

YOUTH GUIDE





KIT MATERIALS

These materials are included in this kit. If you want to create more, printable materials are also available online at 4-H.org/STEMChallenge.

Educator Kit Includes:

- Facilitator Guide (1)
- Youth Guides (12)
- Telescope kits (2)
- Set of 12 constellation cards (1)
- Cipher wheels (4)
- Cipher answer sheets (2)
- Astro Adventure boxed game (1)
- Hydraulic claw kits (2)

Family Kit Includes:

- Facilitator Guide (1)
- Youth Guides (2)
- Telescope kit (1)
- Set of 12 constellation cards (1)
- Cipher wheels (2)
- Cipher answer sheets (2)
- Astro Adventure boxed game (1)
- Hydraulic claw kit (1)

WELCOME TO GALACTIC QUEST, THE 2021 4-H STEM CHALLENGE!

This will be a thrilling opportunity for you to explore STEM through an out-of-this-world adventure.

The activities in this kit will take you on a journey from a first look at the stars to cultivating crops on a distant world. You will also gain insight into gathering and protecting resources in space! There are four activities in Galactic Quest:

- **Stellar Optics**
- **Cipher Space**
- **Astro Adventure**
- **Cosmic Claw**



Navigating Your Guide

If you are doing Galactic Quest at home, this guide can be used to quickly delve into each activity. If you are doing Galactic Quest with your 4-H club or in a classroom, use this guide to follow along with your teacher, take notes, and have quick access to activity instructions.

In this guide, you will find a section for each activity that contains:

- an overview of the activity;
- space to record your experience;
- extra facts and information; and
- career connections.

At the end you will also see a page to take additional notes and a certificate of completion!

ACTIVITY OVERVIEWS



STELLAR OPTICS

In this activity, you will begin your space adventure by looking at the stars. You will explore principles of light and construct a simple refracting telescope. Using this telescope, you will learn about common constellations that have influenced human cultures for millennia. Since the distortion of light by moisture and other atmospheric particles hinders our view of celestial bodies here on Earth, you will be introduced to the concept of moving outside of Earth and its atmosphere for further exploration.

STEM Skills:

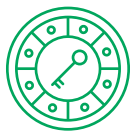
Inquiry skills, collaboration, real-world application, creativity

4-H Pillar Alignment:
STEM

Full-Challenge Time:
60 minutes

Additional Materials:

- Pencils
- Clear cup with water



CIPHER SPACE

This activity introduces concepts of cybersecurity and protecting our assets in space. You will use a Caesar cipher wheel to decode a secret message, encrypt and decipher words with your peers (if doing the activity in a group), and participate in a timed or group relay race. You will learn about careers in cybersecurity, technology, and space. This activity builds the computational thinking skill of pattern recognition as you search for patterns to find a solution to the encryption challenges.

STEM Skills:

Computer science, collaboration, real-world application

4-H Pillar Alignment:
STEM/Civic Engagement/
Healthy Living

Full-Challenge Time:
40 minutes

Additional Materials:

- Pencils
- Paper



ASTRO ADVENTURE

In this board game, you will attempt to expand your influence on our solar system by collecting resources and adding spacecraft to your fleet. You will learn about the resources needed for space exploration and where they could be found. In addition, you will explore the implications of space travel on human health in this interplanetary adventure.

STEM Skills:

Inquiry skills, collaboration, real-world application

4-H Pillar Alignment:
STEM/Healthy Living/Civic Engagement

Full-Challenge Time:
50 minutes

Additional Materials:

- Shallow container to store resource tokens (optional)



COSMIC CLAW

In this activity, you will use the Engineering Design Process to design, build, and operate a robotic claw. Working together or on your own, you will create a model of a hydraulic-powered robotic arm and claw and test it by completing an agricultural task. Ultimately, the mechanical claw should be able to perform a simple grasping, scooping, or raking action to cultivate crops on another world.

STEM Skills:

Inquiry skills, collaboration, real-world application

4-H Pillar Alignment:
STEM/Agriculture/
Healthy Living

Full-Challenge Time:
60 minutes

Additional Materials:

- Phillips-head screwdriver
- Tape (masking/duct)
- String
- Small container of water
- Wire cutters (optional)
- Items for the end of claw (small cups, plastic utensils, bottle caps, suction cups, etc.)
- Items to pick up (small candy, small balls, rice, sand, etc.)
- Starting location (bin or designated area)
- Ending location (bin or designated area)

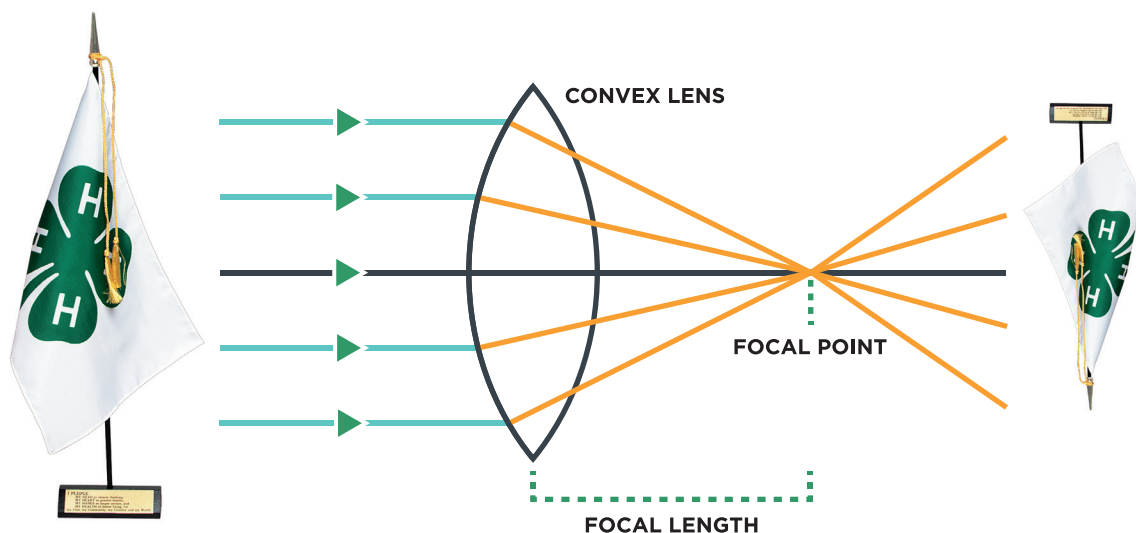
STELLAR OPTICS



Studying the stars is beginning of space exploration! You will expand your universe by creating a telescope to magnify your surroundings, investigate the refraction of light, and discover the fascinating world of constellations. You'll see how scientists are attempting to see more than ever before through Stellar Optics.

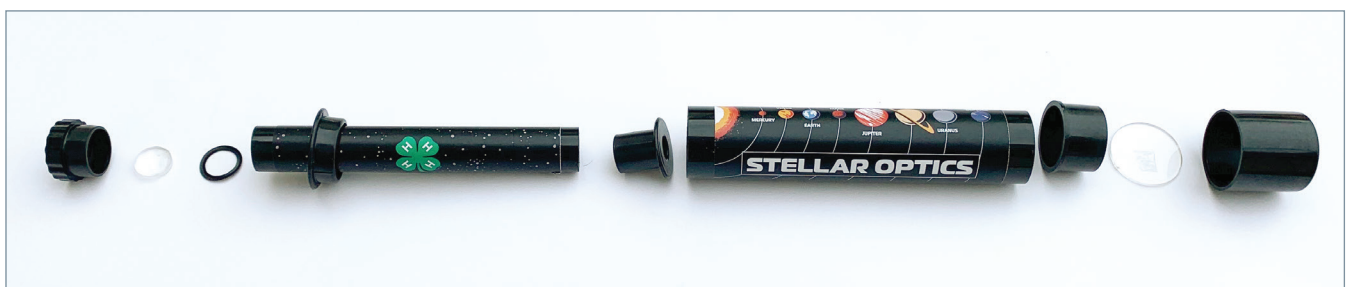
Light Refraction

Lenses are specially shaped pieces of glass or transparent plastic that bend the light travelling through them. Lenses which are thicker in the middle than at the edges are called convex lenses. The figure below shows how a convex lens refracts light to bend the light inward, converging to a single focal point and then back out again. An image seen through a convex lens beyond the focal point will be upside down.



Telescope (Kit)

Order of the pieces left to right are; eyepiece, eyepiece lens, eyepiece washer, inner telescope tube, connection ring (on the inner tube), focusing ring, outer telescope tube, aperture ring, convex objective lens, and objective lens cap.



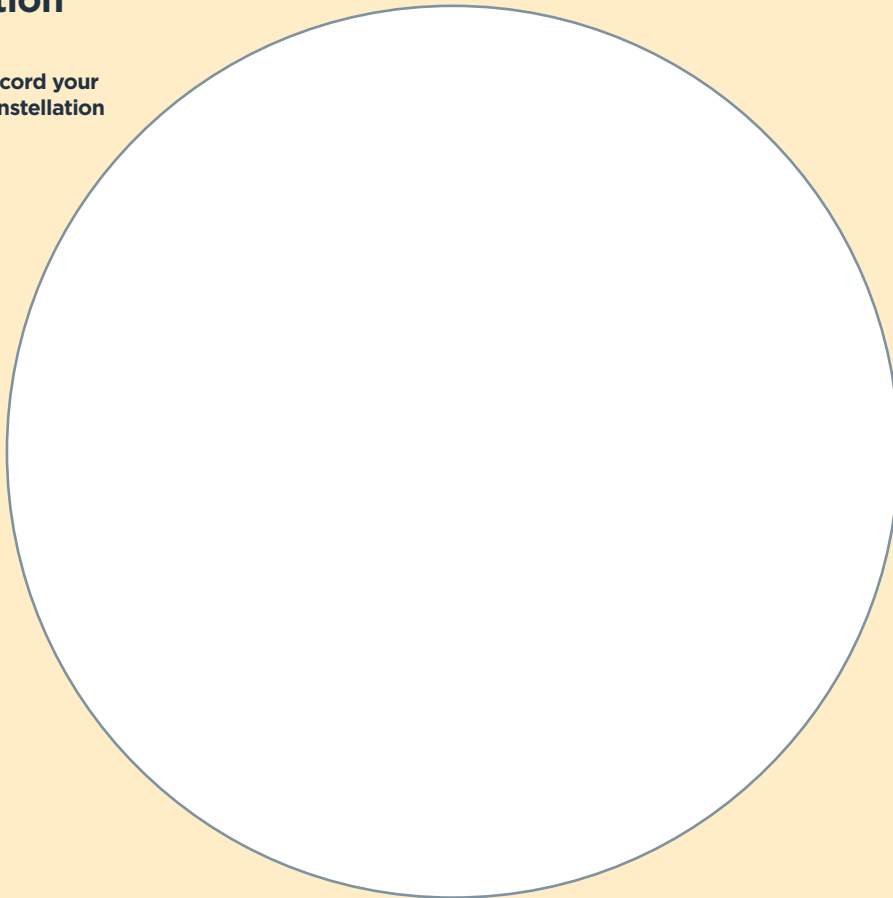


Steps to Stellar Optics

1. Make observations about the lenses. (What do you notice about their shape? How do the sizes and shapes of the lenses compare and contrast? When you hold them up to your eye, how would you describe the appearance of the images—blurry, upside-down, etc.? When you hold them up together, what do you see? How far apart do you have to hold them in order to see a clear image?) You can use the “Notes” section in the back of your guide to record these observations.
2. Assemble your telescope and look through it. Make observations about what you see (**WARNING: Never look at the sun with a telescope, binoculars, or your naked eye. It can lead to serious injury and permanently damage vision.**)
3. Use the telescope to view constellation cards from a distance.
4. In your guide, record the pattern of key stars in the constellations that you can see through the telescope.
5. Connect the stars you record to create your own version of the constellation.
6. Review the reverse side of the constellation card and learn more about your constellation.

Your Constellation

Record your constellation



Name your constellation:	Actual constellation name:
What story goes with your constellation? _____ _____ _____ _____	



Career Connections (STEM)

Physics is a branch of science that studies matter and motion from the tiniest part of an atom to the huge expanse of the universe. It examines many things that affect your daily life such as mechanics, heat and thermodynamics, electricity and magnetism, as well as light and sound. Physics forms the foundation for other branches of STEM including several related to space exploration. Astronomy is a branch of science that uses telescopes, satellites, and models to study celestial bodies and phenomena in our universe. Cosmology is a branch of astronomy that studies the origin and structure of the universe.

Physicists study the natural laws that govern our world and universe to make predictions and solve problems. Physicists work with colleges and universities, national laboratories and governmental agencies, or private companies to apply their knowledge.

Consider these careers related to physics:

- Astronomer
- Astrophysicist
- Atmospheric scientist
- Biophysicist
- Chemical physicist
- Cosmologist
- Data analyst
- Geophysicist
- Laser technician
- Particle physicist
- Physics researcher
- Physics teacher or professor
- Quantum computing scientist



CIPHER SPACE

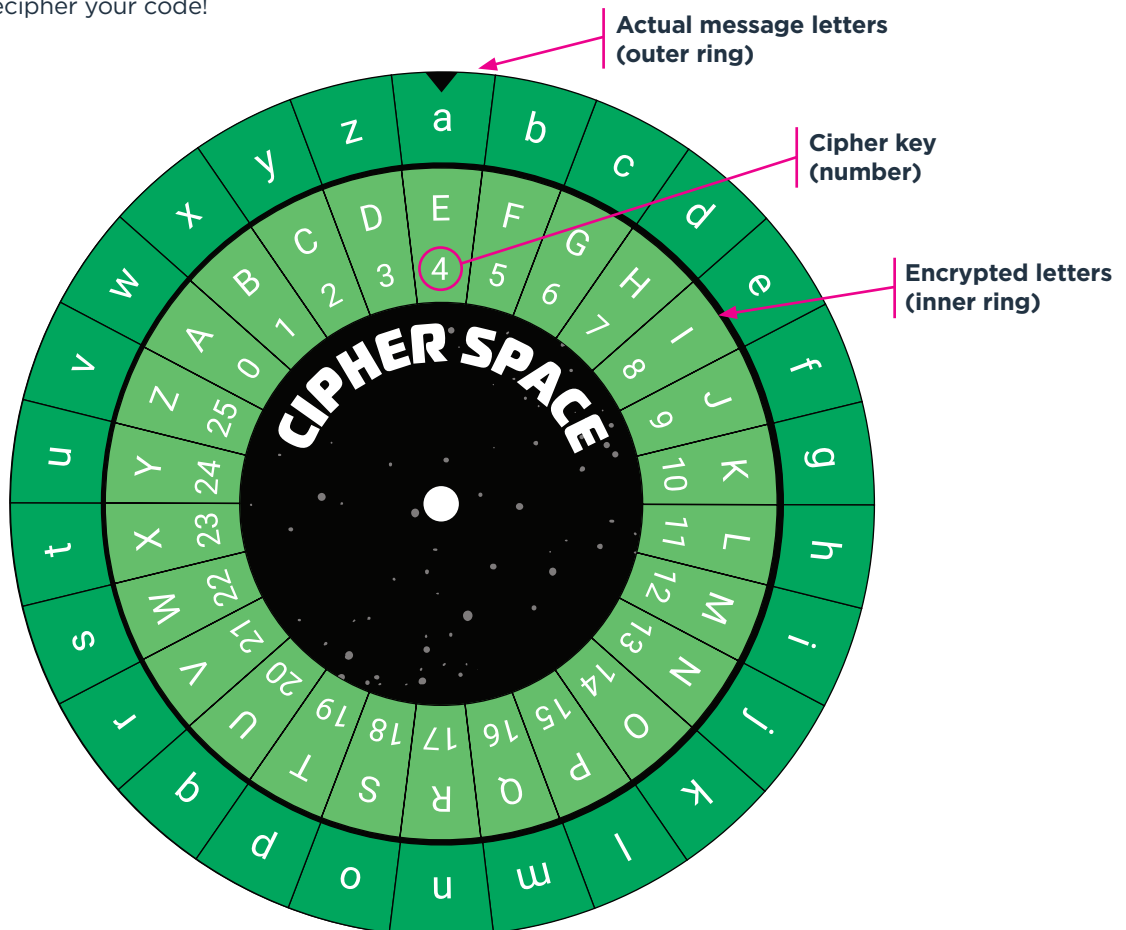


Even though you may not know it, your daily life is connected to space. Hospitals, banks, streetlights, gas pumps, phones, televisions and, and more use a vast network of satellites orbiting our planet. In this activity, you will be introduced to concepts of cybersecurity and protecting our assets in space! You will create a cipher to decode a secret message and encrypt and decrypt words. The race is on to protect our Cipher Space!



Steps in Cipher Space

1. Deciphering a message - use the Caesar cipher wheel to decipher and encrypt the samples in your guide, as well as find the cipher key.
 - The outer base serves as the letters of the actual message (lower-case letters). The inner wheel letters correspond with an encrypted code (upper-case letters).
 - Shift the inner wheel the indicated number of spaces as determined by the cipher key. For example, with a cipher key of “4,” shift the inner circle so that “4” and “E” line up with “a.” “E” is the encrypted letter and “a” the deciphered letter. At this setting, an encrypted “L” would be deciphered to the letter of “h.”
2. Encrypting your message - practice your cybersecurity skills by using your cipher wheel to encode three words or a phrase about something you have learned in this activity.
3. See if others can decipher your code!



Practice your Cybersecurity Skills

Answers are in the Facilitator's Guide, page 20.

Decipher the Code

Cipher Key = **17**

Encrypted Code: **T P S V I J V T L I Z K P**

Deciphered Code: _____

Encrypt the Code

Cipher Key = **21**

Encrypted Code: _____

Deciphered Code: **t r e a t y**

Find the Cipher Key

Cipher Key = _____

Encrypted Code: **Y V G I K**

Deciphered Code: **s p a c e**

Example - Create your own Code

(Encode three words about what you have learned)

Cipher Key = _____

Encrypted Code: _____

Deciphered Code: _____

Cipher Key = _____

Encrypted Code: _____

Deciphered Code: _____

Cipher Key = _____

Encrypted Code: _____

Deciphered Code: _____

Save the Satellite

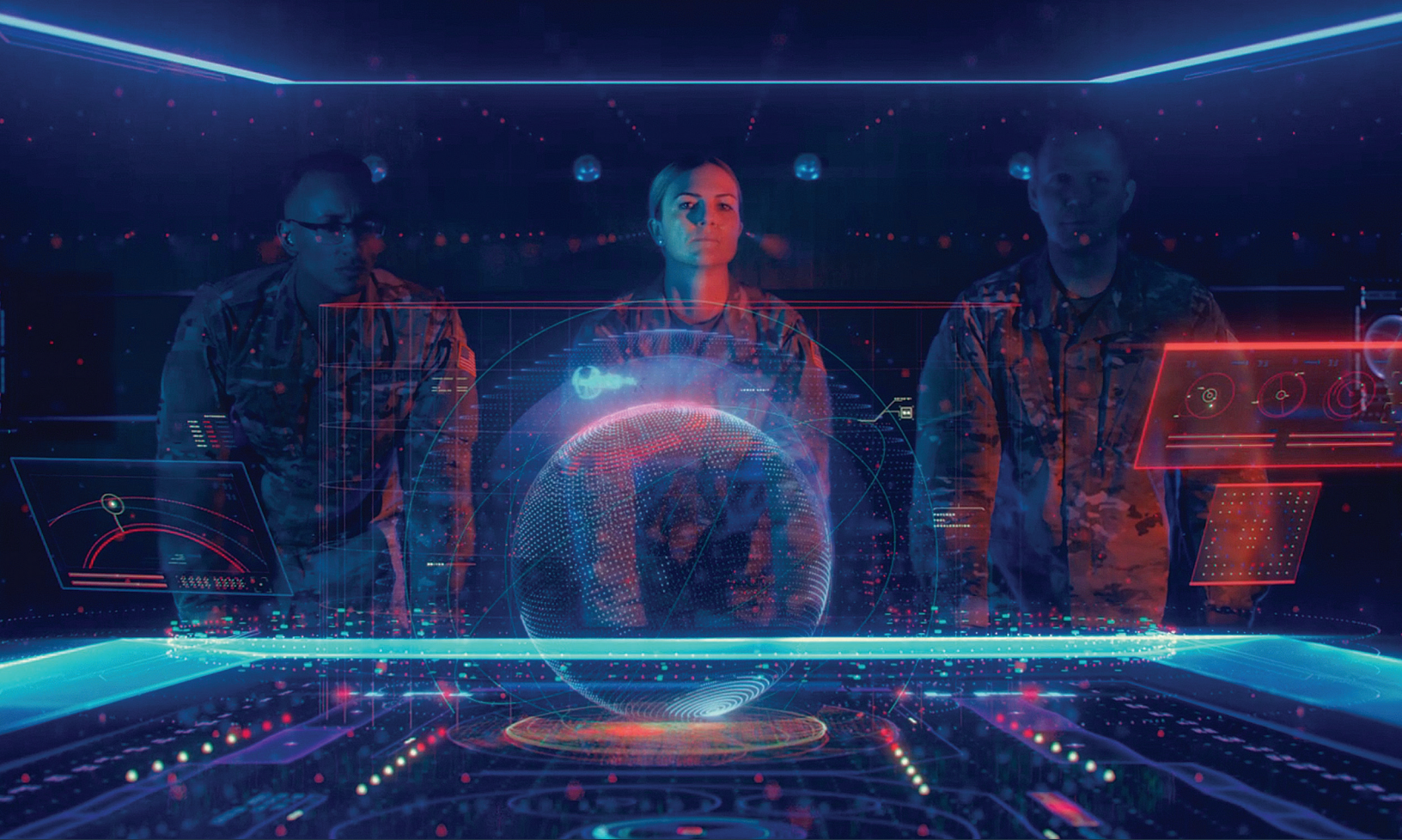
Imagine a satellite is about to collide with an object in space and hackers have disabled the primary communication channel you have with the satellite - now you can't send a message with instructions for the satellite to change its position to a safer location! Use the Cipher Answer Sheets to race and gather the proper information to send a new encrypted message to your satellite and override the hacker's instructions in order to save the satellite! If you are in a group, you can do this as a relay race. If you are playing solo or one-on-one you can time yourself and use the chart below to calculate your protector status.

Answers are in the Facilitator's Guide, page 22.

Example - Protector Status

What's your protector status? Solve the phrase to find out!

TIME TO SOLVE	PROTECTOR STATUS
>15 minutes	Guiding Star
11-15 minutes	Planetary Protector
6-10 minutes	Cosmic Codebreaker
1-5 minutes	Intergalactic Guardian



Career Connections (STEM/Civic Engagement)

Space Operations in the United States Space Force

The United States Space Force is a new branch of the Armed Forces. You might be surprised to learn that most of what Space Force does affects us on the ground. That's because the satellites in orbit around Earth affect almost everything people do every day. As we like to say, there's no such thing as a day without space.

Satellites don't just control the GPS app on your phone. ATMs, the stock exchange, gas pumps, traffic lights and power grids are just the beginning. In purely military applications, satellites help us with ground combat control, guided missiles, surveillance and every piece of global communication.

In Space Force, we launch rockets and manage space debris orbiting around Earth. The debris field requires constant tracking because at 17,000 mph, a piece of metal the size of a coin in orbit isn't junk. It's a missile.

As you might guess, some of what we do is classified. As commerce and exploration expand into our solar system, we're developing ways to stay ahead of the future and protect that expansion. Asteroid mining and 3D printing bases on the moon aren't science fiction anymore.

To learn more about opportunities within Space Force, visit airforce.com/spaceforce.



UNITED STATES
SPACE FORCE™

ASTRO ADVENTURE



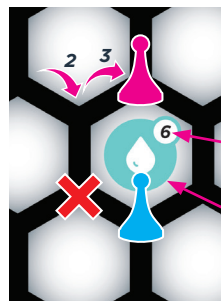
In this board game, you will attempt to expand your influence on our solar system by collecting resources and adding spacecraft to your fleet. You will learn about the resources needed for space exploration and where they could be found. In addition, you will explore the implications of space travel on human health in this Astro Adventure.

Begin your Adventure

The objective of the game is to collect resources and be the first player to get all your pawns (orbiter, lander, shuttle, and spaceport) on the board. You collect resources through situation cards and when your pawns are adjacent to a color-coded world when the number on the world is rolled on the dice. You can also trade resources with Earth or other players.

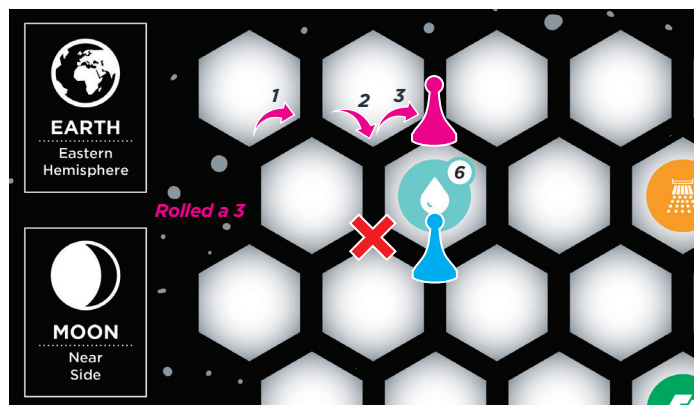
General Rules

- Move your pawn along segments of lines between the hexagons and come to rest where the lines of each hexagon intersect. Each line segment counts as one move indicated by the dice. If a five is rolled, a player can move their pawn five intersections or places. If you do not wish to move your pawn on your turn, you do not have to.
- A pawn cannot pass through an intersection where there is another pawn.
- A pawn cannot end its move on a place adjacent to another pawn. There has to be at least one place between every pawn when they are at rest.



Six must be rolled in order to gain that resource

A world rich in a specific resource



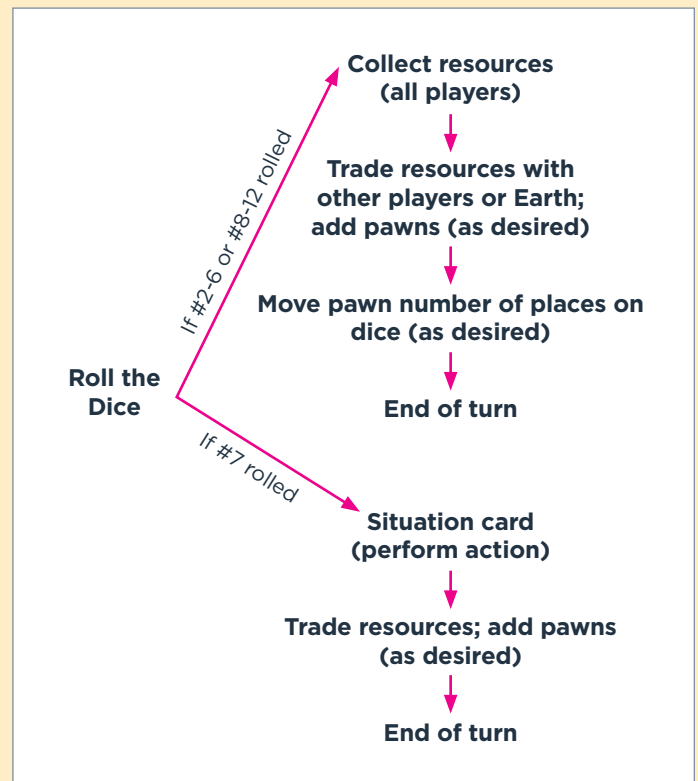


Getting Started

1. Roll the dice to see who goes first and establish a playing order that will be used the entire game.
2. Each player will place a pawn on the left side of the gameboard by the Earth, Moon, or International Space Station (ISS).
3. With the hexagonal lines serving as various paths a player can move and the intersections of those lines serving as places that player pawns can stop, each player will roll the dice, choose their own path, and move the indicated number of places.
4. Once all players have one pawn on the board, the Astro Adventure can begin!

Astro Adventure

5. On your turn, roll the dice.
 - If a 2-6 or 8-12 is rolled, **all** players who have a pawn next to a world with that number will collect one resource of the corresponding color.
 - If the number 7 is rolled, the player will draw a situation card, read it aloud, and follow the instructions. Keep the card for the rest of the game.
6. Next, while it is still your turn, you can take other actions:
 - Add a new pawn to the left side of the gameboard by trading four different resources, one of each type—water, carbon, propellant, and rare minerals—with Earth.
 - Trade resources with Earth at a 4:1 ratio. (You must have four of a single kind of resource to trade for one of the desired resources.)
 - **Initiate trades with other players!** (Both players involved in a trade must agree on the terms.)
7. This ends your turn unless you rolled a 2-6 or 8-12, in which case you have the option to move a pawn, even one you just added to the game board, the number of places indicated on the dice.
8. **The first player who gets all four of their pawns on the board and shouts “Blast Off” wins the Astro Adventure!**



Play for Points

Another way to determine the winner for Astro Adventure is having the most points when a player gets all four of their pawns on the board or when time is up! This is a great method if you only have a limited amount of time to play, or if older youth want to play Astro Adventure with a different game strategy. All players will total their points using the table on the right when the game is over. **The player with the most points wins the Astro Adventure!**

ITEM	POINTS FOR EACH ITEM
Water Resource	1
Carbon Resource	2
Propellant Resource	3
Rare Minerals Resource	4
Situation Card	2
Pawn	11

Game strategy can be affected by the likelihood you would roll a certain number. You may have noticed some numbers are rolled more often than others. You can calculate the percentage of time that certain numbers are rolled and compare that to the theoretical probability. Fill in the table by either rolling the dice as many times as you can for one minute and record the numbers or record the numbers that occur while you are playing the game. The more you roll, the closer your actual percentage will be to the theoretical probability.

NUMBER (Displayed on dice) Example: "2"	FREQUENCY 13 (if it was rolled 13 times)	ACTUAL PERCENTAGE ((rolls with displayed number/total rolls)*100) If there were 85 total rolls, the formula would be: (13/85)*100 = 15.3%	THEORETICAL PROBABILITY (This number is in the Facilitator Guide. You have a theoretical probability of rolling a '2', 2.78% of the time.)
2			2.78%
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
		← Total number of rolls Add everything above	

Collecting and trading resources was important to winning the game. What did you notice about the availability of resources? If a government or other entity placed restrictions on how many resources were available to each player, how would it have affected the game? Write down one "new rule" you would make for the game and how you would change your strategy based on that rule.



Career Connections (STEM/Civic Engagement/ Healthy Living)

Our human bodies are well-adapted for life on Earth. Spending even a few days in the weightless environment of space can cause severe muscle loss and other negative effects. Therefore, we are studying how to keep astronauts and future space explorers fit and healthy during long periods of time. Scientists are experimenting with training routines and diets that will provide the nutrients and exercise astronauts need.

Future space travel will also rely heavily on harvesting and processing raw materials to sustain human life and space travel. For this reason, the fields of chemistry, mineralogy, metallurgy, mining and more will be used to capitalize on resources that are available independent of Earth. In addition, policy-makers, leaders, and diplomats will put their skills to the test to create the legal framework surrounding space exploration and property rights for interstellar cooperation.

Consider these careers related to space exploration:

- Astronaut
- Chemist
- Dietician
- Electrician
- Engineer
- Geoscientist
- Medical professional
- Metallurgist
- Nutritionist
- Physiologist
- Technician



COSMIC CLAW



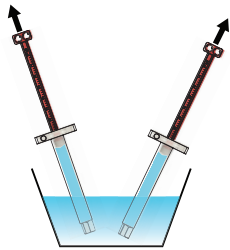
A pivotal step in space exploration is finding a way to sustain life independent of Earth. In this activity, you will learn about the cultivation of crops and mechanization that will be needed to manipulate and harvest resources in the far-off reaches of space. Fulfill your quest to sustain life on another world with Cosmic Claw.

Assemble the Cosmic Claw

BUILD THE HYDRAULICS:

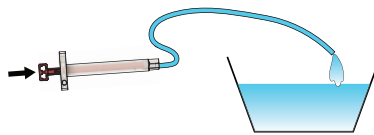
01.

Fill both cylinders with water. (Place the tip of each cylinder in the water and pull the piston away from the tip to fill the cylinder with water.)



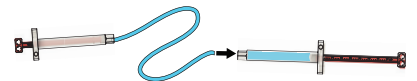
02.

Fill the tubing with water by attaching a full cylinder to one end and pushing the piston. (Repeat the process as necessary to fill the tubing completely with water.)



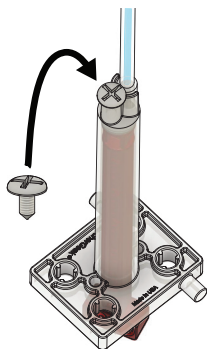
03.

Attach the second cylinder to the opposite end of the tubing. (Remove all bubbles from cylinders and tubing. Tip the cylinder so any bubbles rise to the base of the tube. Push the air out and refill.)



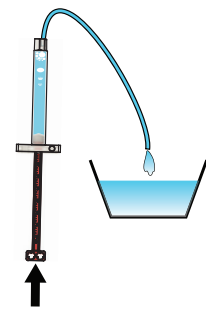
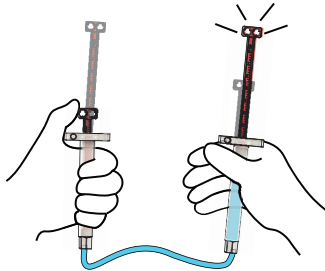
04.

Insert a cylinder screw into each cylinder to secure the tubing.



05.

Your hydraulics are done! Test them out, then proceed to the next phase.

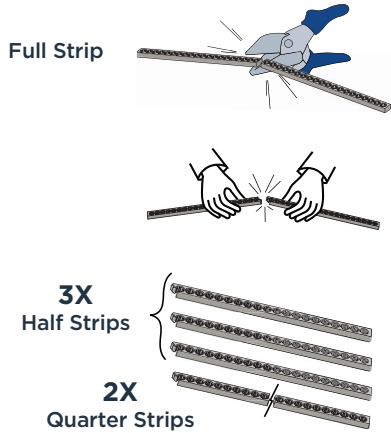


Assemble the Cosmic Claw

CREATE THE CLAW:

01.

Cut or snap both full-sized strips in two, making four half-sized strips.



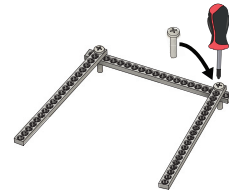
02.

Take one half-sized strip and cut or snap it in half, making two quarter-sized strips.



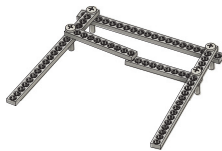
03.

Screw the three half strips together at each end, making a long strip with two joints. Bend the joints to form the shape of a "U".



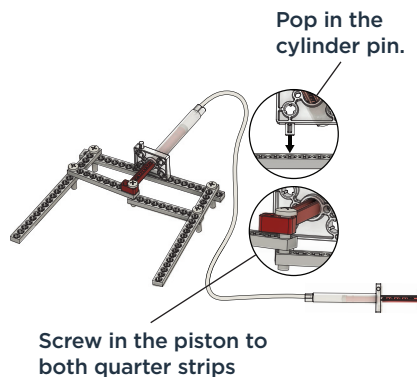
04.

On each of the outside strips, screw the end of a quarter-sized strip to the half-sized strip approximately three holes away from the existing screw.



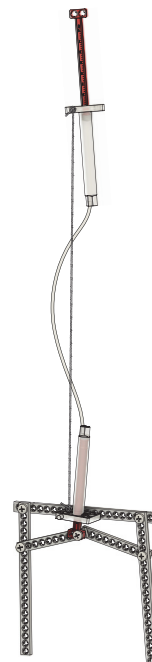
05.

Add the cylinder assembly to the middle of the center half strip. Pop in the cylinder pin and screw in the piston to both quarter strips where they meet in the center.



06.

Begin tinkering with the design and consider what you could add to the ends to assist with grasping and scooping. Attach various grasping/scooping/raking implements to the end of the robotic arm with tape or zip ties.





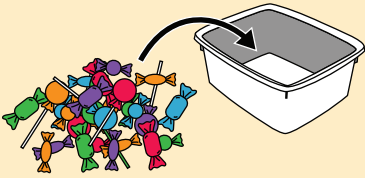
Harvest Challenge

01.

In one minute, harvest as many “crops” as you can. Record your result. Select a harvest challenge. (Earn 5 points for every crop harvested and an additional 1 point for every second remaining.)

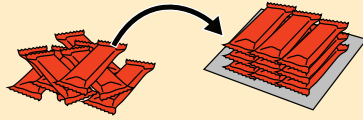
MISSION 1

Your crops are ready for harvest, but the planet you are on gets limited sunlight. Pick up and dump as many crops into a container as possible. How many crops can you harvest?



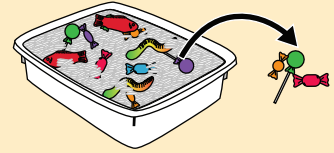
MISSION 2

Edible crops need to be put away in a safe place for later. You have to pick up and neatly stack your crops for storage. How many crops can you stack in a designated space?



MISSION 3

Many plants are useful for both their roots and their leaves. Use your cosmic claw to separate the crops from the soil. How many crops can you dig out and remove?



02.

Alter the design of your cosmic claw as needed.

03.

Repeat the process with other members of your team (if applicable).

04.

Try another harvest challenge or increase the level of difficulty by adding alien lifeforms or non-edible crops you need to avoid contacting. (Subtract 10 points for any lifeform or non-edible crop harvested.)

05.

Continue optimizing your design and/or rework the design and rebuild the claw.

06.

Test each new design to determine which design works better.

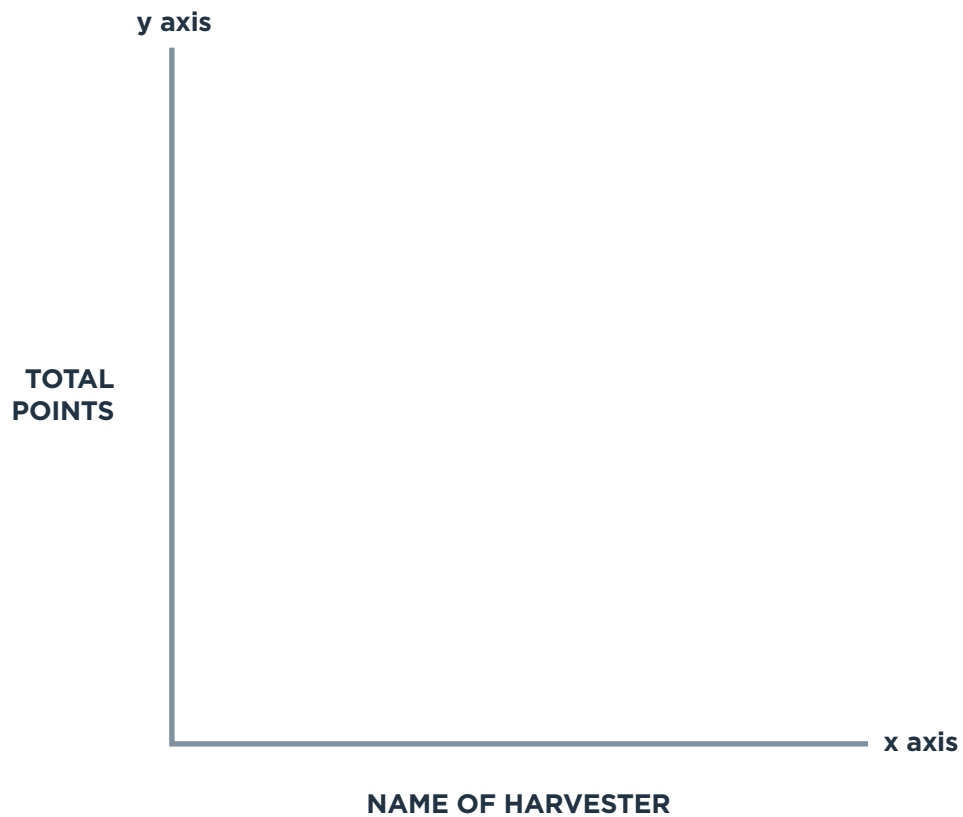
In your haste to harvest quickly, some non-edible crops and lifeforms got mixed into the same container. Use your cosmic claw to sort items by type and see how many you can get in one minute.



Tally the number of crops you or your team is able to harvest and convert that information to a bar graph. Each time you attempt to improve the design, put an asterisk (*) on the person's name who used the redesigned claw. This will help you keep track of how many times you attempted to optimize your design.

Name of Harvester (x-axis)	Number of Crops Harvested (+5 points each)	Seconds remaining (+1 point each)	Number of lifeforms or non-edible crops harvested (-10 points each)	Total (y-axis)
<i>Example</i>	10	2	1	= (10*5)+(2*1)-(1*10) =42

CROPSHARES





Career Connections (STEM/Agriculture/ Healthy Living)

Robotics have revolutionized several industries where simple, repetitive tasks are required, such as in the agricultural industry. Robots perform simple actions repeatedly, like mass harvesting a crop, or completing one step of a process in a long assembly line of robots. Precision agriculture uses technology with pinpoint accuracy to target specific needs of plants while reducing waste. More specialized robots can even perform more complex functions like milking a dairy cow when she comes into a parlor. By using robots for this work, human labor is saved for more important tasks.

Robots have also benefited industries where work is needed in environments that are hazardous to humans, such as space exploration. Every time an astronaut leaves the safety of the space vehicle there is risk. In addition, some tasks require more power or more precision than a human can perform in space. Therefore, we can reduce risk and improve performance by allowing robots to do tasks. Cultivating crops on distant worlds is an ideal function for robots in space exploration!

We need these positions to grow food to sustain human life in space:

- Agronomist
- Botanist
- Horticulturist
- Mechanical engineer
- Robot technician



CONGRATULATIONS!

This certificate is awarded to:

for completing the

GALACTIC QUEST **THE 2021 4-H STEM CHALLENGE!**



Presented by:

Date:







4-H
STEM
Challenge

Program supported by:



FACEBOOK



UNITED STATES
SPACE FORCE™



COOPERATIVE EXTENSION
College of Agriculture, Forestry and Life Sciences



United States
Department of
Agriculture

National Institute
of Food and
Agriculture

In 4-H, we believe in the power of young people. We see that every child has valuable strengths and real influence to improve the world around us. We are America's largest youth development organization—empowering nearly six million young people across the U.S. with the skills to lead for a lifetime.

Learn more online at 4-H.org/STEMChallenge.