



# DISCOVER



## 4-H ASTRONOMY CLUBS



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## Description

The Discover 4-H Clubs series guides new 4-H volunteer leaders through the process of starting a 4-H club or provides a guideline for seasoned volunteer leaders to try a new project area. Each guide outlines everything needed to organize a club and hold the first six club meetings related to a specific project area.

## Purpose

The purpose is to create an environment for families to come together and participate in learning activities while spending time together as a multi-family club. Members will experiment with new 4-H project areas.

## What is 4-H?

4-H is one of the largest youth development organizations in the United States. 4-H is found in almost every county across the nation and enjoys a partnership between the U. S. Department of Agriculture (USDA), the state land-grant universities (e.g., Utah State University), and local county governments.

4-H is about youth and adults working together as partners in designing and implementing club and individual plans for activities and events. Positive youth development is the primary goal of 4-H. The project area serves as the vehicle for members to learn and master project-specific skills while developing basic life skills. All projects support the ultimate goal for the 4-H member to develop positive personal assets needed to live successfully in a diverse and changing world.

Participation in 4-H has shown many positive outcomes for youth. Specifically, 4-H participants have higher participation in civic contribution, higher grades, increased healthy habits, and higher participation in science than other youth (Lerner et al., 2005).

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## Utah 4-H

4-H is the youth development program of Utah State University Extension and has more than 90,000 youth participants and 8,600 adult volunteers. Each county (Daggett is covered by Uintah County) has a Utah State University Extension office that administers the 4-H program.

## The 4-H Motto

"To Make the Best Better!"

## The 4-H Pledge

I pledge: My HEAD to clearer thinking, my HEART to greater loyalty, my HANDS to larger service and my HEALTH to better living, for my club, my community, my country, and my world.

## 4-H Clubs

What is a 4-H Club? The club is the basic unit and foundation of 4-H. An organized club meets regularly (once a month, twice a month, weekly, etc.) under the guidance of one or more volunteer leaders. It elects its own officers, plans its own program, and participates in a variety of activities. Clubs may choose to meet during the school year, only for the summer, or both.

## Club Enrollment

Enroll your club with your local Extension office. Each member will need to complete a Club Member Enrollment form, Medical History form, and a Code of Conduct/Photo Release form. (Print these from the [www.utah4h.org](http://www.utah4h.org) website or get them from the county Extension office).

## Club Officers

Elect club officers during one of your first club meetings. Depending on how many youth are in your club, you can decide how many officers you would like. This will typically include a president, vice president, pledge leader, and secretary. Other possible officers or committees are: song leader, activity facilitator, clean-up supervisor, recreation chair, scrapbook coordinator, contact committee (email, phone, etc.), field trip committee, club photographer, etc. Pairing older members with younger members as Sr. and Jr. officers may be an effective strategy to involve a greater number of youth in leadership roles and reinforce the leadership experience for all ages. Your club may decide the duration of officers (6 months, 1 year, etc.).



## A Typical Club Meeting

Follow this outline for each club meeting:

- Call to order – President
- Pledge of Allegiance and 4-H Pledge – Pledge Leader (arranges for club members to give pledges)
- Song – Song Leader (leads or arranges for other club member to lead)
- Roll call – Secretary (may use an icebreaker or a “get acquainted” type of roll call to get the meeting started)
- Minutes of the last meeting – Secretary
- Business/Announcements – Vice President
- Club Activity – Activity Facilitator arranges this. It includes a project, lesson, service, etc. These are outlined by project area in the following pages.
- Refreshments – Refreshment coordinator
- Clean Up – Clean-up supervisor leads others in cleaning up



## Essential Elements of 4-H Youth Development

The essential elements are about healthy environments. Regardless of the project area, youth need to be in environments where the following elements are present in order to foster youth development.

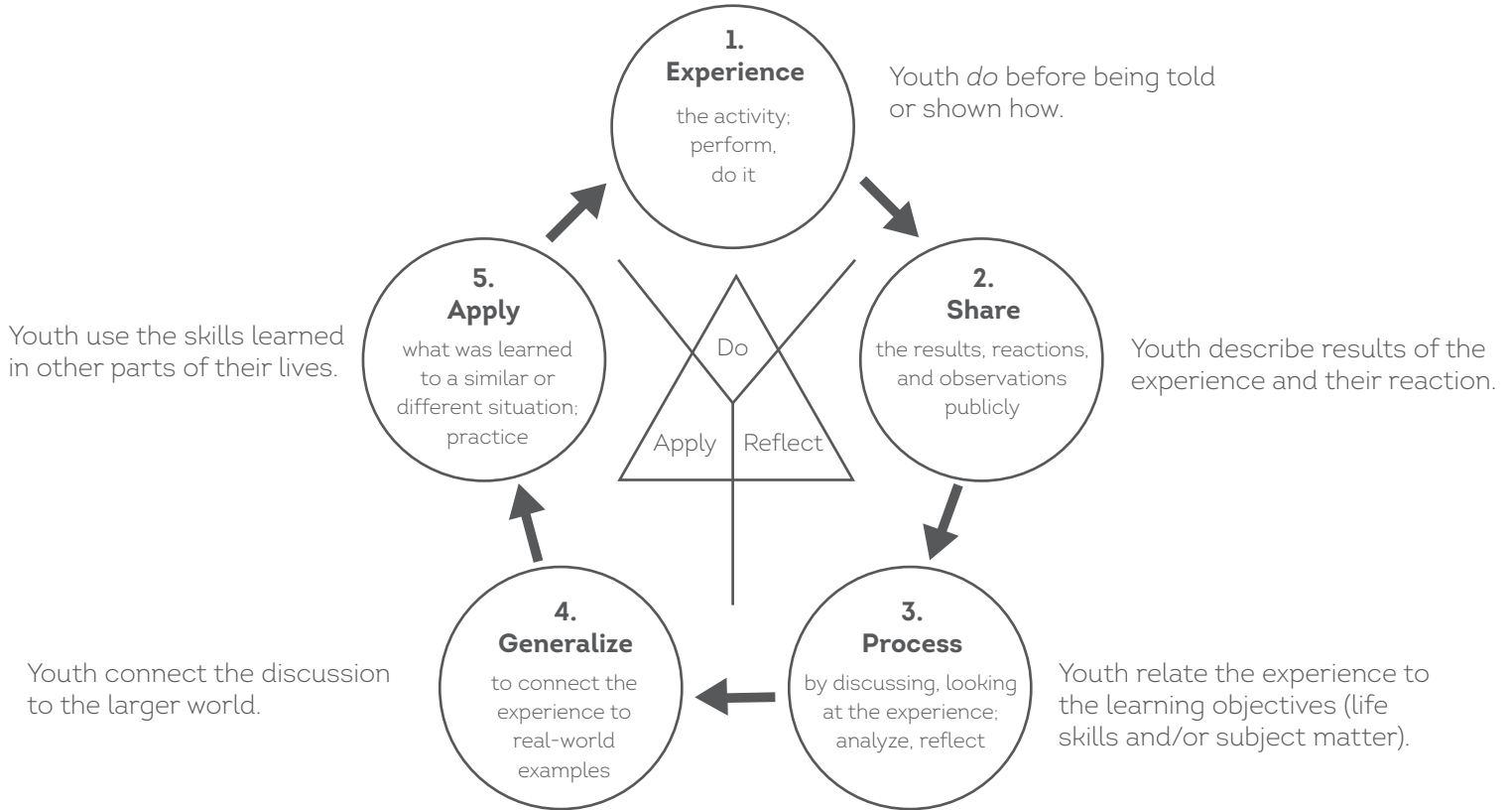
1. **Belonging:** a positive relationship with a caring adult; an inclusive and safe environment.
2. **Mastery:** engagement in learning, opportunity for mastery.
3. **Independence:** opportunity to see oneself as an active participant in the future, opportunity to make choices.
4. **Generosity:** opportunity to value and practice service to others.

(Information retrieved from: <http://www.4-h.org/resource-library/professional-development-learning/4-h-youth-development/youth-development/essential-elements/>)



## 4-H “Learning by Doing” Learning Approach

The Do, Reflect, Apply learning approach allows youth to experience the learning process with minimal guidance from adults. This allows for discovery by youth that may not take place with exact instructions.



## 4-H Mission Mandates

The mission of 4-H is to provide meaningful opportunities for youth and adults to work together to create sustainable community change. This is accomplished within three primary content areas, or mission mandates - citizenship, healthy living, and science. These mandates reiterate the founding purposes of Extension (e.g., community leadership, quality of life, and technology transfer) in the context of 21st century challenges and opportunities. (Information retrieved from: [http://www.csrees.usda.gov/nea/family/res/pdfs/Mission\\_Mandates.pdf](http://www.csrees.usda.gov/nea/family/res/pdfs/Mission_Mandates.pdf))

- Citizenship:** connecting youth to their community, community leaders, and their role in civic affairs. This may include: civic engagement, service, civic education, and leadership.
- Healthy Living:** promoting healthy living to youth and their families. This includes: nutrition, fitness, social-emotional health, injury prevention, and prevention of tobacco, alcohol, and other drug use.
- Science:** preparing youth for science, engineering, and technology education. The core areas include: animal science and agriculture, applied mathematics, consumer science, engineering, environmental science and natural resources, life science, and technology.

## Getting Started

1. Recruit one to three other families to form a club with you.
  - a. Send 4-H registration form and medical/photo release form to each family (available at [utah4h.org](http://utah4h.org)).
  - b. Distribute the Discover 4-H Clubs curriculum to each family.
  - c. Decide on a club name.
  - d. Choose how often your club will meet (e.g., monthly, bi-monthly, etc.).
2. Enroll as a 4-H volunteer at the local county Extension office (invite other parents to do the same).
3. Enroll your club at the local county Extension office.
  - a. Sign up to receive the county 4-H newsletter from your county Extension office to stay informed about 4-H related opportunities.
4. Identify which family/adult leader will be in charge of the first club meeting.
  - a. Set a date for your first club meeting and invite the other participants.
5. Hold the first club meeting (if this is a newly formed club).
  - a. See *A Typical Club Meeting* section above for a general outline.
    - i. Your activity for this first club meeting will be to elect club officers and to schedule the six project area club meetings outlined in the remainder of this guide. You may also complete a-d under #1 above.
  - b. At the end of the first club meeting, make a calendar outlining the adult leader in charge (in partnership with the club president) of each club meeting along with the dates, locations, and times of the remaining club meetings.
6. Hold the six project-specific club meetings outlined in this guide.
7. Continue with the same project area with the 4-H curriculum of your choice (can be obtained from the county Extension office) OR try another Discover 4-H Club project area.



## Other Resources

Utah 4-H website: [www.utah4-h.org](http://www.utah4-h.org)

National 4-H website: [www.4-h.org](http://www.4-h.org)

4-H volunteer training:

To set up login:

<http://utah4h.org/volunteers/training/>

To start modules: (password = volunteer)

## References

Information was taken from the Utah 4-H website ([utah4h.org](http://utah4h.org)), the National 4-H website ([4h.org](http://4h.org)), the Utah Volunteer Handbook, or as otherwise noted.

Lerner, R., M. et al. (2005). Positive youth development, participation in community youth development programs, and community contributions of fifth grade adolescents: Findings from the first wave of the 4-H Study of Positive Youth Development. *Journal of Early Adolescence*, 25(1), 17-71.

**We would love feedback or suggestions on this guide; please go to the following link to take a short survey:**

**Go to <https://goo.gl/iTfiJV> or [Click here to give your feedback](#)**



# 4-H ASTRONOMY CLUB *Meetings*



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## What is Astronomy?



### Supplies

- Key Figures in Astronomy History worksheet (one copy for each club member)
- Computers or tablets
- Internet access

### INTRODUCTION

Astronomy is a very interesting science that involves the study of everything outside the Earth's atmosphere. During this club meeting, participants will learn what astronomy is. They will also learn about how astronomy has evolved throughout history. Club members will then perform an internet investigation to learn about key historical figures in the field of astronomy.

According to the Encyclopædia Britannica, astronomy is the "science that encompasses the study of all extraterrestrial objects and phenomena." This means that everything outside of the Earth's atmosphere - from asteroids and the sun to far away galaxies and planets - falls within the realm of astronomy.

The early origins of astronomy can be traced back to prehistoric civilizations. Some of the earliest astronomical observations we have record of were made by the Babylonians as early as 2000 BC. By 300 B.C., Babylonian astronomers had developed sophisticated methods for predicting the movement of the planets. There are also some records of Greek astronomical studies and investigations. Some ancient cultures, such as the Greek and Native American tribes, named constellations after mythological figures and legends. Many of these names are still used today to identify constellations and stars.

We know a lot more about astronomy now than we used to, but there are still many things to discover. The universe is so big that we probably will never finish discovering new stars and planets. While much of the work that astronomers do today uses advanced technology like the Hubble Space Telescope, astronomy is one of the only modern sciences where amateurs can still contribute and make great discoveries!

### PRIOR TO MEETING

- Print out or make copies of the Key Figures in Astronomy History worksheet. Make sure there are enough worksheets for each club member to have their own copy.





# HISTORICAL INVESTIGATION

TIME: 40-45 MINUTES

1. Pair up participants into groups of two or three. Pass out the Key Figures in Astronomy History worksheet to each club member.
2. Explain to the club members that they will be learning about four key people who contributed to the field of astronomy: Claudius Ptolemy, Nicolaus Copernicus, Johannes Kepler, and Galileo Galilei. Specifically, the youth should be looking for what these men discovered with respect to the structure of the solar system. For each person on the worksheet, the youth should list a key idea/discovery that that person had/made and the evidence that led to that idea/discovery.
3. After the youth have their worksheet and understand what they will be writing down, have them get on the internet to begin their investigation. It may be helpful to point the youth toward the sites listed below:
  - a. <https://www.khanacademy.org/partner-content/big-history-project/big-bang> (This site has clear information on Ptolemy, Copernicus, and Galileo.)
  - b. [www.wikipedia.org](http://www.wikipedia.org) (Youth might have to do some digging here to find the information.)
  - c. [www.britannica.com](http://www.britannica.com) (This site has complex or detailed information.)
4. Information summaries have been included for 4-H leaders at the end of this club. Remember to let the youth conduct the investigation on their own as much as possible.
5. After the youth have filled out their worksheets, discuss what they learned during their investigation.
  - a. What did these men discover?
  - b. How did they discover it?
  - c. What evidence did they use to support their discovery?
  - d. How does their discovery match with what we think today?
  - e. How do astronomers make discoveries today?
  - f. What tools do astronomers have now that these men did not have?
6. Investigation tips:
  - Read the first paragraphs or the summary of an article before getting into the body. The summary may contain the information you are looking for.
  - Look for headers or sections that relate to the information you want.
  - If you find yourself spending lots of time reading one section, skim the article or webpage (quick read it) to see if you can spot the information you want.
  - If you're not sure what you should be looking for, don't be afraid to ask for help.



## Historical Figures Summaries:

### Claudius Ptolemy

Claudius Ptolemy was a Greek mathematician and astronomer who lived from about 100 A.D. to 170 A.D. in Alexandria, Egypt. In astronomy, he is known for his work and models depicting the Earth as the center of the solar system. He created many tables predicting the position of the sun, moon, planets, and stars. Ptolemy used visual observations to form his tables and theories.

Idea: The Earth is the center of the solar system.

Evidence: The movement of the sun, moon, planets, and stars.

### Nicolaus Copernicus

Nicolaus Copernicus was born on February 19, 1473, in Poland. While other astronomers before Copernicus had suggested that the Earth orbits the Sun, Copernicus received credit for publishing and formalizing this theory. He theorized that the sun, not the Earth, was the center of the "universe" (for us the solar system) and that the movement and rotation of the Earth were what caused the stars in the sky to move. Copernicus based his theory off visual observations.

Idea: The sun is actually the center of the solar system.

Evidence: The movement of the planets better match the Earth orbiting the sun.

### Johannes Kepler

Johannes Kepler was born in Germany on December 27, 1571. Early in his career, Kepler worked with an astronomer named Tycho Brahe. A year and a half after Kepler had begun working with Tycho Brahe, Brahe died unexpectedly. Kepler decided to continue Brahe's research on the orbit of Mars, and this led him to make an important discovery. While studying Brahe's data about Mars, Kepler found that his observations did not match with Copernicus' circular orbit theory. Acting on a hunch, Kepler tried instead to match the data to an elliptical orbit. This hunch proved to be a success, and this discovery led to Kepler's first law of planetary motion, which states that all planets follow elliptical orbits around the sun. Much of Kepler's work was based off visual observations of the night sky.

Idea: The planets orbit the sun and follow elliptical orbits, not circular, orbits.

Evidence: Data from the observation of Mars' orbit matches this idea.

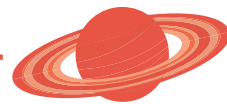
### Galileo Galilei

Galileo Galilei was born on February 15, 1564, in Italy. Galileo made many discoveries important to astronomy, physics, and science in general. He is most well-known for his work in promoting and supporting Copernicus' theory that the sun, not the Earth, is the center of the solar system. Galileo also used a telescope to observe the phases of Venus and to discover the four largest moons of Jupiter. Much of Galileo's evidence for his theories came from observations he made using his telescope.

Idea: Copernicus and Kepler are correct, the Earth orbits the sun.

Evidence: The phases of Venus and the moons of Jupiter.





## Reflect

- What investigation skills did you learn during this activity?
- Why might it be important to understand how to search for accurate information on the internet?
- Besides the internet, what other places might you be able to use to find information like this?
- How can you verify the information you found is correct?

## Apply

- How might good investigation skills help a scientist in their job?
- How might good investigation skills be useful in school?

## 4-H MISSION MANDATES

### Citizenship

Point out that, as citizens, it is important for us to be informed with accurate information so that we can positively contribute to our communities.

### Science

Data collection and researching a problem are both important parts of any science. Recording information about stars and planets like these astronomers did is collecting data. Reading about discoveries that others have made and about current scientific theories is part of researching a problem.

## ESSENTIAL ELEMENTS

### Belonging

When dividing the club members into their groups, make sure that they work with someone they haven't worked with recently.

### Independence

Club members will learn that they can make better decisions by seeking out accurate and relevant information.

### Mastery

By performing investigations to learn about specific topics, club members will gain experience with and master self-inquiry and independent discovery.

### References and Other Resources

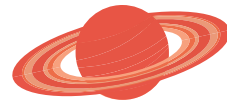
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## Key Figures in Astronomy History

### Claudius Ptolemy

Birth Year:

Death Year:

Idea/Discovery:

Supporting Evidence:

### Nicolaus Copernicus

Birth Year:

Death Year:

Idea/Discovery:

Supporting Evidence:

### Johannes Kepler

Birth Year:

Death Year:

Idea/Discovery:

Supporting Evidence:

### Galileo Galilei

Birth Year:

Death Year:

Idea/Discovery:

Supporting Evidence:





## Our Neighbor, the Moon



### Supplies

- |  |   |
|--|---|
| Activity 1:  |   |
| • Softball   | • Non-glossy black paint  |
| • Tennis ball  | • Hot glue  |
| • String or yarn   | • Scissors  |
| • Permanent marker   | • Tape  |
| Activity 2:  | • Black construction paper  |
| • Shoe boxes (one per participant)                             | Alternate Activity:   |
| • Styrofoam balls (size of a tennis ball; one per participant) | • Styrofoam balls (one per participant)                             |
| • Fishing line   | • Wooden dowels (between 6 and 12 inches long; one per participant) |
| • Flashlights (one per participant)                            | • Flashlight  |
|  | • A dark room   |

### INTRODUCTION

While the Moon is our closest neighbor in space, we often don't realize how far away the Moon actually is. During this club, club members will learn to visualize how far the Moon is from the Earth by using a simple scale model. Additionally, club members will discover how the different phases of the Moon are created and whether or not the Moon rotates.

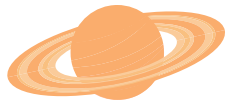
The Moon is one of the most prominent features of the night sky and has been a subject of scientific study for thousands of years. Many cultures and civilizations have used the Moon to track the passage of time. It may be surprising to think about, but the Moon actually contributes to the survival of many ecosystems here on Earth. This contribution mainly comes in the form of the tides – the regular rising and falling of the ocean – which many marine organisms depend upon for survival.

While some television shows and movies humorously suggest that the Moon is made of cheese, we know from the NASA Apollo missions that the Moon is rocky and dusty. As a result, the Moon reflects sunlight very well. This reflective quality makes the Moon look like it is fairly close to us, but have you ever thought about how far the Moon actually is from the Earth? It may be farther than you think.

### PRIOR TO THE MEETING

- Ask participants to bring a shoebox and flashlight to make their Moon phases box.
- Wrap the string, yarn, or ribbon around the softball and cut it so that it goes around the softball a little more than nine and a half times. The scaled length that we want for the model is nine and a half times the circumference of the soft ball, but make it a little longer so that you can easily hold the ends.
- With a permanent marker, make a few marks on the string. Make a mark near each end of the string to show the actual scaled length for the model. The string will be held against the surface of the balls at that point. Make another mark about one centimeter in from one of the end marks (the width of your pointer finger is about one centimeter). This mark will represent the orbit of the International Space Station (ISS). Put the string away until it gets used during the first activity.





# DISTANCE TO THE MOON

TIME: 10 MINUTES

1. Present a softball and a tennis ball to the club members and explain that these balls will be used to represent scaled-down versions of the Earth and the Moon.
2. Let the club members have 3 to 5 minutes to figure out and decide how far they think the Moon should be from the Earth in this scale model. Give them the balls and have them experiment by placing the balls on the ground and varying the distance between them.
3. Invite the club members to discuss and think about what clues they could use to improve their guess (example: how big the Moon looks in the night sky compared to the balls).
4. Once the club members agree and have a guess, discuss with them why they think their guess is right.
  - a. What clues did they use to help them judge distance?
  - b. What things made it difficult to guess the distance between the Softball (Earth) and the tennis ball (Moon)?
  - c. What tools could they use to get a more accurate measurement? (If they knew the actual distance between the Earth and the Moon and the actual size of the Earth, they could use scale to measure where to put the tennis ball.)
5. Pull out the string cut earlier and explain to the club members that the Moon orbits about 30 Earth diameters, or 9.5 Earth circumferences, away from the surface of the Earth.
6. Have one of the club members hold the end marked with the orbit of the ISS against the softball.
7. Ask another club member to hold the other end of the string against the tennis ball. Tell them to hold the string so that the two distance marks are right against the surface of each ball.
8. Keeping the string against the balls, move the softball and tennis ball apart until the string straightens out all the way.
9. Point out the mark representing the height at which the International Space Station orbits.
10. Now that you have a scale model of the Earth and the Moon, discuss with the club members what they think of the result.
  - a. Were they surprised by the distance between the Earth and the Moon?
  - b. Explain that it is often hard for us to picture or understand large distances in our mind. This, however, is an important part of astronomy because the universe is huge! Using scale models can help us understand large distances a little better.





# MOON IN A BOX

TIME: 30-40 MINUTES

This activity might take more time than you have available in one club meeting depending on how quickly participants can work. If necessary, consider completing this activity between two club meetings. Make sure that club members don't rush their work, as quality work will be more rewarding in the end.

Open the shoebox and paint the inside black, including the inside of the lid. Leave the box and lid to dry.

1. Take a paperclip and straighten it out. With the straightened paperclip, carefully poke a hole all the way through the center of the Styrofoam ball.
2. Cut an 8 to 10 inch long piece of fishing line and push it through the hole in the Styrofoam ball.
3. Tie a knot in one end of the line and pull the line so the knot gently presses against the Styrofoam ball. Use a little bit of hot glue (if necessary) to secure the ball on the fishing line.
4. Once the paint is dry, poke a small hole in the center of the box lid and run the fishing line through it. You want to do this so that the Styrofoam ball will hang down in the box when the lid is put back on.
5. In the center of one of the long sides of the box, cut a hole just large enough to stick the end of the flashlight in. Make the hole small enough so that the flashlight will fit snugly.
6. Make three small eyeholes in the center of the remaining sides of the box. These will be viewing ports to see the Moon phases. Another viewing hole should be made as close to the flashlight as possible so someone can look through the hole without bumping into the flashlight.
7. Four other viewing ports should be made to see the crescent and gibbous phases. At this point, it may help to draw some lines on the bottom of the box to help you align these last holes. First, draw two perpendicular lines going through the center of the bottom panel that align with the flashlight hole and the first three viewing holes you made. Then, draw two other diagonal lines at 45 degree angles to the first two. Your last four viewing ports should align with these diagonal lines.
8. Cut some small flaps from construction paper and tape them on the box so that they cover the viewing ports when not in use.
9. Stick the flashlight in its hole and turn it on.
10. Place the lid on the box, and pull on the fishing line to adjust the Styrofoam ball so it hangs in the center of the box. Glue the line down once you have it adjusted.
11. Finally, look through the different view ports to see the different phases of the Moon!



## PHASES AND ROTATIONS

TIME: 10-15 MINUTES

This is an alternate activity. It is a simplified activity to demonstrate the phases and rotation of the Moon.

1. Give each club member a Styrofoam ball and a dowel. Tell them to carefully press the ball onto the dowel so the dowel goes about two inches into the ball. The Styrofoam ball will represent the Moon for this activity.
2. Once the club members have their moons ready, have them stand up and spread out so that they have two arm's length spacing around them.
3. Holding their moon out at arm's length by the stick, have the youth spin slowly around in place three or four times. Explain that because of how the Moon is gravitationally locked or tidal locked with the Earth, the same side of the Moon always faces the Earth.
4. Does the Moon rotate? Discuss this question. (The Moon in fact does rotate about its axis. If it didn't rotate, then we would see different parts of the Moon as it orbits the Earth. It takes the Moon the same amount of time to complete one rotation as it does to orbit the Earth once. That means that one lunar day is about 28 days long.)
5. Before the next part of the activity, ask the club members if they know what the phases of the moon are and how they are created. If they don't know, have them make a few guesses.
6. Turn off the lights or take the club members to the dark room.
7. With the flashlight on, have the club members space themselves out again. Explain that the flashlight will be used to shine on the moons just as the sun does.
8. Have the youth hold out their moons again at arm's length. As they spin slowly counter-clockwise, have them try to identify the eight main phases of the Moon.





## Reflect

- How does the Moon's gravitational pull affect life on Earth?
- Why is it important to understand how far the Moon is away from the Earth?
- How are the phases of the Moon created?

## Apply

- What other things could you learn about or visualize using the concept of scale models?
- What professionals or careers frequently use scale to visualize problems or objects?

## 4-H MISSION MANDATES

### Science

Collaborate, model, and predict are all science abilities used during this club meeting. By working together to guess how far the Moon is from the Earth, club members will be collaborating and making predictions.

## ESSENTIAL ELEMENTS

### Belonging

Make sure that club members work together and listen to each other's opinions as they make predictions about how far the Moon is from the Earth.

### Mastery

By making predictions and testing them, club members will gain experience with how learning occurs through the scientific method.

## References and Other Resources

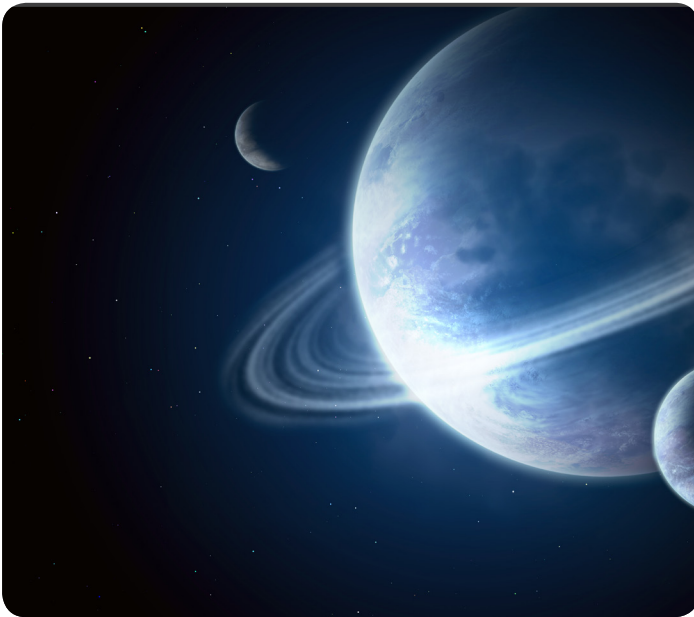
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## The Solar System



### Supplies

- Activity 1
- Solar System on a String handout (one for each member)
  - String (4.5 meters for each club member)
  - Small piece of cardboard to wrap
  - Solar system string around (10 cm x 10 cm, one for each club member)
  - Measuring stick
  - Planet beads (large craft pony beads):
    - Sun - yellow
    - Mercury - solid red
    - Venus - cream
    - Earth - clear blue
    - Mars - clear red
    - Asteroid belt - black
    - Jupiter - orange
    - Saturn - clear gold
    - Uranus - dark blue
    - Neptune - light blue

### INTRODUCTION

The solar system is like our little neighborhood of the galaxy. While most people can recite the names of the planets in the solar system, we don't often consider how far apart the planets are in space. During this club, each club member will make a scale model of the solar system using string and beads. While the size of the planets will not be accurately represented, the average distance from the sun to each planet will.

### PRIOR TO MEETING

- Print out or make copies of the Solar System on a String handout. Make sure there are enough for each club member to have their own copy.

### WHAT TO DO

The solar system is a group of planets and other objects that orbit the Sun. Today, there are eight planets in the solar system as defined by the International Astronomical Union (IAU) which include: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. There are also five dwarf planets currently recognized by the IAU which include Pluto (which was defined as a planet until 2006), Ceres, Haumea, Makemake, and Eris. Within the solar system are other objects such as asteroids, comets, and moons.

When astronomers talk about distances for objects in the solar system, they often use something called an Astronomical Unit (AU). One AU is equal to the average distance between the Earth and the sun, which is about 150 million kilometers or 93 million miles. Using the AU can make certain distances easier to visualize in the context of the solar system.



# STRING AND BEAD SOLAR SYSTEM

Time: 40-45 MINUTES

1. To start off, have each of the club members cut a 4.5 m long piece of string and have them collect their beads.
2. Pass out the Solar System on a String handout (Found in Appendix).
3. Have the club members calculate the scaled distance from the sun for each planet using 10 cm = 1 AU.
4. Once the youth have calculated their scaled distances, they can then begin to measure out the distances and tie their beads to the string.
  - a. Tie the sun bead to one end of the string.
  - b. Make sure club members start with Mercury and work their way out, tying off each bead and measuring their distances from the sun for each planet. Otherwise, their distances will turn out wrong.

## Key for the Solar System on a String Handout:

Planet/Object	Bead Color	Distance from the Sun	Scaled Distance (cm)
Sun	Yellow	0.0 AU	0
Mercury	Solid Red	0.4 AU	4
Venus	Cream	0.7 AU	7
Earth	Clear Blue	1.0 AU	10
Mars	Clear Red	1.5 AU	15
Asteroid Belt	Black	2.8 AU	28
Jupiter	Orange	5.2 AU	52
Saturn	Clear Gold	9.5 AU	95
Uranus	Dark Blue	19.2 AU	192
Neptune	Light Blue	30.1 AU	301



## Reflect

- What is an Astronomical Unit (AU)?
- What other things in astronomy could you model using a scaled representation?
- If light from the sun takes about eight minutes to reach Earth, how long does it take sunlight to reach Neptune? (about four hours)
- Why is the Earth's position in the solar system important?

## Apply

- Just as the solar system model you made gave you a big picture of the solar system, how can having a big-picture view of problems help you create solutions?
- How might modeling and measurement skills help you at home?

### 4-H MISSION MANDATES

#### Science

Building and modeling are both abilities and tools used by scientists and engineers. Creating a representation of the solar system with string and beads is both building and modeling.

#### ESSENTIAL ELEMENTS

##### Independence

By working on their own model of the solar system, club members practice using basic math skills and gain confidence through independent discovery.

##### Mastery

Using scale models is a great way to learn how to visualize vast distances. Making a scale model of the solar system will help participants master spatial visualization and scale.

#### References and Other Resources

Planets. (2016). Retrieved June 16, 2017, from <http://www.enchantedlearning.com/subjects/astronomy/planets/>

String and Bead Solar System Activity adapted from Utah State University Extension 4-H Aggie Adventures for Kids: Space Explorers Camp







## Solar System on a String

Planet/Object	Bead Color	Distance from the Sun	Scaled Distance (cm)
Sun	Yellow	0.0 AU	
Mercury	Solid Red	0.4 AU	
Venus	Cream	0.7 AU	
Earth	Clear Blue	1.0 AU	
Mars	Clear Red	1.5 AU	
Asteroid Belt	Black	2.8 AU	
Jupiter	Orange	5.2 AU	
Saturn	Clear Gold	9.5 AU	
Uranus	Dark Blue	19.2 AU	
Neptune	Light Blue	30.1 AU	

## Solar System on a String

Planet/Object	Bead Color	Distance from the Sun	Scaled Distance (cm)
Sun	Yellow	0.0 AU	
Mercury	Solid Red	0.4 AU	
Venus	Cream	0.7 AU	
Earth	Clear Blue	1.0 AU	
Mars	Clear Red	1.5 AU	
Asteroid Belt	Black	2.8 AU	
Jupiter	Orange	5.2 AU	
Saturn	Clear Gold	9.5 AU	
Uranus	Dark Blue	19.2 AU	
Neptune	Light Blue	30.1 AU	





## Stars, Galaxies, and Other Celestial Objects



### Supplies

Activity 1:

- Plain printer paper or white construction paper
- Sewing pins
- Pencils

Activity 2:

- One set of galaxy pictures for each group (found in Appendix).

### INTRODUCTION

When scientists discover new things, they often try to classify their discoveries. Classifying things can help identify similarities and differences between objects or organisms. During this club meeting, participants will explore how they might classify galaxies using pictures. They will also experiment with a safe method for observing the sun and will learn about sunspots.

### PRIOR TO MEETING

- For the first activity of this club meeting, make sure that the weather is going to be sunny and clear.
- Print out the galaxy cards and star field. Make sure to print out enough galaxy card sets and star field pictures so that each group can have its own set.

### WHAT TO DO

The sun, as our closest star, is an object of immense study and observation. Stars are gigantic bodies of gas, mainly hydrogen and helium. Because of the immense amount of matter that a star contains, gravity in the core of the star actually smashes atoms together causing a process called nuclear fusion. As fusion occurs, massive amounts of energy are released. This energy is eventually emitted into space as electromagnetic radiation, or light.

Because the sun is so hot, we have only been able to study it from a distance. Using special cameras and satellites, scientists are able to study the sun by taking images of the visible light, ultraviolet, and even X-Ray radiation emitted by the sun.

**WARNING:** Never look directly at the sun! Never look at the sun with a camera, binoculars, telescope, or anything else. Doing so can cause severe, permanent eye damage within seconds. Make sure that participants understand not to look directly at the sun.

Stars like our sun tend to group together to form galaxies such as the Milky Way. In the Milky Way alone, there are estimated to be between 100-400 billion stars. Scientists have calculated that the Milky Way is about 100 thousand lightyears across. From what we can see, there are tens of thousands of galaxies in the universe. Astronomers have developed systems to classify galaxies according to shape and size. Classifying galaxies might help us to better understand how galaxies form and evolve.





# PINHOLE SUN VIEWER

Time: 10-15 MINUTES

1. Pair up the club members with a partner. Each partnership will need two pieces of white paper and a pencil.
2. Have the partnerships use a pin to poke a hole in the center of one of their papers. For clarity, we will call the paper with the pinhole the viewer and the other paper will be called the screen.
3. When all the partnerships have poked a hole in one paper, head outside.
4. Once outside, one partner will be in charge of holding the viewer and the other partner will hold the screen. Place the screen on the ground in the sun. Hold the viewer in the air about a meter away from the screen so that the shadow of the viewer covers the screen. Use the shadow of the viewer to line up the viewer with the screen. Remember, do not look at the sun!
5. At this point, a small image of the sun should begin to appear on the screen. Tilt the screen if necessary to see the sun better and move the viewer slowly back and forth to get a clear image.
6. Once they can see the sun clearly, have the screen holder trace the sun and any sunspots they can see with their pencil. (The image might not be big enough to see sunspots, or there may not be any sunspots present to trace.)
7. Discuss with the club members what they saw:
  - a. What did they have to do to get a clear image of the sun?
  - b. Did they notice any sunspots? If so, how many did they see?
  - c. What did the image of the sun look like?
  - d. Did the image of the sun look like they thought it would?
8. If there is time, let the participants experiment with their sun viewers:
  - a. What happens if you make the pinhole bigger?
  - b. Is there a way to make the image of the sun bigger?





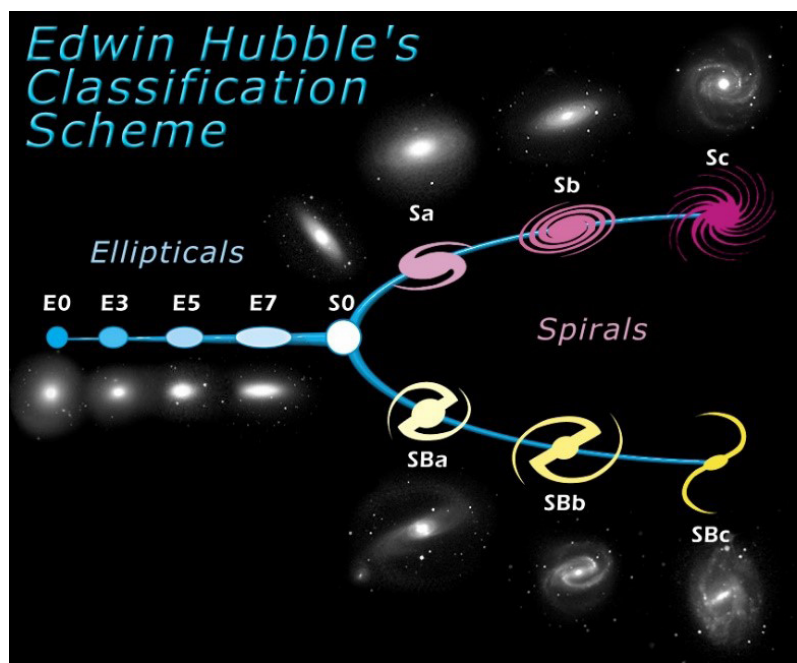
# GALAXY SORTING

TIME: 20-25 MINUTES

Galaxy Sorting

1. Divide the club members into groups of four to six and give a set of galaxy pictures to each group.
2. Explain to the club members that they are going to take on the role of astronomers for this activity. As astronomers, they are going to sort and classify the different galaxies that are shown in the pictures they have. They are free to classify and sort these galaxies in any way that makes sense to them, but they should do so as a group.
3. Give the groups about ten minutes to sort and classify the galaxies. Then discuss what classification system each group came up with.
  - a. What criteria did they use to classify the galaxies?
  - b. Where there any galaxies they had a hard time classifying?
  - c. What challenges did they face in trying to classify their galaxies?
4. Point out that, because astronomers can only observe galaxies from one viewpoint (Earth), we often can't see the entire shape of a galaxy. As seen from Earth, a spiral galaxy may just look like a disk.

There is not one right way to classify galaxies. The system that astronomers use today to classify galaxies was formed through trial and error and has improved as we have learned how galaxies form. Hubble's galaxy classification scheme is the most commonly used scheme for classifying galaxies in both professional and amateur astronomy.





## Reflect

- Why should we be careful when observing the sun?
- How can classifying new objects help us learn about them?
- How does our perspective here on Earth affect how we study the universe?

## Apply

- In what ways can sorting and organizing help you at home and at school?
- Can you think of any examples of classification systems used in the world around you?

### 4-H MISSION MANDATES

#### Citizenship

By working in groups for these activities, club members will learn how to make decisions working in a group or team.

#### Science

Classification and collaboration are both skills used by scientists. Sorting galaxies makes use of categorization or classification. Having students work in groups is collaboration.

### ESSENTIAL ELEMENTS

#### Belonging

Remember to have club leaders join a group.

#### Independence

By participating in a group and helping to make decisions, club members will develop the ability to express their opinions and listen to the opinions of others.

#### Mastery

Scientists learn through trial and error. By participating in these activities, club members will learn that there is not always one right answer to a problem and that good solutions often take time to develop.

### References and Other Resources

Sun. (2017, August 07). Retrieved August 08, 2017, from <https://en.wikipedia.org/wiki/Sun>

Galaxy Sorting activity adapted with permission from NSF-funded activities in Project STAR: The Universe in your Hands, © The President and Fellows of Harvard College.

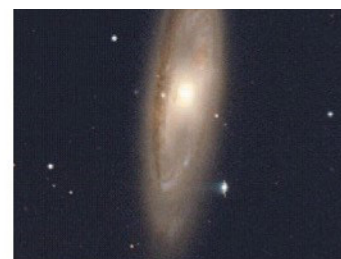




**M32**



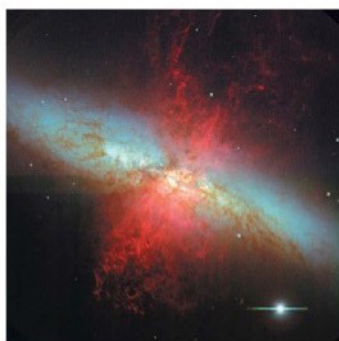
**M101**



**M65**



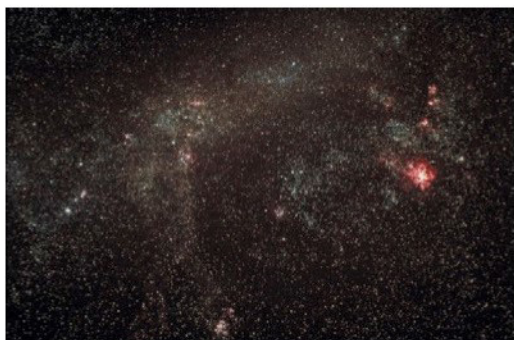
**M109**



**M82**



**M51**



**Large Magellanic Cloud**



**Arp 252**



**NGC 4565**



**M81**







**M87**



**M104**



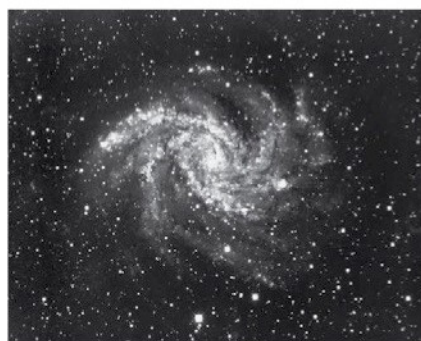
**NGC 2146**



**NGC 1365**



**NGC 4650a**



**NGC 6946**



**Leo 1**



**NGC 253**



**M59**



**NGC 1073**





## Constellations and Stargazing



### Supplies

- |   |  |
|---|--|
| Activity 1:   | • Orion constellation picture (one for each club member)                   |
| • Uncle Al's Sky Wheel printout (one for each club member)  | • Glue (Quick drying craft glue is best, but white Elmer's glue will work) |
| • Scissors  | • Tape   |
| • Tape or glue  | • Scissors   |
| Activity 2:   | • Black button thread  |
| • 8.5" x 11" pieces of cardboard (two for each club member) | • Pony beads (white if possible)   |
| • Big Dipper picture (one copy for each member)             | • Pencils  |

### INTRODUCTION

Stargazing is perhaps the easiest way for anyone to get involved in amateur astronomy. Stargazing does not require a telescope or other equipment, although it is best done outside the range of city lights on a clear night. During this club meeting, participants will make their own Sky Wheel that they can use to go stargazing. Club members will also make two 3D Constellations to learn about perspective and to see that, although the stars in a constellation appear to be close together when seen from Earth, they may actually be far apart.

### PRIOR TO MEETING

- Print copies of Uncle Al's Sky Wheel. If possible, print them out on cardstock. ([http://www.lawrencehallof-science.org/do\\_science\\_now/science\\_apps\\_and\\_activities/star\\_wheels](http://www.lawrencehallof-science.org/do_science_now/science_apps_and_activities/star_wheels))
- Print a copy of the Big Dipper and Orion pictures for each club member.
- Ask participants to bring cardboard with them to make their 3D Constellations.

### WHAT TO DO

Ancient cultures used the stars to form constellations often named after mythological characters. These constellations, and the stories associated with them, have been passed down by people who used them to navigate, tell the time of the year, etc. Because of that, constellations such as Orion, Scorpio, and Ursa Major are now well-known parts of the night sky.

A constellation is defined as "a group of stars forming a recognizable pattern that is traditionally named after its apparent form or identified with a mythological figure" (Oxford English Dictionary). The International Astronomical Union recognizes 88 official constellations today which are used to divide up and define regions of the sky. When a new planet or star is discovered, astronomers will refer to the constellation region it resides in to let others know where the planet or star is located. The Big Dipper and Little Dipper, commonly thought of as constellations, are actually called asterisms and are part of the larger Ursa Major and Ursa Minor constellations respectively.



## ASSEMBLE A SKY WHEEL

Time: 10-15 MINUTES

1. Pass out a copy of Uncle Al's Sky Wheel to each club member.
2. Have them cut out and assemble the wheel by following the printed instructions that accompany the wheel.
3. They can then take their Sky Wheel stargazing at night!

## 3D CONSTELLATIONS

TIME: 20-30 MINUTES

1. Hand out a copy of the Big Dipper picture to each club member.
2. Have them carefully glue the picture to a piece of cardboard so it has a cardboard backing. Use as little glue as possible so that the glue will dry fast and the pictures won't wrinkle.
3. Once the glue is mostly dry, have club members carefully poke small holes through the picture and cardboard backing where each star in the Big Dipper is located. They can use a large needle or small ballpoint pen to poke the holes. Diagrams have been included showing each star of interest with its name and distance.
4. Each club member should cut eight pieces of string about 75 cm long.
5. Stick each piece of string through a hole so that about one-inch sticks out the back side. Tape the one-inch length of thread to the cardboard.
6. Place a bead on each string by first running the thread through it, then around and through it again. Done correctly, the thread should loop around the bead. This way, club members can move their beads back and forth along the string, but they will stay in place when let go.
7. Once a bead is placed on each thread, participants should bring the free ends of all the threads together. Tie these ends in a tight knot around a washer about 56 cm from the cardboard.
8. Have the participants calculate the scaled distance to each star using a scale of 2.5 cm = 100 lightyears. One of the easiest ways to do so is to set up a ratio:

$$\frac{\text{actual distance}}{100 \text{ lightyears}} = \frac{\text{scaled distance}}{2.5 \text{ cm}}$$

Therefore, the scaled distance would be equal to the actual distance in lightyears divided by 100 lightyears times 2.5 cm. For younger participants, you could just give them the scaled distances listed in the table below.



9. Once the club members have calculated the scaled distances, have them place their beads in the correct locations. Each distance should be measured starting from the washer.
10. Now that the beads are in place, you should be able to see each star pattern if you hold the picture in front of you and look through the washer. This same process should be repeated for the Orion constellation. What happens if you look at the stars from one side? How about from an angle?

<b>Star Pattern</b>	<b>Star Name</b>	<b>Distance from Earth (lightyears)</b>	<b>Scaled Distance (cm)</b>	<b>Scaled Distance (in)</b>
<b>Orion</b>	Alnilam	1340	34	13.4
	Alnitak	800	20.3	8.0
	Bellatrix	240	6.1	2.4
	Betelgeuse	640	16.3	6.4
	Meissa	1050	26.7	10.5
	Mintaka	915	23.2	9.2
	Saiph	700	17.8	7.0
	Rigel	800	20.3	8.0
<b>Big Dipper</b>	Alcor	81	2.0	0.8
	Alioth	81	2.0	0.8
	Alkaid	101	2.5	1.0
	Dubhe	124	3.1	1.2
	Megrez	81	2.0	0.8
	Merak	79	2.0	0.8
	Mizar	78	2.0	0.8
	Phecda	84	2.0	0.8







## Reflect

- How does your perspective change the pattern you see when looking at your 3D Constellation?
- Why do you think the stars in the Big Dipper are closer together than the stars in Orion?
- Do you think that the same constellations we can see here on Earth are visible from other planets?

## Apply

- How does your perspective of the world affect what you think and do?
- Why is it important to recognize that our perspective, or the way we see things (such as the stars), might be different than the perspective of others around us?

### 4-H MISSION MANDATES

#### Science

Modeling and measurement are both things that scientists and engineers do extensively. Making a 3D representation of constellations and star patterns is modeling, which also involves measurements.

### ESSENTIAL ELEMENTS

#### Mastery

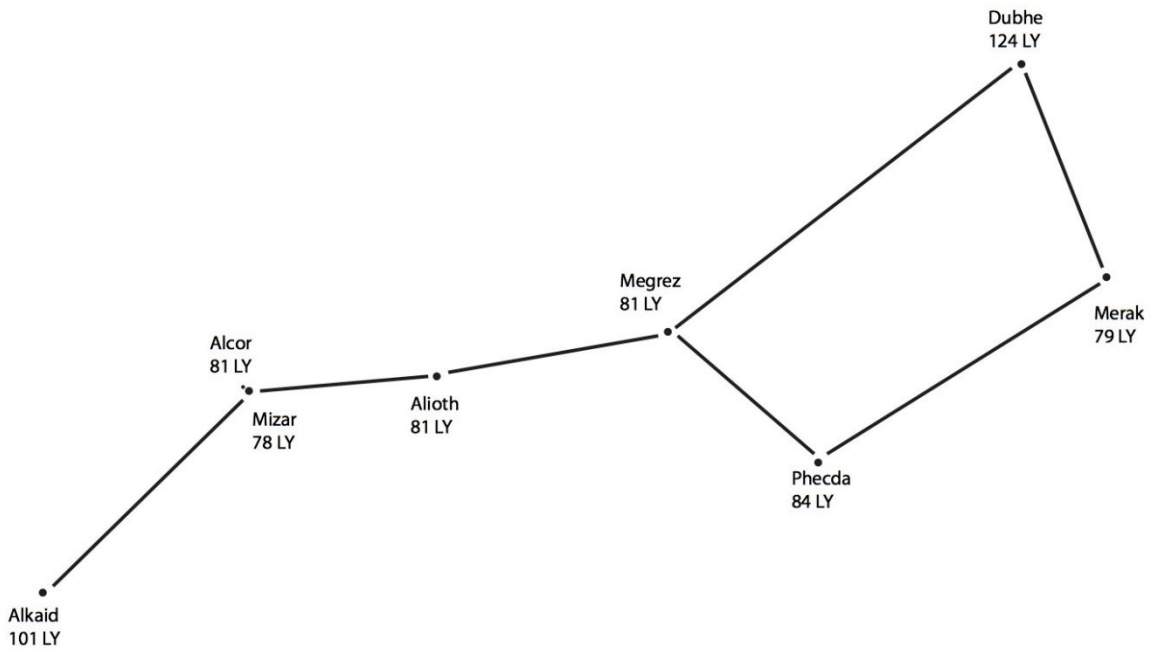
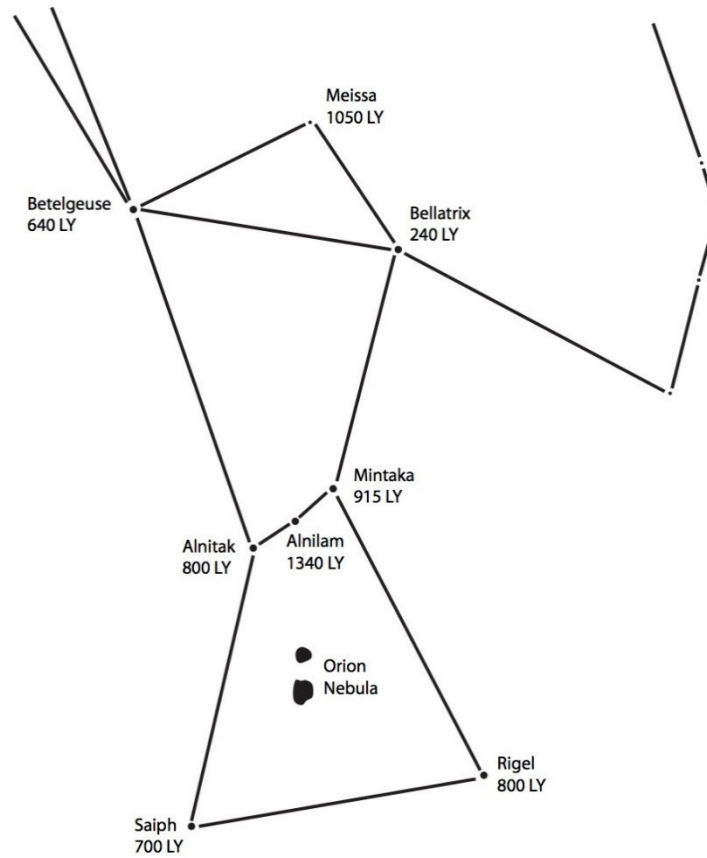
By using ratios and scale, participants will learn that basic math skills can be used to create a hands-on learning experience and a replica of something far away.

#### References and Other Resources

3D Constellations activity adapted with permission from NSF-funded activities in Project STAR: The Universe in your Hands, © The President and Fellows of Harvard College.

Constellation. (n.d.) Oxford Dictionaries. Retrieved August 8, 2017, from <https://en.oxforddictionaries.com/definition/constellation>









## Telescopes and Modern Astronomy Technology



### Supplies

Activity 1:

- A pair of reading glasses (“Weak” glasses; those with low numbers—will work the best)
- A magnifying glass
- A flashlight
- Masking tape
- A piece of waxed paper

Activity 2:

- Computers or tablets
- Internet access

### INTRODUCTION

Telescopes are perhaps the most commonly used astronomical tools in the world. The first known telescopes were invented in the Netherlands in 1608. Galileo Galilei developed his own telescope in June of 1609 after hearing about the Dutch invention, and within a year he had improved the design.

There are two basic types of telescopes in wide use today: refractive and reflective. Refractive telescopes use lenses to refract light that enters the telescope to create a magnified image. This type of telescope is limited in how large it can be before images will become distorted. Reflective telescopes use mirrors to collect light and magnify images.

Modern astronomers also use telescopes that can “see” light waves that are out of the visible spectrum. Radio telescopes are basically large dishes or antennas that are used to receive cosmic radio waves. One such radio telescope was used at the Parkes Observatory in 1969 to receive live television transmissions from the NASA Apollo 11 Mission. There are also Microwave, X-ray and Gamma ray telescopes in use by astronomers today. X-ray and Gamma ray telescopes are usually deployed on satellites because the Earth’s atmosphere and magnetic field blocks these types of waves.

In this lesson, participants will learn how a basic telescope works. They will be able to experiment with some basic optics to see how light and images are manipulated by lenses. Club members will also learn about the Hubble Space Telescope, one of the most iconic tools of modern astronomy.

### PRIOR TO MEETING

- Make sure you have a pair of glasses you can use for activity 1. Prescription glasses are usually not good for this activity.



## BUILD YOUR OWN TELESCOPE

TIME: 15-20 MINUTES

1. Place the flashlight on a table and turn it on.
2. Tape one side of the glasses to a meter stick, chair, or another object to keep it steady. Place the glasses so they are at about the same height as the flashlight and about 13 feet away from the table. The exposed lens will be the objective lens of our telescope.
3. Hold a piece of wax paper in front of the exposed lens on the side opposite to the flashlight. Move away from the lens until the light forms an image of the flashlight. This is the focal point of the objective lens.
4. Have someone hold the paper at the focal point. Face the back side of the paper and, with the magnifying glass, look at the image of the flashlight. Adjust the magnifying glass until the image of the flashlight is magnified.
5. Remove the wax paper. You should now see a brighter image of the flashlight.
6. Try to look at other objects around the flashlight by moving the magnifying glass around a little bit.
7. Give the participants time to see if they can improve their telescope at all.

## THE HUBBLE SPACE TELESCOPE

TIME: 15-20 MINUTES

1. Have the club members go to [http://hubblesite.org/the\\_telescope/](http://hubblesite.org/the_telescope/) and explore how the Hubble Space Telescope works.
2. Give them a few questions to explore:
  - a. When was the Hubble Space Telescope launched? (1990)
  - b. Is the Hubble Space Telescope a refractive or reflective telescope? (reflective)
  - c. Why are space telescopes better than ground telescopes? (the atmosphere distorts light)
  - d. What problem did the Hubble Space Telescope face after launch?
  - e. How do scientists use the Hubble Space Telescope to study the universe?





## Reflect

- What is refraction? (Refraction is the bending of light as it travels from one substance (e.g., air) to another (e.g., glass).)
- What is reflection? (Reflection is where light bounces off a surface or object.)
- How is a reflective telescope different from a refractive telescope?

## Apply

- Can you think of any examples of where you have seen refraction occur in your life? (e.g., straw in a glass of water, rainbow, glasses)
- What are some examples of objects that reflect light well? (e.g., mirrors, polished metal, water)

## 4-H MISSION MANDATES

### Science

Building, modeling, observing, and testing are all things done by scientists and engineers. By making and testing a simple telescope, club members learn through observation how telescopes work and how lenses refract light.

### ESSENTIAL ELEMENTS

#### Belonging

Remind club members that when working in teams, positive communication and listening are very important. Try and make sure that every club member has a task to help with.

#### Mastery

When making their telescope, participants may not get it exactly right the first time. Trial and error will help them to learn that not everything goes great the first time around. Through experimentation, participants will better understand how lenses work.

### References and Other Resources

Brand, J., & Hipschman, R. (n.d.). Make Your Own Telescope.

Retrieved June 15, 2017, from <http://www.exploratorium.edu/exploring/space/activity.html>

Telescope. (2017, August 07).

Retrieved August 08, 2017, from <https://en.wikipedia.org/wiki/Telescope>





## More to *Discover*

Congratulations on completing your Discover 4-H club meetings! Continue with additional curriculum in your current project area, or discover other 4-H project areas. Check out the following links for additional 4-H curriculum.

1. [www.discover4h.org](http://www.discover4h.org)
2. <http://www.4-h.org/resource-library/curriculum/>
3. <http://utah4h.org/curriculum/>

## Become a 4-H Member or Volunteer

To **register** your Utah club or individuals in your club, visit and contact your county Extension office.

<http://utah4h.org/about/>

<http://utah4h.org/join/index>

For help registering in 4-H online, visit:

<http://utah4h.org/staffresources/4honlinehelp>

Non-Utah residents, please contact your local 4-H office:

<http://www.4-h.org/get-involved/find-4-h-clubs-camps-programs/>



## Stay *Connected*

### Visit Your County Extension Office

Stay connected with 4-H activities and news through your county Extension office. Ask about volunteer opportunities, and don't forget to register for your county newsletter. Find contact information for counties in Utah here:

<https://extension.usu.edu/locations>

## Enjoy the Fair!

Enter your project or create a new project for the county fair. Learn about your county fair and fair judging here:

<http://utah4h.org/events/index>



## Participate in Local or State 4-H Activities, Programs, Contests, or Camps

For Utah state events and programs, visit:

<http://utah4h.org/events/index>

<http://utah4h.org/projects/>

For local Utah 4-H events and programs, visit your county Extension office:

<https://extension.usu.edu/locations>

Non-Utah residents, please contact your local 4-H office:

<http://www.4-h.org/get-involved/find-4-h-clubs-camps-programs/>



## Discover *Service*

### Become a 4-H Volunteer!

 <http://www.youtube.com/watch?v=UBemO5VSyK0>

 <http://www.youtube.com/watch?v=U8n4o9gHvAA>

To become a 4-H volunteer in Utah, visit us at:

<http://utah4h.org/join/becomevolunteer>

### Serve Together as a 4-H Club or as an Individual 4-H Member

Use your skills, passions, and 4-H to better your community and world. You are needed! Look for opportunities to help in your area or participate in service programs that reach places throughout the world (religious groups, Red Cross, etc.).

### Hold a Club Service Project

USU Collegiate 4-H Club hosted "The Gift of Giving" as a club activity. Club members assembled Christmas stockings filled with needed items for CAPSA (Community Abuse Prevention Services Agency).

<http://tinyurl.com/lu5n2nc>



## Donate 4-H Projects

Look for hospitals, nursing homes, or other nonprofit organizations that will benefit from 4-H projects. Such projects include making quilts for CAPSA or Primary Children's Hospital, or making beanies for newborns. During Utah 4-H State Contests, 40 "smile bags" were sewn and donated to Operation Smile.

## Partner with Local Businesses

92,000 pounds of processed lamb, beef, and pork were donated to the Utah Food Bank in 2013 by multiple companies.

<http://tinyurl.com/pu7lxyw>

## Donate Money

Clubs or individuals can donate money gained from a 4-H project to a worthy cause. A nine-year-old 4-H member from Davis County donated her project money to help a three-year-old battle cancer.

<http://tinyurl.com/mqtfwxo>



## Give Us Your *Feedback*

Help us improve Discover 4-H curriculum. We would love feedback or suggestions on this guide.

Please go to the following link to take a short survey: [Click here to give your feedback](#)

or go to: <https://goo.gl/iTfiJV>