Exploring the Night Sky: Fall/Winter

This lesson plan is to be used during the Fall/Winter Celestial Seasons: **Autumn Equinox (Sept. 22 or 23) through the Spring Equinox (Mar. 20 or 21)**

Program Purpose: The purpose of this program is to give students a better scientific and cultural understanding of the elements in the night sky.

Program Length: 1 hr

Program Age: 6th-12th

Maximum number of participants: 150 including adults (max. for lodge)

Objectives: After completing this activity students should be able to:

- Explain how moon phases occur
- Describe and explain at least two common misconceptions that people have about the moon
- Explain what a star is
- Explain 3 ways that the night sky has been used throughout history
- Recognize the stories and myths surrounding stars
- Be able to locate some of the constellations in the night sky

Preparation
Before class arrives, set up computer and projector and gather materials.

Materials: Earth beach ball, moon on a stick, projector or strong flashlight to represent the sun, constellation myth cards, binoculars if desired, and telescope. Paper and pencils for make your own constellation.

Basic Outline

I. Intro
II. Moon Facts
III. Lunar Cycles
IV. Stars & the Sun
V. Constellations
VI. Stories about the Stars
VII. Stargazing
VIII. Conclusion

Introduction
Optional: Pass out myth cards and instruct selected students to remember the name on the card, but not to read the backside yet. These students will read the myth when you instruct them to. You may want to have a flashlight handy to pass to those reading the cards if you have the lights very low in the lodge.

The night sky has been sparking people's imaginations and curiosity for centuries. It still does the same thing to this day. Tonight, we will learn more about the objects that light up our night sky, starting with the moon. For the following questions give a thumbs-up if the statement is true and a thumbs-down if it is false.

Moon Facts
True or False: The moon has lots of holes in it and is therefore made of cheese. **FALSE**. Some cartoons may show the moon as cheese, but it is actually a solid ball of rock covered with many other rocks from the size of huge boulders to tiny pebbles. The surface is covered with a couple inches of dust that is very soft. The holes are actually millions of craters that were formed from meteors hitting the moon's surface a long time ago when the solar system was young. The moon also has huge mountains, valleys and hills, called highlands. There are also dark smooth areas called maria or seas. The first Apollo mission landed on the Mare Tranquilitatis (the Sea of Tranquility), they found out that these areas were not seas but ancient lava flows, but the name still stuck.

True or False: The moon is about the same size as the Earth. **FALSE**, the moon is much smaller. If we were to put the moon flat (2160 miles in diameter) on the Earth it would be almost as wide as the United States.

True or False: The moon is our closest celestial neighbor. **TRUE!** It is about 230,000 miles away, which is very close when it comes to talking about distances in space. It took two days for the astronauts, traveling in the fastest rocket ever built, to reach the moon. If we were to take a regular airplane (747) to the moon going 400 miles per hour it would take us 26 days to get there.

True or False: The moon has less gravity than on earth. **TRUE.** $1/6^{th}$ the gravity of earth to be exact! Have you ever seen footage of astronauts bouncing along the moon's surface? If you threw a baseball while you were on the moon it would travel 6 times farther than it would have on Earth. Imagine the size that the baseball field would have to be! With this low gravitational force the moon doesn't have an atmosphere. There isn't any wind or precipitation to blow or wash away the marks left by the astronauts, footprints, and they will still be there ~10 million years from now.

*True or False: The moon is **always** very cold*. **FALSE**. Since the moon has no atmosphere like we do on Earth to protect it from the powerful rays of the sun, it gets very hot when the sun is shining on it (hotter than boiling, 260 degrees Fahrenheit) and in the shadows of the moon it gets very cold, -280 degrees Fahrenheit.

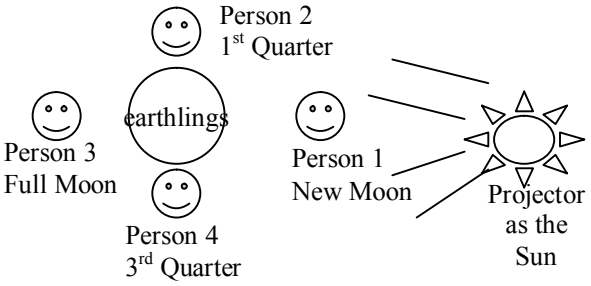
Lunar Cycles
Raise your hand if you think the Earth revolves around the sun. Yes it does! Does anyone know if the earth revolves around the moon or does the moon revolve around the earth? The moon revolves around the earth! Let's demonstrate this.

Have the projector set up on one side of the room. Ask, What does this represent? The Sun! Have a volunteer take the Earth beach ball. What direction does the Earth rotate? Counter-clockwise! And how long does it take for the Earth to rotate on its axis? 24 hours! We know the Earth orbits the sun, in what direction? Counter-clockwise! And how long does this take? 365 days.

Now, while this is happening we also have the moon. Have a volunteer come be the moon. Does the moon rotate on its axis? If so, in what direction? Yes, counter-clockwise. How long does this take? 28 days. We know the moon orbits the earth, in what direction? Counter-clockwise. Ask them how long this takes? About 28 days! If it takes the moon 28 days to orbit the earth and 28 days to rotate on its axis, this causes the same side of the moon to always face the earth. Demonstrate this a couple times. Have them notice that one side always faces the earth (face) and that all sides of the moon receive sunlight at some point, so there is no "dark side" of the moon just a "far side".

What causes the different shapes of the moon that we see? We see the moon because sunlight is reflecting off of it. Add to this the moon orbiting the earth. Can someone describe the different shapes they have seen? So let's see what causes these different phases of the moon to happen.

Have the kids all scoot together sitting on the floor in tight blob. (Then turn off the lights and have the projector or someone holding a bright flashlight standing to one side of the crowd.) Ask if anyone can guess what this is representing. The SUN! Now all of you together in the blob represent the earth and its earthlings. Next have four people stand around the earthlings (one directly in front the sun and place the other three like below).



Explain that as the moon revolves around the earth, the sun lights different parts of its surface. For example, give the "moon" to person #1. Have them hold it above their head and ask the "earthlings" how much of the surface that they can see is lit up? Their answer should be that they can see none of it. This is what we call a **new moon** when none of the surface is visible or it just looks black. This is because it is between the earth and the sun. As it revolves we see more of the moon. This is called a **waxing moon** because we see more and more of the moon.

Pass the moon to person #2 have them hold it above their head and ask the earthlings how much of the moon's surface they can see. They should only see half. Explain that this is called the **first quarter** (also called a half-moon) because the moon has completed one-quarter of its orbit around the earth. As it revolves we will see more and more of the moon until…..

Pass the moon to person # 3 and ask the earthlings what they see? They should see all of the surface, which is called a **full moon**. There are 12 calendar months, but 13 lunar months. When there are two full moons in one month, the second one is called a "Blue moon".

Now as it continues to revolve we see a smaller part of the moon. This is called a **waning moon** because we see less and less of the moons surface.

Pass the moon to person #4 and ask the earthlings what they see? They should see half of the moon again. Explain that is called the **third quarter**, it has made it three quarters around the moon. Then you will see less and less of the moon until you see a new moon again.

Now we know that we see other shapes of the moon besides just half of it, none of it, or all of it. Where could we place someone to make a **crescent moon**? (place someone between person #1 & #2 or between #1 & #4). Now the other term that is opposite of crescent is **gibbous** (a shape that is convex – bulges out). Where can we place them to make that shape?" (between person #2&#3 or #3&#4).

Review with them the different terms and go through the cycle again using the terms: new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, waning crescent.

Explain that one of the most common misconceptions about the moon is that we see the shadows of the Earth cast upon the moon. This is NOT True! What we are seeing is how the light hits the moon. For example, when there is a full moon, it is completely lit with light - with the myth we should be seeing a shadow on the moon. Can demonstrate this with the projector, moon ball, etc. if you want.

Cultural & Natural Importance of the Moon
We are used to seeing the moon in the night sky very often and we don't give much thought at to it being there, but why should we care about it or appreciate it?

- Songs, art, stories, folklore, proverbs
- Gives light
- Used as a measurement of time – The sun was used for short measurements and the moon for longer time periods. Moon and month come from the same root word.
- Research: NASA had 22 missions to the moon (1964-1972), 6 successful human landings
- Words – Moon oriented, Honeymoon, Lunatic, Moon madness, Moon flower, Mooning

If the moon didn't exist our world would be quite different!

- Earth would spin much faster because the interactive force between the moon and the earth slow us down. This fast spin would cause strong winds and storms.
- No solar or lunar eclipses.
- Might get hit by asteroids more often because the moon takes some that would otherwise hit us.
- Would have been no "moon race" in the 1960's, which is pretty important in modern day culture.

Optional: If there is extra time allotted for this class, talk about Lunar Eclipses at this time. See Appendix A

Stars & The Sun
Now that we've explored the moon, let's move further out into the great big universe and investigate the stars.

How were the stars created?
One of the first questions that our ancestors may have asked when they looked at the night sky could have been, how were the stars created? Many cultures have different stories to explain this.

Read Native American Coyote Story See Appendix B

Today we know that stars are burning balls of gas made mostly of hydrogen, helium, and dust. Gravity is the force that holds the dust and gas together in once place.

What is our closest star?
The closest star to earth is the sun, although it is still 93 billion miles away from earth and its light takes 8 minutes to reach us. For an idea of its size think about this: If the sun were the size of your head, the earth would be the size of your pupil! The sun is about 4.5 billion yrs old-we think it will live another 5.5 billion yrs.

The Sun's center is an incredible 15 million degrees Celsius. A pinhead that hot, 90 miles away, would kill you. The sun is a yellow star, which is about medium in heat. Blue & white stars are hotter than the sun, while orange and red stars are cooler than the sun.

Optional: Did you know that stars have lives?
Stars are born when heavy clouds of dust and hydrogen gases are squished into a big ball by gravity and begin to spin. The ball is now a star and it uses its gases as fuel to give off heat and light. Eventually, the star runs out of gases and it will begin to shrink and die. Smaller stars just burn out, but larger ones can become black holes, which are so massive that they don't allow anything near them to escape their incredibly strong pull of gravity, even light. The bigger the star, the shorter its life. The sun is a medium-sized star.

What is a shooting star?
They are tiny bits of debris burning up in the upper atmosphere of earth. They are also called meteors.

Why do stars twinkle?
The Earth's atmosphere isn't uniform. When light passes through a weird patch, it gets warped and twinkles. Imagine the atmosphere as a smudged window: things look different through the smudged bits. Stars twinkle and planets don't, because the light from stars are mere pinpoints and have to travel farther than the broad discs of light from nearby planets.

How many stars are there?
Imagine you are on a beach with a shovel and wheelbarrow. You shovel and shovel sand until the pile is taller than you. You reach up and pick one grain off of the top. That teensy weensy grain is all of the stars that we can see with our naked eye. The rest are all the stars in the sky and the universe that we can't see! Scientists think that just in our galaxy—the Milky Way—there are at least 200 billion stars. That's a lot of stars to keep track of.

Constellations
The constellations are divided into four seasons depending on when they can be seen in our night sky. But, they can also be divided into months depending on when it is easiest to see these constellations (*See Appendix D for more information*).

There are two different motions that the earth goes through that determine which constellations we see at different times of the year. The first is the earth revolving around the sun, and the second is the earth is rotating on its axis. Just like our closest star, the sun, all of the stars in the sky rise and set due to the rotation of the earth. Why can't we see the stars that are "behind" the sun at a certain point during the earth's revolution? Using the earth ball, can anyone demonstrate where the earth would be in relation to the sun when we cannot see the constellation Orion?

To make sense of the night sky, humans have divided the stars into 88 constellations, and cultures around the world have created myths and stories about them. What kinds of things could these constellations be used for?

- Navigation-especially sailors
- Telling time-the night sky changes from season to season, and ancient people used this to tell when it was time to plant crops or to store up food for the winter.
- For entertainment-creating myths and telling them is fun! In the past they didn't have video games and TV to amuse themselves with.

All right, let's take a look at some of these constellations.

Circumpolar stars and constellations are ones that you can see all year long because they are inline with the axis of the earth.

The Big Dipper & Ursa Major

This first pattern of stars is one of the most recognizable and one of the first that we learn about when we are young. Does anyone know what it is? The Big Dipper is not actually a constellation, but rather it is a part of the constellation Ursa Major (The Big Bear). The big dipper is less than half the length of the constellation, and there are many stars further south that create the bear's legs. We call a pattern like the Big Dipper an asterism because it is not one of the "official" constellations. Rather, it is just a group of stars that is easily recognizable.

Polaris the North Star & Ursa Minor

If you follow the last two stars in the ladle of the Big Dipper they point to a pretty important star—Polaris, also known as the North Star. This star has been used for navigation for centuries. It is also the last star in the handle of the Little Dipper. The Little Dipper is also an asterism, and all of the stars make up the constellation Ursa Minor (The Little Bear).

During the nineteenth century when slaves were trying to escape the South to find freedom in the north, they would refer to the big dipper as the drinking gourd in songs and stories. To "follow the drinking gourd" was similar to how shipmen would use the North Star for navigation across the oceans and seas.

Cassiopia

The third circumpolar constellation that we'll look at is Cassiopia. It is on the opposite side of the Little Dipper from the Big Dipper, and it looks like the letter W.

Perseus & Andromeda (FALL)

Keep following the line from the North Star through the middle of Cassiopia and keep going until you hit three bright stars that are part of Andromeda. Perseus is just to the left of Andromeda and below Cassiopia. Not only are these constellations near each other in our Night Sky but there is a story about them as well.

Read A Greek Love Story – See Appendix C

Orion (WINTER)

This constellation is very bright and easy to distinguish in the night sky. One easy way to find Orion is to look for the three stars that make up his belt. Or, you could look for the four stars that make up his shoulders and knees. The star that is Orion's right shoulder is called Betelgeuse (which means "armpit of the central one") and the star representing his left is called Bellatrix. Rigel (Orion's left knee) is the brightest star in the constellation and the 7th brightest star in the sky (Betelgeuse is the 9th brightest in the sky). The relative brightness of the stars comprising the constellation Orion makes it easy for people to recognize when it is visible November through April.

Take a look at the four stars that make up the body of Orion. Do they look far apart or close together? Actually, they are light years apart. A light year is the distance that light can travel in a year, about 6 billion miles! The left most star is 81 light years from Earth, the middle star is 78 light years away, and the right most star is 100 light years away. That's a big difference, but stars are so far away that they appear to line up and look closer to each other than they actually are.

Canis Major & Canis Minor (WINTER)

Every good hunter must have a dog, and Orion has two. These constellations are called Canis Major and Canis Minor (the Big Dog and the Little Dog). Follow the angle of Orion's belt to our left to find the Big Dog easily recognized because it contains the star Sirius. Sirius is the brightest star in our night sky and under certain conditions it can be seen during daylight by the naked eye. Orion's second dog, Canis Minor is a bit harder to find because it consists of only two stars neither of which are relatively bright.

If you've ever heard the phrase, "the Dog Days of Summer", you know that this refers to the hottest part of the season. Because the star Sirius is so bright the ancient Egyptians thought that during the summer, the heat was intensified because Sirius rose each morning and traveled across the sky in conjunction with the sun. We now know that the sun produces all of the heat that

we experience on these long summer days, but it is a neat story about how other cultures hypothesized about all that takes place in our sky.

Milky Way
On a very clear night, if you find a spot away from city lights, you might see a cloudy band across the sky: that is the Milky Way. The people of many cultures had ideas about what the Milky Way was. Now we know that what we are actually looking at is our galaxy—The Milky Way Galaxy.

Where do we fit in with all of these stars? Our sun is one star that is part of a galaxy of hundreds of billions. If you stretched our galaxy out on a ruler that measured light years instead of inches, the ruler would be 100,000 light years long, and the sun would be at 27,000 light years.

The Planets of our Solar System
Planets are often colored, and they move across the sky differently than stars. For example the stars Castor and Pollux in this constellation won't move away from each other, but Saturn will. If you want to know what an object is, watch it over the course of a month or so. If it changes position from the stars that it is near, then it is a planet. The closer a planet is to Earth the faster it moves across the sky. Mars and Saturn are planets that you might see in the winter night sky.

Star Gazing
Show the star map one more time and look at where constellations are relative to one another-especially well-known ones like the Big Dipper-Polaris-and Orion's belt. Have students pick a constellation or two to look for when they go outside. Hand out star maps and encourage students to use them. Possibly organize students into teams and see who can identify the most constellations to you in 5 minutes. Use the telescope and possibly binoculars to see stars more closely.

Optional Activity: Make a Constellation
Divide students into groups of 3-4 and give each group a large piece of paper. Take round plastic chips (like poker chips) and scatter them across the paper to create the location of the stars. Students should then "connect the dots" by drawing lines between the stars in any way they would like to create a picture/constellation. Students should then draw the entire picture, and create a story/myth to go along with their constellation.

Conclusion
Ask for final questions and collect materials. Encourage students to keep looking at the night sky.

References
Cornell University Astronomy:
http://curious.astro.cornell.edu/moon.php

Inconstant Moon www.inconstantmoon.org

NASA http://lunar.arc.nasa.gov/project/faq.htm

Nova
http://www.pbs.org/wgbh/nova/tothemoon/origins.ht ml

Northern Stars Planetarium Teachers Guide:
www.northern-stars.com

Ranger Rick's Naturescope: Astronomy Adventures

Scholastic Teacher Resources:
http://teacher.scholastic.com/researchtools/articlearc hives/

Appendix A
More Moon Information

Lunar Eclipses
Now sometimes, the moon can seemingly disappear right before our eyes. Does anyone know what special event is called? A Lunar Eclipse! This is a special time when the moon, earth, and sun line up just exactly right so that the Earth DOES cast a shadow on the moon.

Optional: For older students you can explain the reason why this doesn't happen all the time, because the moon's orbit is tilted 5 degrees off the earth's orbit around the sun. This means that the moon spends most of the time either above or below the plane of the earth's orbit. During full moons the moon usually passes above or below the earth's shadows and no eclipse takes place. But two to four times each year, the moon passes through some portion of the earth's shadows and a type of eclipse occurs.

Using the materials here (projectors, earth ball, moon ball) does anyone think they can create this event right here in the room? Assist them in getting volunteers or anything else they need. Somehow they should have the projector shining at the Earth beach ball so that it creates a shadow on the moon.

Appendix B
Native American Coyote Story

In the first days when the sun dropped below the western hills in the evening, the sky was left dark and empty. "We cannot find our way; we are afraid!" the animals cried. So the creator called a council meeting and told the animals that they would have one night to create patterns in the sky. Then he picked up a stone and placed it in the sky saying, "This stone will be called a star, and it will be a home star, a campfire that doesn't move. Look for it if you are lost, it will help you find your way." Then he said, "Go to the river and collect as many of the sparkling stones as you can and use them to make pictures of yourselves in the sky." The animals

started to work, but many of them were too small to carry enough stones to make their pictures. So the creator gave coyote a bag full of stones to carry to the sky for the little animals. Coyote didn't want to carry the big bag of stones to the sky and after a while decided that he would take a rest. He lay down and fell asleep.

Just before dawn, coyote awoke and suddenly realized that the other animals still needed the stones that he carried. He grabbed the bag and flung it into the sky, scattering the stones everywhere. At that moment, dawn broke and the animals had to return to the earth. From that day on, the pictures that the animals created, as well as all the stones coyote scattered, could be seen in the sky. Unfortunately, there is a sad ending to this story. Due to his laziness, coyote forgot about creating his own picture in the night sky, thus when coyotes gaze up into the heavens, they do not see their own picture. This makes them very sad and they howl into the night.

Appendix C

A Greek Love Story

This is a classic Greek tale of love and betrayal that has many versions…. This one has been developed over the course of many star programs.

Divide up the class and assign them the actions and sounds of one character. Tell them that when their characters name is said - to do their assigned action and sound.

- **Cassiopeia** (screw up your face and HISSSSSS)
- **Andromeda** (descending Aaaahh, as if sighing – hands to one side of the face, head tilted slightly)
- **Perseus** (fists o hips, chest out, saying regally DUNT DA DAAH)
- **Cetus** or the monster (hands on either side of the face, startled look, GASP)
- **Pegasus** (rear up, WHINNY)

" Long, long ago there was a kingdom found along the coast of the Red Sea in what is now called Ethiopia. The king, named Cepheus, was not the brightest of men. The queen was both bright and beautiful. Her name was **Cassiopeia**.

Everyone agreed that **Cassiopeia** was beautiful – only problem was that she knew it as well. She bragged about her beauty to anyone who would listen – and with her being queen, everyone had to listen. **Cassiopeia** even boasted that she was more beautiful than the sea nymphs who lived in Poseidon's kingdom under the sea. Well, no one was more beautiful than sea nymphs and the nymphs demanded that Poseidon avenge their honor.

Poseidon sent a big, mean, slimy, green **sea monster** to attack the port city of Cepheus and **Cassiopeia**. That **sea monster** pushed up tidal waves, and it ate ships, and pretty soon the people cried out their king and queen, "MAKE IT STOP!"

Cepheus and **Cassiopeia** asked Poseidon what they needed to do to call off the big, mean, slimy, green **sea monster**. Poseidon told them to chain their beautiful daughter **Andromeda** to a rock, let the **sea monster** eat her, and all would be forgiven.

Well, would your parent do that to you? Do you think **Andromeda's** parents would that to ther? They did, just like that! So there's **Andromeda** chained to a rock and here comes the big, mean, slimy green **sea monster**. All hope is lost, right?

Well, who should happen by at this time on his winged shoes? Why of course, it's **Perseus**! He was flying home after cutting off Medusa's head. (If no one can explain who Medusa is, I tell the group: "Medusa was another one of those women who thought she was the most beautiful – the gods did not like her bragging either and the changed her into an ugly woman with snakes for hair. If you looked at her, you turned to stone. Perseus figured out a way to cut her head off without turning to stone himself, but that's another story!").

Well, **Perseus** looks at **Andromeda** and **Andromeda** looks at **Perseus** and what happens? They fall in love, of course!

Perseus shows Medusa's head to the **sea monster**. It turns to stone, falls into the ocean, and busts into a billion pieces – that's where we get coral from, by the way. The last drop of blood from the **sea monster** touches the water and out springs **Pegasus**, the winged horse. **Perseus** unchains **Andromeda** and they fly off together on **Pegasus** to live happily ever after.

Is that the end of the story? No! **Cassiopeia** and her husband haven't been properly punished. The gods decreed that she and Cepheus would remain chained to their thrones in the northern sky for all eternity. Now, that may not seem like such a bad punishment but, as the night sky "revolves" around Polaris, Cepheus and **Cassiopeia** are upside down for 12 hours each day. And what happens to you when you hang upside down? Your hair stands on end, your face turns red, and if you are wearing a dress, your underwear shows! There is no worse punishment for a beautiful woman!

And that's the story of **Cassiopeia**, **Andromeda**, **Perseus**, **Pegasus**, and the big, mean, slimy, green **sea monster**!"

Appendix D

Constellations by Month

This is a list of all 88 constellations split up into the months when they are **best** seen in the sky. The months listed assume that you are looking at the sky at **9:00 PM**. For every hour later than 9:00, add half of a month. For every hour before 9:00, subtract half a month. The constellations are typically visible for more than just one month, depending on where you are on the Earth. If you need to know exactly when a constellation is visible, check in a star atlas or on a planisphere.

January

- Caelum
- Dorado
- Mensa
- Orion
- Reticulum
- Taurus

February

- Auriga
- Camelopardalis
- Canis Major
- Columba
- Gemini
- Lepus
- Monoceros
- Pictor

March

- Cancer
- Canis Minor
- Carina
- Lynx
- Puppis
- Pyxis
- Vela
- Volans

April

- Antlia
- Chamaeleon
- Crater
- Hydra
- Leo
- Leo Minor
- Sextans
- Ursa Major

May

- Canes Venatici
- Centaurus
- Coma Berenices
- Corvus
- Crux
- Musca
- Virgo

June

- Boötes
- Circinus
- Libra
- Lupus
- Ursa Minor

July

- Apus
- Ara
- Corona Borealis
- Draco
- Hercules
- Norma
- Ophiuchus
- Scorpius
- Serpens
- Triangulum Australe

August

- Corona Austrina
- Lyra
- Sagittarius
- Scutum
- Telescopium

September

- Aquila
- Capricornus
- Cygnus
- Delphinus
- Equuleus
- Indus
- Microscopium
- Pavo
- Sagitta
- Vulpecula

October

- Aquarius
- Cepheus
- Grus
- Lacerta
- Octans
- Pegasus
- Piscis Austrinus

November

- Andromeda
- Cassiopeia
- Phoenix
- Pisces
- Sculptor
- Tucana

December

- Aries
- Cetus
- Eridanus
- Fornax
- Horologium
- Hydrus
- Perseus
- Triangulum