All About the Solar System!

Target Grade: Elementary
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Site: Oxford B
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Brief Overview

This lesson will teach students about the various components of our solar system. They will gain a greater understanding of how the Earth's rotation and revolution around the sun lead to different seasons and constellations visible to us in the sky. Lastly, students will explore how scientists have come to learn all these facts about the solar system through satellites.

Teaching Goals

- **Earth's rotation**: As Earth revolves around its axis, we experience different seasons. Also, because of the angle the Earth is at as it revolves, there are different constellations that are visible in the sky. These constellations can help humans orient themselves on Earth
- **Planets**: There are 8 planets in our solar system. The **inner planets** are Mercury, Venus, Earth, and Mars while the **outer planets** are Jupiter, Saturn, Uranus, and Neptune.
- **Comets**: Comets are mostly made of dirt and ice and can develop a tail when too close to the Sun.
- **Satellites**: Satellites are needed to image different planets and learn about space. All satellites have a power source, a communication device, and an orientation finder.

Careers and Applications

Astronomers study the solar system in order to understand more about how our universe formed. They use knowledge of stars and constellations to determine the age of certain sections of our universe. Scientists and engineers also help design the satellites and other equipment used in order to get a closer look at space.

Agenda

- Introduction
- Demo 1: Seasons and Constellations (10-15 min)
- Module 1: Comets (15-20 min)
- Demo 2: Modeling the Solar System (5-10 min)

- Module 2: Designing Satellites (20-25 min)
- Conclusion

Introduction

Right now, our 4th/5th graders are learning that the Earth revolves around the Sun and rotates on its axis. The goal of this lesson is to use those concepts to explain why we have seasons and see constellations. We will also review the order of the planets and show their relative sizes through an interactive demo. Finally, we will discuss how satellites are important tools for studying space, and will give kids the opportunity to build their own satellites.

Demo 1: Seasons and Constellations

Introduction

Using a globe and a light source to represent the sun, we will show how the Earth revolves around the sun, and how this determines what season we experience. After a brief discussion about stars and constellations to pique their interest, we will visually demonstrate how the location of the Earth affects the constellations we see.

Teaching Goals

1. We have seasons because the Earth is tilted on its axis.
2. Before smartphones and Google Maps, people used constellations to find their way through unknown territories and to determine the time of year
3. Some constellations are present year-round, while others are seasonal

Background for Mentors

The Earth's four seasons: summer, winter, fall, and spring can be explained by the tilt of the Earth on its axis. When the Earth is tilted towards the sun, we experience summer and when it is tilted away from the sun we experience winter in the Northern Hemisphere. During fall and spring, the sun shines equally on both the Northern and Southern Hemispheres. There are over 80 constellations visible in the night sky, many of which were discovered and named during ancient times. Ursa Major and Ursa Minor are two of the most well-known constellations because they are present year-round and are used to identify the North Star. Thus, these constellations have been used throughout history by sailors and explorers to navigate unknown terrains. There are several seasonal constellations as well including Scorpius (summer), Orion (winter), Pegasus (fall), and Leo (Spring).

Materials

- 1 Light Source
- 1 Globe
- 4 Paper Labels, one for each season
- Constellation printouts attached below

Procedure

1. Have the students sit in a circle with the light source in the middle and ensure that everyone can see
2. Position the light source next to the globe such that the students can see the light

shining on the globe.
3. This light source will represent the sun!
4. Ask them where they are from. They should be able to locate North America, and hopefully Berkeley.
5. You can mention that our day goes by through a spin of the globe. Tell them that while it's daytime in North America, it may be night time in Asia.
6. Physically move the entire globe around the light source (our sun) to simulate our seasons.
7. Label each of the 4 areas around the light source, and make sure to note the tilt of the Earth.
8. As you move the globe, make sure the students understand that this tilt is the reason for seasonal changes.
9. Introduce Ursa Major as and Ursa Minor as constellations that are present year-round
10. Talk about each of the seasonal constellations as you complete the circle around the sun

Demo 2: Modeling the Solar System

Introduction

We will be using variously sized fruits to show the relative sizes of the eight planets in our solar system. The smallest planet (Mercury) will be represented by a peppercorn, while the largest planet (Jupiter) will be represented by a beach ball. The relative spacing between the planets will also be shown as the distance between the fruits. This module serves to get the kids thinking about how the solar system is organized, and how different planets compare to each other.

Teaching Goals

1. There are **eight planets** in the solar system and they all located at different distances from the sun
2. The **inner planets** are: Mercury, Venus, Earth, Mars
3. The **outer planets** are: Jupiter, Saturn, Uranus, Neptune

Background for Mentors

There are eight total planets, from inside to out: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Each of them are different sizes, from Mercury being the smallest to Jupiter being the largest. In order to be considered a planet, a celestial body must a) orbit a star, b) be big enough that gravity has forced it into a spherical shape c) be big enough that its gravity has cleared away other nearby objects of a similar size. Pluto was once considered a planet, but has since been classified as a "dwarf planet" because it does not satisfy the third criteria.The following diagram will show which fruits represent which planets.

Materials

- Large beach ball (Jupiter)
- Large grapefruit
- Apple
- Lime
- Blueberry
- Cherry
- Cherry tomato
- Peppercorn

Procedure

1. Let the kids guess what the first planet is, and if they get it right let them guess which fruit represents it.
2. Repeat the above process for the rest of the planets
3. As you go through the planets you can talk about interesting things you know about them (like Jupiter's "eye")

Module 1: Comets!

Introduction

In this module, students will learn what comets are made of and a little about how they behave. Mentors will create a model (made of dry-ice and dirt) that mimics the composition of a real comet nucleus, while teaching the students about comet behavior. The students will gather around to watch the model created before their eyes!

Teaching Goals

1. Comets are mostly made of dirt and ice
2. A comet develops a tail when it gets close to the Sun
3. A comet's tail always points <u>away from the Sun</u>
4. Comets move in elliptical orbits with random orientations
5. Meteor showers are caused when Earth moves through the debris left behind by comets

Background for Mentors

Comets are small solar-system bodies which are composed of frozen gases (ice), rock, and dust. They are dark in color, irregular in shape, and made of ancient material from the formation of the solar system. Each comet has a tiny frozen part, called a nucleus. The nucleus contains icy chunks (frozen gases with bits of embedded dust). A comet warms up as it nears the Sun and develops an atmosphere, or **coma**. The Sun's heat causes the comet's ice to change to gases so the coma gets larger. The coma may extend hundreds of thousands of kilometers (much larger than the comet's nucleus, the diameter of which is usually only a couple kilometers in length).

Comets move in random orbits around the sun, travelling along very elongated elliptical paths which are usually not aligned with the plane of the solar system. Their orbits can be tilted in all directions with respect to the plane of the solar system. New comets are unpredictable (a comet can approach the inner solar system at any time and from any direction). Most comets orbit the Sun in a distant outer region of the solar system called the Oort cloud. The Oort cloud is a spherical shell of comet nuclei that surrounds the entire solar system. These Oort cloud comets have long orbital periods: they can take as long as 30 million years to complete one trip around the Sun!

Interesting fact: Comets may have brought water and organic compounds, the building blocks of life, to the early Earth and other parts of the solar system.

Materials

- 2 kg (4-5 pounds) dry ice
- 2 liters of water
- A handful or two of soil
- 2 spoonfuls of molasses, dark corn syrup or pancake syrup
- 1 spoonful of rubbing alcohol
- Plastic dishpan or other large plastic container
- Wooden or sturdy plastic spoons (**not metal!**) for mixing
- Thick, winter gloves
- Protective eye goggles
- Hammer

Procedure

***** Have mentors introduce some of the teaching goals in the classroom before beginning the module (get the students excited about comets!).**

***Also suggested that you clearly tell the students that they are NOT to touch the dry ice under any circumstances during the module. Mentors will be doing the procedure.

1. Find a spacious place outdoors to do the module
2. Line the large, plastic bowl with a plastic bag
3. In the bag-lined bowl, mix together about one half liter of water, half of the dirt, and all of the syrup and rubbing alcohol.
4. Place your dry ice in a double plastic bag. Wrap it in the cloth towel and put it on the ground.
5. Use the hammer to smash the dry ice into tiny pieces.
6. Pour the crushed dry ice into the lined container with the water-dirt mixture. It will make lots of vapor.
7. Use wooden or plastic spoons to stir the mixture. Keep stirring until it gets thick.
8. Lift the plastic bag out of the container.
9. Using thick gloves, pack the slush (still in the plastic bag) into a ball. Keep packing until you have a solid, frozen lump.
10. Remove the lump (comet) from the plastic bag.
11. Sprinkle more dirt onto your comets. Pour water over them until they have a frozen

layer of water all over them. TADA! YOU HAVE A COMET NUCLEUS!

***Depending on the consent of the school, the amount of students there are at site, the degree of rowdiness of the students, etc., your group may decide to let each of the students briefly hold the finished comet model <u>while using both gloves</u>.

Additional Notes for Mentors

SAFETY WARNING: Dry ice is -79 degrees C (-110 degrees F). Even brief exposure will cause “burns.” Be careful when handling it. Always wear gloves to protect your hands, and safety goggles to protect your eyes.

Module 2: Designing satellites

Introduction

In this module, mentees will have the chance to design and build their own satellites by drawing inspiration from real satellites that have been sent into space to collect data. Not all of the materials are required, and other materials can be added to give students more creativity with their designs.

Teaching Goals

1. Scientists and engineers use satellites to image different planets and learn about space.
2. While satellites can look very different from one another, they each have a power source, a communication device, an orientation finder, and carry science instruments
3. Satellites need to be launched into space to collect data, and must therefore be built to be as durable, lightweight, and inexpensive as possible

Background for Mentors

A satellite is any object that orbits a planet or star. In addition to the Earth and moon which are natural satellites, there are thousands of artificial satellites in space. Artificial satellites allow scientists and engineers to image objects in space, study phenomena like magnetic fields, and discover new planets. Satellites come in different shapes and sizes but all share some common features. All satellites have a power source, a communication device, and an orientation finder. The power source can be solar panels or a battery, and the communication device is often an antenna to send and receive information from Earth.

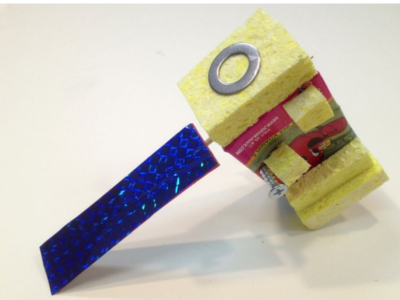
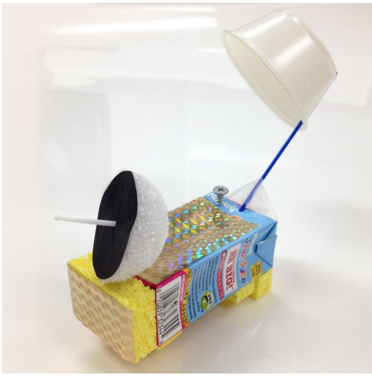
Materials

- Juice boxes or other small boxes (4)
- Toothpicks (10)
- Chopsticks (3)
- Plastic cups and bowls (4)
- Popsicle sticks (10)
- Straws (10)
- Paperclips (5)

- Construction paper (10 sheets)
- Balloons (4)
- CDs or DVDs (4)
- Sponges (4)
- Tape (2 rolls)
- Elmer's glue (1 bottle)
- Rubber bands (3-4)
- Q-tips (6)

Procedure

1. Print out some images of satellites (attached) and discuss the components of each with the class.
2. Tell students they can build their satellites however they choose as long as they incorporate each of the required components (a power source, a communication device, an orientation finder, and one or more science instruments)
3. Challenge students to make their satellites as lightweight as possible, or using as few materials as possible
4. Have each student present their final creations to the rest of the group. They should explain the function of each material they used.


Possible satellite designs

Additional Notes for Mentors

Students may choose to work together or individually. Mentors can motivate students by allowing them to take their satellites home at the end of site.

Conclusion

Wrap up by recapping the teaching goals and expanding about the uses of satellites.

References

- Build your own spacecraft. Kristen Erickson, NASA Space Place. https://spaceplace.nasa.gov/build-a-spacecraft/en/
- Constellation Patterns. Kara Nelson, BetterLesson https://betterlesson.com/lesson/resource/3192471/teacher-demonstration-mov
- Planets of the Solar System Shown to Relative Scale Using Fruit. Glen Tickle,

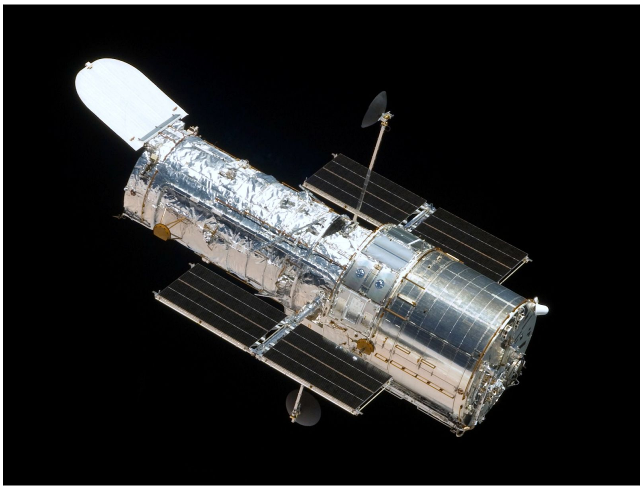
Laughing Squid.
https://laughingsquid.com/planets-of-the-solar-system-shown-to-relative-scale-using-fruit
- Lesson Plan D2 Comets and Meteors. Starry Night High School

Summary Materials Table

Material	Amount per Group	Expected $$	Vendor (or online link)
Construction Paper	10 sheets	--	120 Bechtel
Elmer's glue	1 bottle	-	120 Bechtel
Juice boxes or other small boxes	4	-	Collect over the next week
Toothpicks	10	-	120 Bechtel
Rubber bands	4	-	120 Bechtel
Q-tips	3	-	120 Bechtel
Globe	1	$10	Amazon
Dry Ice	-	-	Maya's Lab
Water	-	-	Available in classroom
Soil	-	-	Near/around school, mentor's backyard.
Chopsticks (3)	3	-	120 Bechtel
Plastic cups/ bowls	4	-	Collect over the next week / Bechtel
Popsicle sticks	10	-	120 Bechtel
Straws	10	-	120 Bechtel
Paperclips	5	-	120 Bechtel
Balloons	4	-	120 Bechtel

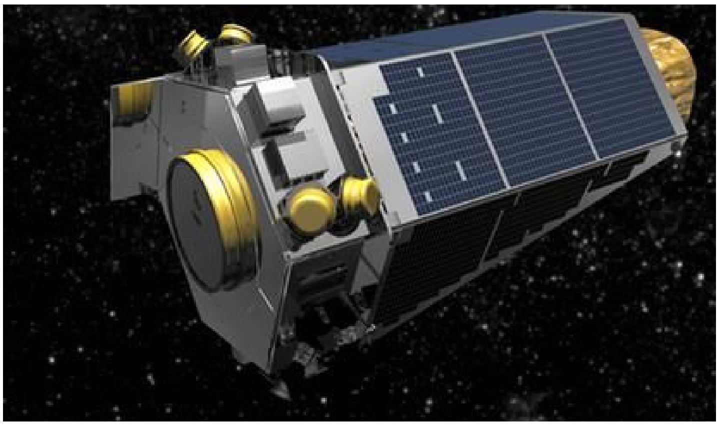
CDs or DVDs	4	-	120 Bechtel
Sponges	4	-	120 Bechtel
Tape	1-2 rolls	-	120 Bechtel
Large beach ball	1	$5	Amazon https://www.amazon.com/INTEX-FBA_59020EP-Glossy-Colorful-Inflatable/dp/B01M08B6MB/ref=sr_1_7?ie=UTF8&qid=1541385623&sr=8-7&keywords=inflatable+beach+balls
Large grapefruit	1	$2	Safeway
Apple	1	<$1	Safeway
Lime	1	<$1	Safeway
Blueberry	1	<$0.5	Safeway
Cherry	1	<$0.5	Safeway
Cherry tomato	1	<$0.5	Safeway
Peppercorn	1	-	Maya’s kitchen

Satellites



Hubble Telescope

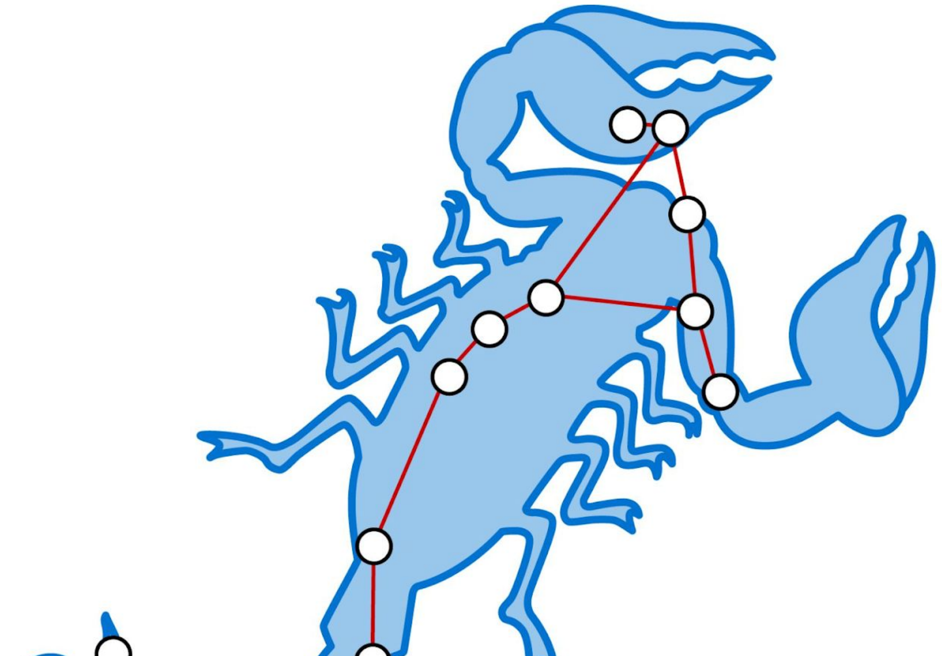
Soil Moisture Active Passive



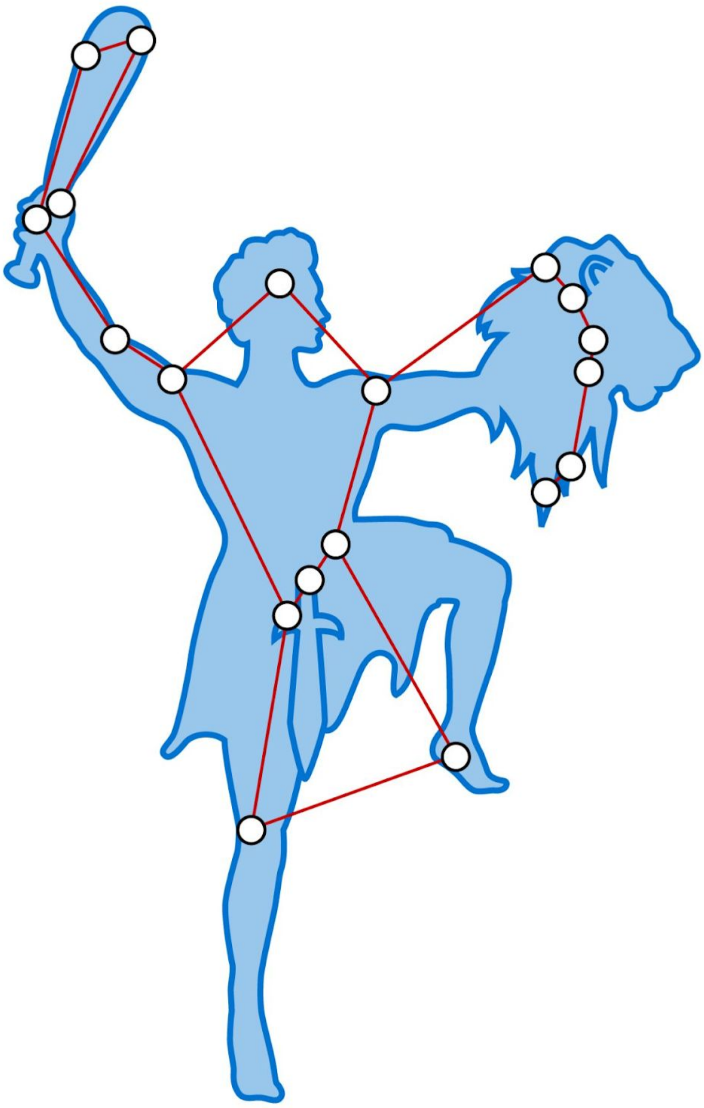
FASTSAT

Kepler Telescope

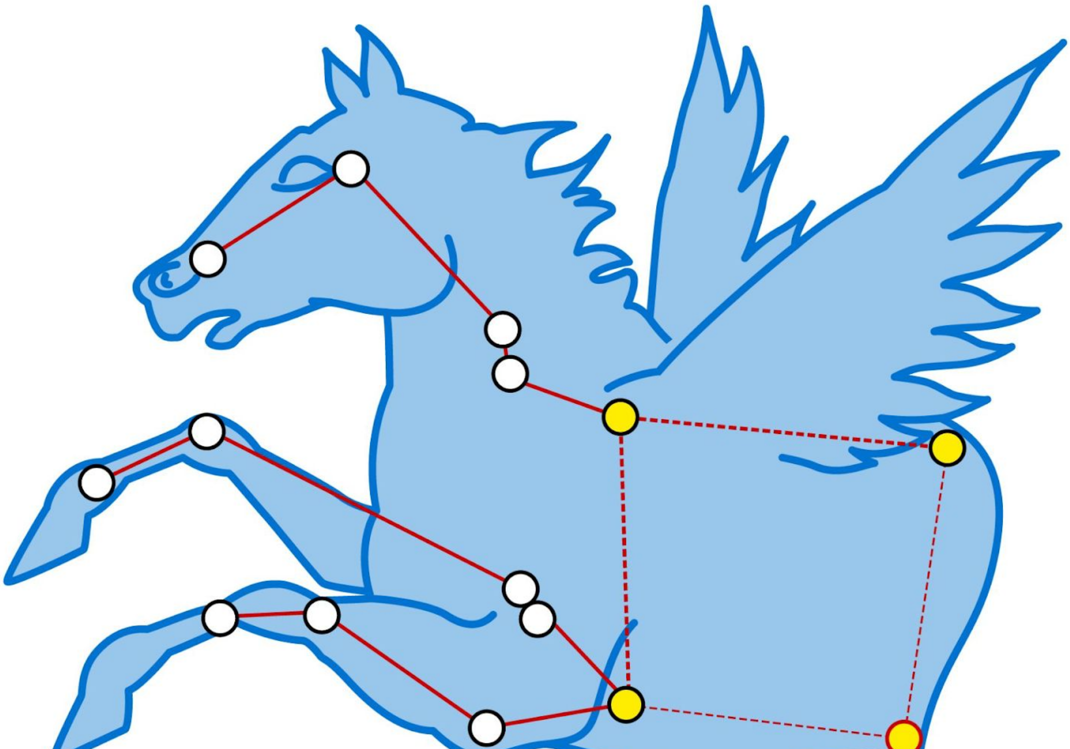
Scorpius -- Summer



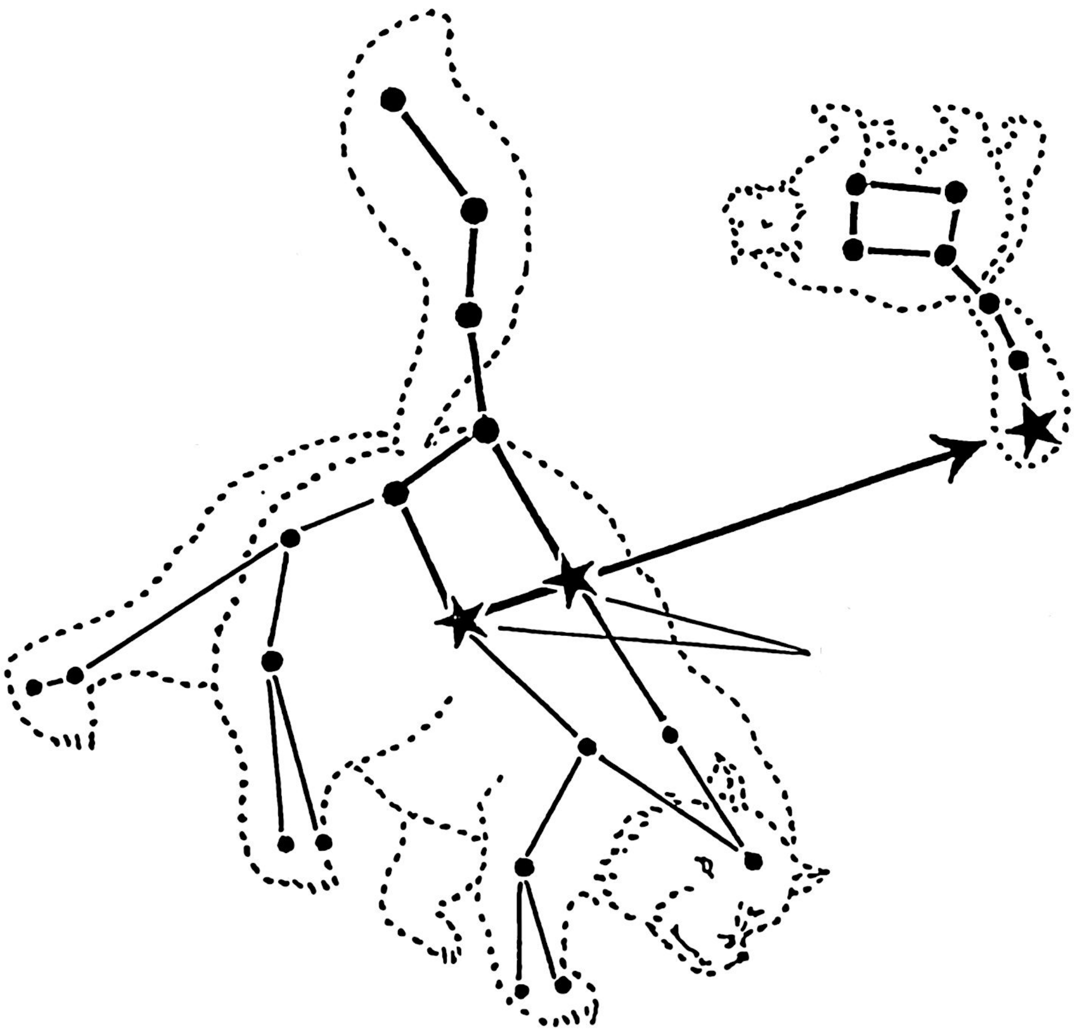
Orion -- Winter



Pegasus -- Fall



Ursa Major and Ursa Minor -- Year-round



Leo -- Spring