7.5 cm (3 in)	120 ms (0.12 sec.)
10 cm(4 in)	140 ms (0.14 sec)
12.5 cm(5 in)	160 ms(0.16 sec)
15 cm(6 in.)	180 ms (0.18 sec)
17.5 cm(7 in)	190ms (0.19sec)
20 cm (8 in)	200 ms (0.20 sec)
22.75 cm (9 in)	220ms(0. 22 sec)
25.5 cm (10 in)	230 ms (0.23 sec)
27.5 cm (11 in)	240 ms (0.24 sec)
30.5 cm. (12 in.)	250 ms. (0.25 sec.)

YOUR MISSION: DO A SPACEWALK!

Ask students: Why might muscular strength and coordination be important for a spacewalk? Have students use descriptors to verbally communicate their answers.

In space, astronauts must be able to perform physical tasks that require muscle strength and coordination. One task that certain astronauts must be able to complete is an Extra Vehicular Activity (EVA), or spacewalk. Spacewalks allow a crew member to examine the outside of space vehicles (like the space shuttle and the International Space Station) and make repairs or changes to the vehicle if necessary. Although safely tethered (attached) to the space vehicle, the conditions under which a spacewalk is completed can be long and strenuous for the crew member. An astronaut must manipulate (move) his or her fingers within large, thick gloves – sometimes for hours at a time. A spacewalk also involves coordinating arm and leg movements to move around. Astronauts prepare for EVAs by practicing these strenuous (really hard) tasks and movements underwater in a huge pool. By training on Earth, crew members learn to rely on their upper body strength and coordination to pull and secure themselves close to the vehicle and to complete their assigned tasks in space.

Students will perform the “bear crawl” and “crab walk” to increase muscular strength and improve upper and lower body *coordination*. They will also record observations about improvements in muscular strength and upper and lower body *coordination* during this physical experience in their Mission Journal.

It’s a Space Fact!

Just like you, astronauts must develop muscular strength and *coordination*. In a reduced-gravity environment, astronauts are unable to walk like they do on Earth. Instead, they *coordinate* their hands, arms, and feet to pull and push themselves from one place to another. Before their mission, they practice these movements underwater with divers and specialists at the Neutral Buoyancy Laboratory (NBL) in Houston, Texas. Whether inside a space vehicle or outside doing *Extra Vehicular Activities (EVA)*,strong muscles and *coordination* help astronauts move in space.

Many activities require strength and *coordination* so you can support your weight and move without falling over. When you ride a skateboard, do push-ups, crawl across the ground, or lift your backpack, you are developing muscular strength and *coordination*.

- Coordination: Using your muscles together to move your body the way you want it to.
- Extra Vehicular Activity (EVA):Any human movement activity that takes place in space, outside the space vehicle, commonly called a spacewalk

Equipment

- Mission Journal and pencil
- tape measure or meter stick

Optional equipment:

- watch or stopwatch

MISSION ASSIGNMENT: Coordinated Strength Training

Have students do the following: *Measure the distance for your student ahead of time or have the students measure out the course themselves*

Distance: about 12 m (40 ft).

Have students:

- Bear Crawl: Get down on their hands and feet (facing the floor) and walk on all fours like a bear. Try to travel the measured distance. Go to the end of the line. Rest for two minutes. Repeat two times.
- Crab Walk: Reverse the “bear crawl”. Sit on the ground and put their arms and hands behind them, knees bent and feet on the floor. Lift themselves off the ground (facing upwards).Try to travel the measured distance. Go to the end of the line. Rest for two minutes. Repeat two times.
- Record observations before and after this physical experience in their Mission Journal.

Increasing the Challenge:

- Have students complete a 6m (20 ft) relay with other classmates. Travel the measured distance doing the crab walk and return to the starting place doing the bear crawl. Repeat three times.
- Increase the above acceleration by completing an 18 m (60 ft) relay. *Stress to your students that once they complete this acceleration they will have traveled 36 m (118 ft).*
- Continue the above acceleration. This time have students wear hand and ankle weights.

Your Mission: Planet You Go, Gravity You Find

Mass is the amount of matter an object is made of. It is always the same, but its weight changes depending where or on which planet it is. Students will perform the same exercise with balls of different weights, as if they were in different gravitational conditions. They will play with medicine balls to strengthen their arm and torso muscles and improve their coordination. As a space explorer of the future, they will be prepared to deal with different gravity environments in our galaxy! They will record observations about improvements in this training in their Mission Journal.

Strong abdominal and back muscles, or core muscles, protect your spine, maintain proper posture, and transfer energy through your body for powerful movements such as swinging and throwing. These muscles are engaged as you sit, turn your body, or even just stand still. Strong arm muscles allow you to lift weights easily, without feeling pain and are useful in most sports.

- Core muscles: The muscles that stabilize, align, and move the trunk of the body; the abdominal and back muscles.
- Coordination: Using your muscles together to move your body.
- Muscular strength: The ability to use your muscles to move or lift things, and yourself.
- Medicine ball: A medicine ball (also known as an exercise ball, a med ball, or a fitness ball) is a weighted ball. Often used for rehabilitation and strength training, it serves an important role in the field of sports medicine.

It's a Space Fact!

When you jump into the air, you automatically land back on the ground. Apples and leaves fall from trees, and when you drop glass it breaks on the floor. Everything is pulled to the Earth due to the force of gravity. The force of gravity is also present on the Moon. Because the Moons gravity is 1/6 of the Earth's gravity, the Moon's gravitational pull is not as great as that of the Earth. This is the reason why an astronaut jumping on the surface of the Moon is automatically a long-jump champion. Astronauts can jump further than 10 meters! On Mars, gravity is less than half the gravity here on Earth but on Jupiter it is more than double. This means that on Jupiter's surface you would have a hard time to climb the stairs because the gravity on Jupiter would pull you to the ground much more than the Earth does. Astronauts will not walk on other planets in the near future but still their training takes into account the influence of gravity because during their mission they will be in a free-fall microgravity environment. When astronauts are back on Earth after a six-month stay on the International Space Station, they feel tired, as if everything is extremely heavy. Astronauts need to train to get acquainted again with Earths' gravity and do that using medicine balls to strengthen their muscles.

MISSION ASSIGNMENT: Medicine Ball Training

To have students perform the following exercises, you will need to be in a gym equipped with:
3 balls (medicine, etc.) with different weights:
e.g. 1 kg – 1.5 kg– 2.5 kg (2 lbs – 3lbs- 6lbs)
Divide students into teams and instruct students to do the following:
Jumping:

- Squat with the ball in their hands.
- Jump extending their body and lifting the ball above their head.
- Squat again.
- Cover a length of 3 meters while jumping with the ball in their hands.
- Run back.
- Pass the ball to their teammate.
- Team that finishes first wins.

Balls in a circle:

- Form a circle with about 5-10 children total.
- Stand with their legs shoulder width apart.
- Make the ball roll on the ground towards their classmate. The ball must stay on the floor and not be thrown!
- If the ball passes through their legs, they are out of the circle. If not, they throw it again.
- Redo the two exercises with the heavier balls.

Have students record observations before and after this physical experience in their Mission Journal.

Increasing the Challenge:

Have students:

- Jump a 4 meters distance.
- Do a circle with the entire class, instead of just 9 classmates.
- Do the circle facing each other's back.

Extensions:

- Find different types of balls: e.g. basketball, volleyball, football, tennis ball, etc. Why are they different? Do they weigh differently and why?
- Determine the gravitational pull of each planet in our solar system relative to Earth's gravitational pull. How many Earth years does it take for each planet to make a complete revolution around the Sun. Calculate your weight and age on each planet in our solar system as you jump from one planet to the next.

YOUR MISSION: SPACE ROLL-N-ROLL

In the microgravity environment of the International Space Station astronauts can perform spectacular rolls. Here on Earth, because of gravity these rolls are not as easy. Students will imitate astronauts being upside down and making their own body roll. They will perform a series of somersaults on the ground to improve their body coordination, flexibility, balance and strengthen their back, abdominal and leg muscles. They will record observations about improvements in this somersaults training in their Mission Journal.

Performing a somersault requires the ability to coordinate your body movements, good balance and muscle power. Some daily activities that require flexibility and body coordination include dancing, walking, picking up an object from the ground or simply grasping something. To become more flexible, you need to stretch regularly and use the full body range of motion. To enhance your body coordination, you need to practice and stay focused.

- Coordination: Using your muscles together to move your body the way you want it to.
- Stretching: Elongating one or more muscles as much as possible.

It's a Space Fact!

In space, astronauts can perform spectacular rolls. You can watch some amazing somersaults on the Mission X- Train like an Astronaut website. On the International Space Station (ISS) astronauts seem to be floating. The astronauts inside the ISS experience microgravity or weightlessness, floating around in no particular direction. There's no up or down for them! Therefore astronauts can easily do acrobatics and they can do a series of somersaults without any particular effort. In order to stop rolling, they must stop themselves by reaching out to hold on to an object or person. This happens because there are no forces which oppose their movements. Here on Earth, things behave differently. When an acrobat makes a flip, he needs to jump high and be quick enough to rotate completely before gravity pulls him back to the ground. Similarly, when you roll, you let your body fall to the ground but then you need to fight gravity with your muscles to complete the exercise sitting or in a vertical position. If you are well trained with somersaults on Earth, you will enjoy performing amazing flips once you will become an astronaut!

MISSION ASSIGNMENT:
Somersaults Training

Have students follow the following instructions to train like an astronaut: In order for students to perform the exercise, you will need to be in a gym equipped with: A thick and long mat or a carpeted room.

Beginner somersault:

- Bend their knees, bringing their chin into their chest.
- Put their hands close to their feet.
- Put their head down carefully Roll in a straight direction.
- Complete the somersault sitting on the mat.

- Each child does this exercise 3 times. It is important to do the exercise well, and not too fast.

Intermediate somersault:

- Start in the same position as the beginner somersault.
- Complete the somersault standing.
- Each child does this exercise 3 times.
- It is important to do the exercise well, and not too fast.

Advanced somersault

- Stand.
- Get into a squat and do the somersault.
- Complete the somersault standing.
- Each child does this exercise 3 times.
- It is important to do the exercise well, and not too fast.

Have students record observations before and after this physical experience in their Mission Journal.

Increasing the Challenge:

- Put a hula-hoop on the mat. Have students do a somersault through it without touching the hula-hoop.
- Put a hula-hoop at a certain height above the mat and do a somersault through it.
- Somersault from a vertical head down position.
- Stand upside down with your feet on the wall. Hands very close to the wall and stand in a vertical position facing the wall. Let your shoulder touch the floor and do the somersault.

YOUR MISSION: CREW STRENGTH TRAINING

NASA researchers are working to lessen muscle atrophy and loss of bone density in astronauts involved in prolonged space flights. Both of these physical changes can be hazardous to astronauts on an extended exploration mission. Injured or weak crew members may not be able to perform their assigned tasks, causing safety concerns for themselves, as well as fellow astronauts. All crew members need to be in top physical condition to ensure the completion of the mission. Astronauts also need strong muscles and bones to perform tasks while exploring a lunar or Martian surface. They must be able to lift, bend, build, maneuver and even exercise during a mission. Both the moon and Mars have enough gravitational force to require strong muscles and bones to do these tasks. If a crew member happens to trip and fall, the strength of their muscles and bones can mean the difference between getting up and returning to work, or having to end the mission and return back to Earth. On Earth, the strength of muscles and bones is important to being physically fit and healthy. Severe muscle atrophy or bone loss in space could mean a crew member might fail to recover his or her pre-flight physical condition back on Earth. Therefore, astronauts do regular exercise and strength training before, during, and after a mission to keep their muscles and bones strong.
Strong muscles and bones are important to your overall health. They are necessary so you can perform chores and tasks at home, at school, or while playing. When you lift an object off the floor, push yourself up out of bed, or bend to see under an object, you are using upper and lower body strength. Physical activities such as these will help keep your muscles and bones strong!

It's a Space Fact!

Astronauts must perform physical tasks in space that require strong muscles and bones. In a reduced gravity environment muscles and bones can become weak, so astronauts must prepare by *strength training*. They work with NASA strength and conditioning specialists on Earth and continue to work in space to keep their muscles and bones strong for exploration missions and discovery activities.

Students will perform body-weight squats and push-ups to develop upper and lower body strength in muscles and bones. They will also record observations about improvements in *strength training* during this physical experience in the Mission Journal.

- Strength Training: Physical activities which use resistance to increase muscle and bone strength, and help improve overall health and fitness.
- Crew(crew members):People working together on a common activity or for a common purpose; a term for NASA astronauts who share their mission with each other.
- Repetition: A motion (such as a body-weight squat or a push-up) that is repeated and usually counted.
- Resistance: An opposing force (through gravity, weight, or equipment).

MISSION ASSIGNMENT: Strength Training

Have students follow the following instructions to train like an astronaut.
Body weight squats:

- Using only their body weight, perform a squat (each squat is a *repetition*).
- Stand with their feet shoulder width apart, back straight, looking forward, arms at their side.
- Lower their body, bending their knees while keeping their back straight (as if sitting).
- Raise their arms forward for balance as they squat.
- At the bottom of the motion, their upper legs should be close to parallel with the floor and their knees should not extend past their toes.
- Raise their body back to a standing position.
- Try to perform 10 to 25 squat *repetitions*, increasing over time as possible. Rest for 60 seconds.

Push-ups:

- Using their arms to lift their body, perform a push-up (each push-up movement is a *repetition*).
- Lie down on the floor on their stomach.
- Place their hands on the floor, under their shoulders, shoulder width apart.
- Using only their arms to lift their body, lift up slightly until their lower body is off the floor and only their toes and hands are touching the floor. (If this is difficult, they may keep their knees on the floor.)
- This will be their starting position.
- Straighten their arms to raise their body. Do not lock their elbows.
- Lower their body back to the starting position.
- Try to perform 10 to 25 push-up *repetitions*, increasing over time as possible.
- Rest 60 more seconds.

This entire routine of *strength training* should be repeated two more times.
Have students record observations before and after this physical experience in their Mission Journal.

Increasing the Challenge:

Have students:

- Complete five squats, holding the last squat for 30 seconds.
- Complete five more squats, holding the last squat for 60 seconds. Rest for 60 seconds. Do this three times for a total of 30 squats.
- Complete 10-25 pushups on a balance ball. They will balance their body on the exercise ball and push off with their hands to complete one push-up.
- *Have the students do this exercise on a padded mat:* Grab two 1-3 lb dumbbells. Get into the push-up position and do five push-ups as their hands balance on the dumbbells.

Now, lift the dumb bell with their right arm off the floor and bring it to their underarm. They will be balancing their body in the push-up position using one arm as you lift their right hand with the dumbbell to their underarm. Do these ten times and repeat with the opposite arm.

YOUR MISSION: BUILDING AN ASTRONAUT "CORE"

MISSION QUESTIONS: Ask students why might astronauts need strong core muscles in space? Have students use descriptors to verbally communicate their answers.

- The most appropriate answers would include:
- To perform spacewalks, or EVAs.
- Movement or maneuvering through hatches or modules.
- Lifting, bending, twisting, turning, and carrying during EVAs or daily tasks in spaceflight.

What are your abdominal and back muscles together commonly called?

- core muscles

What happens to muscles in space?

- muscles weaken

Explain to your students:
Did you know astronauts began training for missions as infants? As an infant, your first job in motor control was to stabilize your core (your stomach and back muscles). You needed a strong upper body to keep yourself sitting up. As an infant, even rolling from your back onto your belly required strength. Astronauts, just like dancers and athletes, rely on their core strength every day. Core strength is important because it powers all of your movements. For example, the abdomen and back muscles work together to support the spine when you sit, stand, bend over, pick things up, and exercise. It's important to your physical well-being as a child and as an adult to have strong core muscles.

It's a Space Fact!

Just like on Earth, astronauts in space must be able to twist, bend, lift, and carry things. They must have strong core muscles so they can perform their tasks efficiently and avoid injury. During missions in space they need to bend their body and hold it straight for extended periods of time. Astronaut's muscles get smaller and weaker over time in a microgravity environment. In order to maintain muscle strength they practice core-building activities before, during, and after their missions. Here on Earth, these activities may include swimming, running, weight training, or floor exercises. In space, they use specialized equipment similar to what you would find here on Earth to keep an exercise routine that will keep their core muscles fit for the job.

Astronauts must have strong core muscles in order to move in the microgravity environment of space. During an EVA, astronauts are working in their spacesuits for 6 or more hours. Having a strong core will aid the astronaut in completing the EVAs successfully.
In the microgravity environment of space, the body does not need the support of the muscles and bones since there is no force of gravity. Due to lack of use the bones and muscles become weaker. To keep their muscles and bones physically fit during their stay in space, astronauts

must follow an exercise program, many work out a minimum of six days a week for at least two hours a day. Exercise in space is essential to an astronaut's health whether in space for a six days or six months.

Students will perform the Commander Crunch and Pilot Plank to improve the strength in abdominal and back muscles. As they train like an astronaut, they will record your observations about improvements in core muscle strength during this physical experience in their Mission Journal.

- Core: The muscles that stabilize, align, and move the trunk of the body; the abdominal and back muscles.
- Stabilize: To keep something at the same level; to maintain that level.
- Posture: A position the body can assume; standing, sitting, kneeling, or lying down.
- Repetition: A motion that is repeated and usually counted.
- Forearm: The part of the human arm extends from the elbow down to the wrist; lower arm.
- Spine: Consists of the spinal cord, vertebrae and discs; supports an animal's body.

Equipment

- Mission Journal and pencil Watch or stopwatch

MISSION ASSIGNMENT: Core Strength Training

Students will do the following activities with a partner.
A warm-up/stretching and cool-down period is always recommended.

Commander Crunches:

- Starting position: Students lie on their back, knees bent, feet flat on the floor. Chin should be pointed to the sky, arms crossed over their chest.

Procedure:

- Using only their abdominal muscles, lift their upper body until their shoulder blades leave the ground.
- Put one hand on their abdomen to feel their muscles working as you raise their shoulders off the floor.
- Lower their shoulders down using only their abdominal muscles to complete one crunch.
- At their partners command, begin to complete as many crunches as possible in one minute, timed or counted by their partner.

Pilot Plank:

- Starting position: Lie down on their stomach.
- Resting on their forearms, make a fist with each hand, place their knuckles on the floor shoulder width apart.

- Using only their arm muscles, push their body off the floor supporting their weight on their forearms and toes.
- Your body should be straight as a board from their head to their feet.

Procedure:

- Using the muscles in their abdomen and back, stabilize their body by tightening these muscles.
- Try to keep this position for at least 30 seconds.
- Switch places with their partner and follow the same procedure.

Have students record observations before and after this physical experience in their Mission Journal.

Increasing the Challenge:

Have students:

- Increase the number of Commander Crunches in one minute.
- Increase the time in which the Commander Crunches and Pilot Plank are performed.
- Repeat the Commander Crunch activity only this time do not cross their arms.
- While holding the medicine ball over their abdomen, do as many crunches as possible in one minute. *Safety: Do not allow students to rest the medicine ball on theirr abdomen. Also, be sure their partner is close by in case they need assistance.*
- Repeat the Pilot Plank activity only this time, extend one leg to the side. Hold their leg out for 30 seconds. Repeat this activity with the opposite leg. Alternate extending each leg to the side.
- Try the Mission Specialist Side Heel-Touches. Mission Specialist Side Heel-Touches Starting position
    - Get in the same starting position as the Commander Crunch.
    - This time have their arms out by their side and their knees bent no less than 45º and no greater than 90º.

  Prep position:
    - Tighten their abdominals and raise their shoulder up slightly. Use the same technique as in doing a Commander Crunch.

  Procedure:
    - Hold this height and bend sideways slightly to the left.
    - Bring their left hand off the floor and touch their left heel.
    - Come back to center.
    - Replace their left hand on the floor.
    - Hold this height and bend sideways slightly to the right.
    - Raise their right hand off the floor.
    - Touch their right hand to their right heel. This is one completed repetition.
    - Do as many repetitions as possible for one minute, timed or counted by their partner. Switch places with their partner and follow the correct procedure to complete Mission Specialist Side Heel-Touches.

YOUR MISSION: JUMP FOR THE MOON

MISSION QUESTION: Ask students what they think jumping is good for in an astronaut's life and why an astronaut might need strong bones. Have students use descriptors to verbally communicate their answers.

Explain to your students:

Stronger bones will allow you to run, jump, work and play with less chance of injury. A stronger heart and more muscular endurance will allow you to be physically active for a much longer time! You are already improving bone strength and heart and muscle endurance when you repeatedly hop on one leg, jump rope or jump to rebound a basketball.

Students will perform jump training with a rope, both while stationary and moving. They will also record observations about improvements in stationary and moving jump training during this physical experience in their Mission Journal.

- Endurance: The ability to perform an exercise or a physical task over a long period of time.

> **It's a Space Fact!**
>
> On Earth, your weight on your bones provides a constant stress. You maintain your bone strength just by doing regular daily activities like standing, walking, and running! In space, astronauts float – unloading that important stress and weakening their bones. Therefore they depend on nutritionists and strength and conditioning specialists at NASA to plan food menus and physical activities that will help them keep their bones as strong as possible while in space. Stronger bones will help astronauts stay safer while performing all of their assigned tasks – whether in a space vehicle, on the moon, Mars, or once back on Earth. Since some tasks may involve regular lifting and moving of objects, astronauts often rely on the strength of their bones and the *endurance* of their hearts and other muscles for successful completion of these tasks.

MISSION ASSIGNMENT: Jump Training

Stationary:

- With a jump rope, try to jump in place for 30 seconds.
- Rest for 60 seconds.
- Repeat three times.

When mastered, proceed to moving.

Moving:

- Try to jump rope while moving across a smooth surface for 30 seconds.
- Rest for 60 seconds.
- Repeat three times.
- Repeat jump training two more times.

Have students record observations before and after this physical experience in their Mission Journal.

Fitness Accelerations

Have students:

What is the purpose of your myth?

- Jump rope in place for 60 seconds without stopping. Rest for 30 seconds.
- Jump rope side to side for 60 seconds. Repeat this activity three times.
- Jump rope for 30 seconds doing a straddle jump. Rest for 30 seconds then do a straddle jump for 60 seconds. Repeat this activity three times.
- Jump rope in place for 30 seconds. Jump rope side to side for 30 seconds.
- Straddle jump for 30 seconds. Rest for 30 seconds. Do this three times.

Mission Journal: Have students write their hypothesis of what jumping is good for. Were they correct? How do they feel about jumping after?