The Family of the Sun

Lesson SPI Guidelines:

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

2nd Grade:

Science:

- 7.10.2 Investigate how the sun affects various objects and materials.
- 7.10.1 Identify and explain how the sun affects objects on the surface of the earth.

Math SPIs:

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

RLA SPIs:

Writing

- 1.3.1 Write to describe, entertain, and inform.
- 1.3.2 Write in response to literature (e.g., create a new ending to a story, create class books, summarize a story), compose a variety of written works (e.g., friendly letters, journal entries, reports, experience stories) and begin to compose narratives (with a beginning, middle, and end).
- 1.3.3 Brainstorm ideas with teachers and peers, use graphic organizers (e.g., webs, charts, Venn diagrams) independently and/or in group, and use a variety of resources to gather information.
- 1.3.4 Use classroom resources to support the writing process.
- 1.3.5 Compose first drafts using the appropriate parts of the writing process with an emphasis on planning, organizing, and self correcting.
- 1.3.6 Use temporary/creative spelling to spell independently while transitioning to standard spelling in first drafts.
- 1.3.7 Arrange events in a logical and sequential order when writing.
- 1.3.8 Continue to add descriptive words and details to writing.
- 1.3.11 Incorporate suggestions from teachers and peers.

Logic:

- 1.5.4 Compare and contrast information and ideas.

Informational Text:

- 1.6.3 Explore various forms of informational texts (e.g., newspapers, pamphlets, manuals, magazines).
- 1.6.4 Recognize and use text features to comprehend informational texts (e.g., time lines, graphs, charts, maps and legends, illustrations).

Media:

- 1.7.2 Experience and respond to a variety of media (e.g., books, audio, video, ipods, computers, illustrations).

3rd Grade:

Science SPIs:

- CU 7.6.1 Create a model of the solar system depicting the major components and their relative positions and sizes.
- CU 7.6.2 Use a table to compare and contrast the major solar system components.
- SPI 7.6.1 Identify the major components of the solar system, i.e., sun, planets and moons.

Math SPIs:

- 0306.1.6 Identify and use vocabulary to describe attributes of two- and three-dimensional shapes.
- CU 6.4.10 Use reasonable units of length (i.e. kilometer, meter, centimeter; mile, yard, foot, inch) in estimates and measures.
- 0306.1.7 Select appropriate units and tools to solve problems involving measures.

- 0306.4.5 Choose reasonable units of measure, estimate common measurements using benchmarks, and use appropriate tools to make measurements.
- 0306.4.6 Measure length to the nearest centimeter or half inch.
- 0306.4.7 Solve problems requiring the addition and subtraction of lengths.
- 0306.5.2 Solve problems in which data is represented in tables or graphs.
- 0306.5.3 Make predictions based on various representations.

RLA SPIs:

Writing & Research:

- 0401.3.9 Select an appropriate title that reflects the topic of a written selection.
- 0401.3.10 Complete a graphic organizer (i.e., clustering, listing, mapping, webbing) to group ideas for writing.
- 0301.3.1 Identify the purpose for writing (i.e., to entertain, to inform, to respond to a picture, story, or art).

Logic

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

Informational Text:

- 0301.6.4 Locate information using available text features (e.g., charts, maps, graphics).

4th Grade:

Science SPIs:

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

Math SPIs:

- 0406.2.10 Solve contextual problems using whole numbers, fractions, and decimals.
- 0406.1.4 Compare objects with respect to a given geometric or physical attribute and select appropriate measurement instrument.
- 0406.4.6 Determine situations in which a highly accurate measurement is important [or is not].
- 0406.4.7 Determine appropriate size of unit of measurement in problem situations involving length, capacity or weight.
- 0406.4.8 Convert measurements within a single system that are common in daily life (e.g., hours and minutes, inches and feet, centimeters and meters, quarts and gallons, liters and milliliters).
- 0406.5.1 Depict data using various representations (e.g., tables, pictographs, line graphs, bar graphs).
- 0406.5.2 Solve problems using estimation and comparison within a single set of data.
- CU 6.4.12 Estimate the size of an object with respect to a given measurement attribute (length, perimeter, area, or capacity).
- CU 6.4.13 Compare objects with respect to a given attribute such as length, area, and capacity.

RLA SPIs:

Writing and Research:

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

- 0401.3.2 Identify the audience for which a text is written.
- 0401.3.10 Complete a graphic organizer (i.e., clustering, listing, mapping, webbing) to group ideas for writing.

Logic:

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

Informational Text:

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

5th Grade:

Science SPIs:

- SPI 7.6.1 Distinguish among the planets according to their known characteristics such as appearance, location, composition, and apparent motion.
- SPI 7.6.2 Select information from a complex data representation to draw conclusions about the planets.
- SPI 7.12.1 Explain and give examples of how forces act at a distance.

Math SPIs:

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

RLA Standards:

Writing and Research

- 0501.3.1 Identify the audience for which a text is written.
- 0501.3.2 Identify the purpose for writing (i.e., to entertain, to inform, to share experiences, to persuade, to report).
- 0501.3.3 Choose the supporting sentence that best fits the context and flow of ideas in a paragraph.
- 0501.3.7 Select details that support a topic sentence.
- 0501.3.8 Select vivid and active words for a writing sample.
- 0501.3.9 Choose the sentence that best supports the topic sentence and fits the flow of ideas in a paragraph.
- 0501.3.12 Select an appropriate title that reflects the topic of a written selection.
- 0501.3.13 Complete a graphic organizer (i.e., clustering, listing, mapping, webbing) to group ideas for writing.

Logic:

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

- 0501.5.6 Make inferences and draw appropriate conclusions from text.

Informational Text:

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

6th Grade:

Science SPIs:

- CU 7.6.1 Use data to draw conclusions about the major components of the universe.
- CU 7.6.2 Construct a model of the solar system showing accurate positional relationships and relative distances.
- SPI 7.6.1 Use data to draw conclusions about the major components of the universe.
- SPI 7.6.2 Explain how the relative distance of objects from the earth affects how they appear.

Math SPIs:

- 0606.1.1 Make conjectures and predictions based on data.
- 0606.1.3 Use concrete, pictorial, and symbolic representation for integers.
- 0606.2.5 Transform numbers from one form to another (fractions, decimals, percents, and mixed numbers).
- 0606.4.4 Calculate with circumferences and areas of circles.
- 0606.4.1 Identify, define or describe geometric shapes given a visual representation or a written description of its properties.
- 6.3.4 Generate data and graph relationships concerning measurement of length, area, volume, weight, time, temperature, money, and information.

RLA SPIs:

Writing and Research

- 0601.3.1 Identify the purpose for writing (i.e., to inform, to describe, to explain, to persuade).
- 0601.3.2 Identify the audience for which a text is written.
- 0601.3.3 Select an appropriate thesis statement for a writing sample.
- 0601.3.5 Select illustrations, descriptions, and/or facts to support key ideas.
- 0601.3.6 Choose the supporting sentence that best fits the context flow of ideas in a paragraph.
- 0601.3.7 Identify sentences irrelevant to a paragraph's theme or flow.
- 0601.3.8 Select appropriate time-order or transitional words/phrases to enhance the flow of a writing sample.
- 0601.3.9 Select an appropriate concluding sentence for a well-developed paragraph.
- 0601.3.10Select an appropriate title that reflects the topic of a written selection.
- 0601.3.11Complete a graphic organizer (e.g., clustering, listing, mapping, webbing) with information from notes for a writing selection.

Logic:

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

7th Grade:

Science SPIs:

- SPI 7.11.4 Identify and explain how Newton's laws of motion relate to the movement of objects.

Math SPIs:

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

RLA SPIs:

Writing and Research

- 0701.3.1Identify the purpose for writing (i.e., to inform, to describe, to explain, to persuade, to entertain).
- 0701.3.2Identify the audience for which a text is written.
- 0701.3.3Select an appropriate thesis statement for a writing sample.
- 0701.3.5 Select the appropriate time-order or transitional words/phrases to enhance the flow of a writing sample.
- 0701.3.6 Choose the supporting sentence that best fits the context and flow of ideas in a paragraph.
- 0701.3.7 Identify the sentence(s) irrelevant to a paragraph's theme or flow.
- 0701.3.8 Select an appropriate concluding sentence for a well-developed paragraph.
- 0701.3.9 Select illustrations, explanations, anecdotes, descriptions and/or facts to support key ideas.
- 0701.3.10 Select an appropriate title that reflects the topic of a written selection.
- 0701.3.12 Complete a graphic organizer (e.g., clustering, listing, mapping, webbing) with information from notes for a writing selection.

Informational Text:

- 0701.6.1 Formulate clarifying questions before, during, or after reading.
- 0701.6.3 Use text features to locate information and make meaning from text (e.g., headings, key words, captions, footnotes).
- 0701.6.4 Interpret factual, quantitative, technical, or mathematical information presented in text features (e.g., maps, charts, graphs, time lines, tables, and diagrams).

8th Grade:

Science SPIs:

- 7.12.6 Identify factors that influence the amount of gravitational force between objects.
- 7.12.7 Explain how the motion of objects in the solar system is affected by gravity.

- SPI 7.12.5 Determine the relationship among the mass of objects, the distance between these objects, and the amount of gravitational attraction.
- SPI 7.12.6 Illustrate how gravity controls the motion of objects in the solar system.

Math SPIs:

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

RLA SPIs:

Writing & Research:

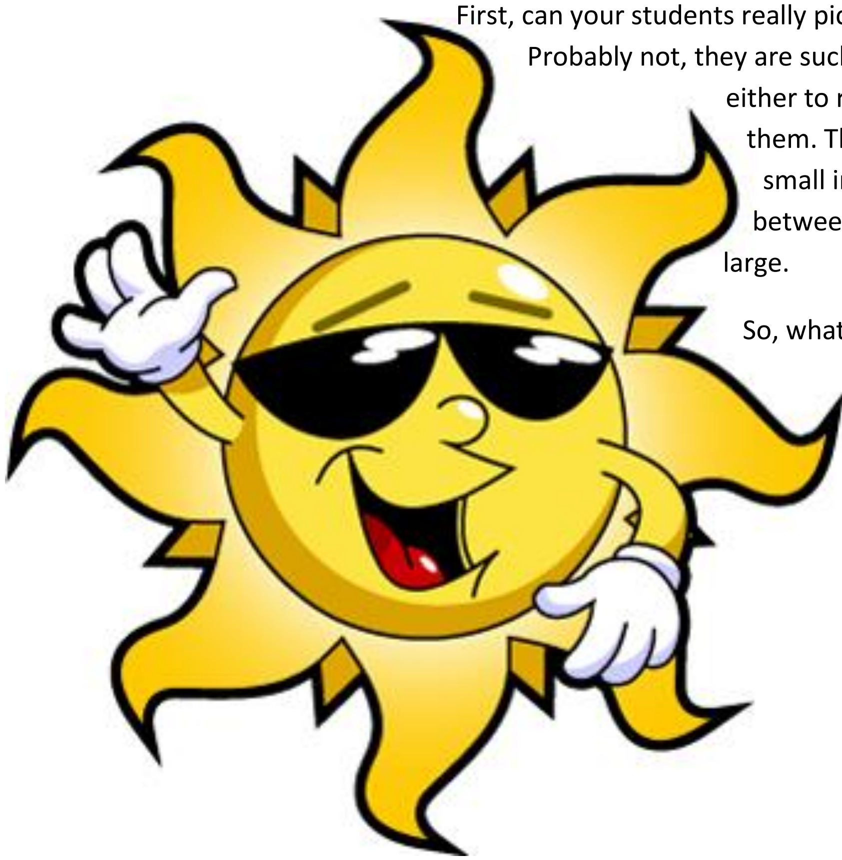
- 0801.3.1 Identify the purpose for writing (i.e., to inform, to describe, to explain, to persuade, to entertain).
- 0801.3.2 Identify the targeted audience for a selected passage.
- 0801.3.5 Select appropriate time-order or transitional words/phrases to enhance the flow of a writing sample.
- 0801.3.6 Choose the supporting sentence that best fits the context and flow of ideas in a paragraph.
- 0801.3.8 Select vivid words to strengthen a description (adjective or adverb) within a writing sample or passage.
- 0801.3.9 Select illustrations, explanations, anecdotes, descriptions and/or facts to support key ideas.
- 0801.3.10 Select an appropriate title that reflects the topic of a written selection.
- 0801.3.12 Complete a graphic organizer (e.g., clustering, listing, mapping, webbing) with information from notes for a writing selection.

Informational Text:

- 0801.6.1 Formulate appropriate questions before, during, and after reading.
- 0801.6.3 Use text features to locate information and make meaning from text (e.g., headings, key words, captions, footnotes).
- 0801.6.4 Interpret factual, quantitative, technical, or mathematical information presented in text features (e.g., maps, charts, graphs, time lines, tables, and diagrams).

The Family of the Sun

What do you begin an astronomy lesson with? A first taste of the constellations? Celestial co-ordinates? Physics? History? Our galaxy, the Milky Way, is a spiral galaxy, like a spinning top, with arms extending from the center like a pinwheel. Our solar system is in the Orion arm of the Milky Way. Our Sun is one of about 100 billion stars in the Milky Way. And our galaxy is just one of roughly 100 billion in the visible universe. With all that to cover, where in the worlds is the best place to start?



First, can your students really picture the dimensions of our solar system? Probably not, they are such an amazing distance apart that it is difficult either to realize or even to know how best to show them. The fact is that the planets are actually quite small in comparison to space, and the distances between them are quite a bit more than ridiculously large.

So, what can we do? Let's do a little something, or two, to help kids actually be able to accurately picture the dimensions of our solar system.

The Planet Walk

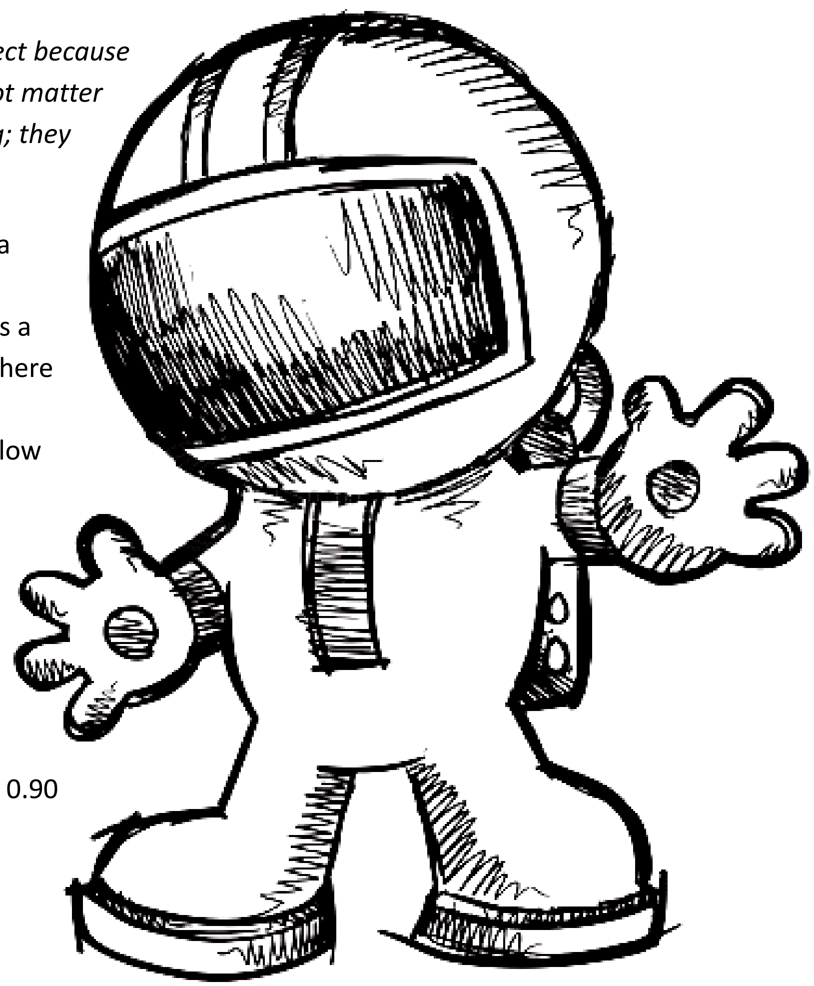
> **Note: Though this is one of the best introductions to space and solar system scale you can do with your students, if it's just not possible to do the Planet Walk due to lack of space, students can still make an accurate scale using the Toilet Paper Solar System activity. The following information can still be introduced through that activity and it's always a good idea to show the students the scale system of objects from this project as they are memorable.**

This exercise allows students to really have an opportunity to visualize just how BIG our Solar System really is. Examining the relative sizes of the planets using models at such a small scale, students realize that the Earth, the biggest thing they have ever touched, is quite small in comparison to the Sun and some of the other planets. The 1,000 Yard Planet Walk Model was/is Copyrighted in 1989 by Guy Ottewell.

First, collect the objects you need. They are:

Objects like the following, ex. peanuts, are perfect because their rough sizes are very memorable. It does not matter if the peanut you have is not exactly .3 inch long; they will remember the object and its size.

- Sun-any ball, diameter 8.00 inches (ex. a bowling ball) A standard bowling ball happens to be 8 inches wide, and makes a nice massive and memorable Sun, but there are plenty of other balls which are near enough in size, just make sure it can't blow away.
- Mercury-a pinhead, diameter 0.03 inch
- Venus-a peppercorn, diameter 0.08 inch
- Earth-a second peppercorn
- Mars-a second pinhead
- Asteroid belt: pepper
- Jupiter-a chestnut or a pecan, diameter 0.90 inch



- Saturn-a hazelnut or an acorn, diameter 0.70 inch
- Uranus-a peanut or coffee bean, diameter 0.30 inch
- Neptune-a second peanut or coffee bean
- Pluto- a third pinhead (or smaller, since Pluto is the smallest planet)
- Note Cards: The three pins must be stuck through note cards, otherwise their heads will be virtually invisible in the ground and they'll truly end up "lost in space". If you like, fasten the other planets onto labeled cards too.
- Tape
- Pencils
- Option: Pennant flags such as the pennants used on bicycles to mark locations and help you not get lost in space.
- Option: Flashlights for each planet if you are doing this activity in the dark. It's a great way to show the darkness of spaces, and a fun way to present the activity. If possible, you'll want a really large flashlight for the Sun!

The first thing to point out to your students is the contrast between the great round Sun and the tiny planets. (And note a proof of the difference between reading and seeing: if you just told your students the differences, the figures such as "8 inches" and ".08 inch" would create very little impression.) Look at the second peppercorn--our "huge" Earth--up beside the huge curve of the Sun.

Ask: **"How much space do we need to make it realistic and accurate?"** Children may think that the table-top will suffice, or a fraction of it, or merely moving the objects apart a little. Adults think in terms of the room or a fraction of the room, or perhaps the hallway outside.

To arrive at the correct answer, introduce scale.

This peppercorn is the Earth we live on.

Establishing the scale

While you are talking and introducing the idea of the model during the following discussion, you will want to establish scale. To provide students with a base, as you discuss, complete the following chart:

	In Reality	In the Model
Earth's width	8,000 miles	8/100 inch
Sun's width	800,000 miles	8 inches

Therefore: scale is	100,000 miles	1 inch
Therefore	3,600,000 miles	36 inches or 1 yard
And Sun-Earth distance	93,000,000 miles	26 yards

See, it works!

Discuss: The Earth is eight *thousand* miles wide! The peppercorn is eight hundredths of an inch wide. What about the Sun? It is eight *hundred* thousand miles wide. The ball representing it is eight inches wide. So, one inch in the model represents a hundred thousand miles in reality.

This means that one yard (36 inches) represents 3,600,000 miles. Have students take a step: this distance across the floor is an enormous space-journey called "three million six hundred thousand miles."

Now, what is the distance between the Earth and the Sun? It is 93 million miles. In the model, how many yards will this work out to be? According to our scale: 26 yards

In order to provide context, as this still may not mean much, have one of the students to start at the side of the room and take 26 paces. Unless you have a huge room, he usually comes up against the opposite wall at about 15!

Clearly, it will be necessary to go outside.

Hand the Sun and the planets to members of the class, making sure that each knows the name of the object he or she is carrying, so as to be able to produce it when called upon.

You will need to have found in advance a spot from which you can walk a thousand yards in something like a straight line. Straightness of the course is not essential; nor do you have to be able to see one end of it from the other. You may even have to "fold" it back on itself.

1. Put the **Sun** ball down, and march away as follows. (After the first few planets, you may want to appoint someone else to do the actual pacing-call this person the "Spacecraft" or "Pacecraft"-so that you are free to talk.)

F.Y.I.

More space missions have been sent to Mars than the rest of the Solar System's planets, but nearly two thirds of all Mars missions failed in some way, leading to rumors of a Mars curse. Is the "Galactic Ghoul" or the "Mars Triangle" real? Looking over the past 48 years of Mars exploration, it makes for sad reading. To date, 26 of the 43 missions to Mars (that's a whopping 60%) have either failed or only been partially successful in the years since the first Marsnik 1 attempt by the Soviet Union in 1960. In total the USA/NASA has flown 20 missions, six were lost (70% success rate); the Soviet Union/Russian Federation flew 18, only two orbiters (Mars 2 and 3) were a success (11% success rate); the two ESA missions, Mars Express, and Rosetta (fly-by) were both a complete success; the single Japanese mission, Nozomi, in 1998 suffered complications en-route and never reached Mars; and the British lander, Beagle 2, famously went missing in 2003. Our efforts to send robots to Mars have been repeatedly thwarted by bad luck and strange mysteries. Is the *Galactic Ghoul* really out there destroying billions of dollars-worth of hardware?Or is it a case of technological and scientific trial-and-error like any other experiment? In any case, the Mars Curse has been a matter of debate for many years, but recent missions to the Red Planet have not only reached their destination, they are surpassing our wildest expectations. Perhaps our luck is changing…

To read more go to:
Universe Today and read the article by IAN O'NEILL
http://www.universetoday.com/13267/the-mars-curse-why-have-so-many-missions-failed/

2. 10 paces. Have the Mercury put down his card and pinhead, weighting them with a pebble if necessary.
3. Another 9 paces. **Venus** puts down her peppercorn.
4. Another 7 paces. **Earth** (It takes about 8 minutes to walk from the Sun to the Earth in our model, just as it takes 8 minutes for a light beam to travel from the real Sun to the real Earth.)

The Moon

The Moon is, on our planet walk scale, 2.4 inches from the Earth. You can, on reaching the position for the Earth, pause and put down a Moon beside it. This Moon will have to be another pinhead (theoretically between the sizes of Mercury and Pluto). Show students that this distance, the length of their thumb; is the greatest distance that Mankind has yet leaped from our home planet.
The apparent size of the Sun ball, 26 paces away from where you hover over your peppercorn planet Earth, is now the same as that of the real Sun- half a degree or arc, or half the width of your little finger held at arm's length. (If both the size of an object and its distance have been scaled down by the same factor, then the angle it subtends (forms) must remain the same.)

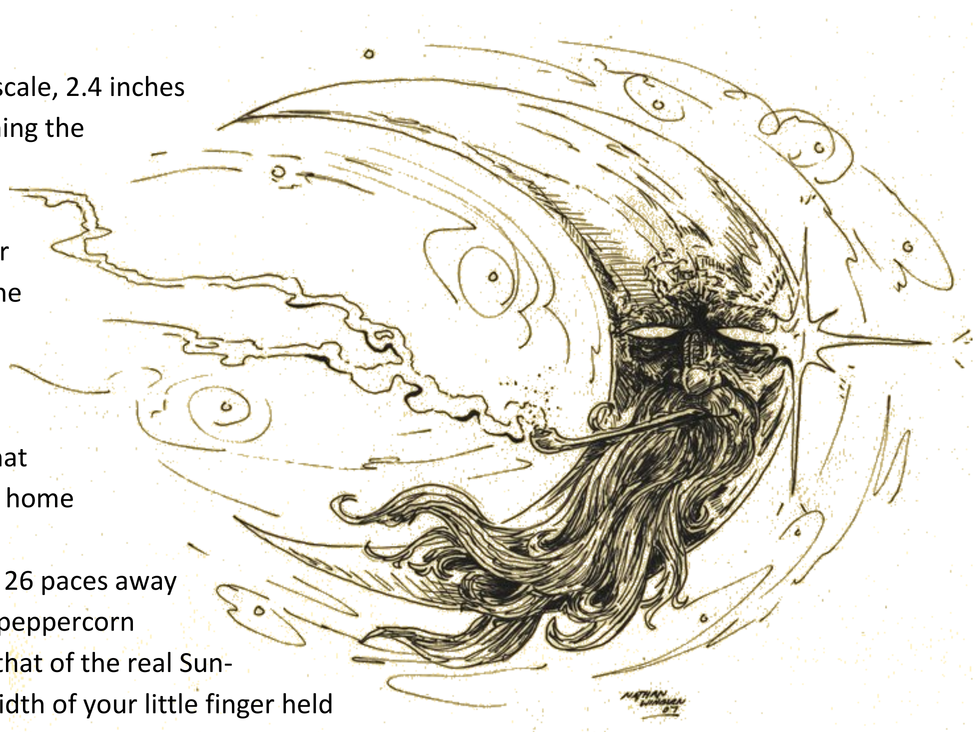


Image Credit: Samurai30.deviantart.com. http://samurai30.deviantart.com/art/old-man-in-the-moon-54581470.

5. Another 14 paces, now we put down **Mars**

Missions to Mars!

Tell students that various missions to Mars are now being suggested or the unmanned trips that have been tried in the past. How far is it to Mars? (14 yards in our model) Or the trips they talk about in science fiction: to Jupiter (109 yards) or to the nearest star (four thousand miles **in our model**).

How long do students think it would take to make these trips?

Things to think about:

- The time it takes to get to the moon, to cross those 2.4 inches in our model, or to go anywhere, really depends on the speed of the spacecrafts.
- The Apollo 11 was launched July 16, 1969 from Kennedy Space Centre. It took a total of 3 days, 3 hours and 49 minutes to fly to the Moon and 3 days to return to Earth

Why do students think it was a shorter return time when they crossed the same distance? Did gravity help out?)

- Afterwards, on April 11, 1970, Apollo 13 was launched from the Kennedy Space Centre and traveled *around* the moon. It took total of 5 days, 22 hours and 54 minutes to fly to the Moon and return back to Earth.
- The shortest trip to the Moon happened in January 2006. The NASA Pluto probe New Horizons, with the speed of 58,000 km/hr, only took 8 hours and 35 minutes to get to the Moon from Earth.
- The longest trip took place in 2003 by the ESA SMART-1 lunar probe. It took 1 year and 6 weeks because it used ion engine which was very fuel efficient, (meaning it used a little fuel to go very far) but very slow. However, these last two missions did not return to Earth.

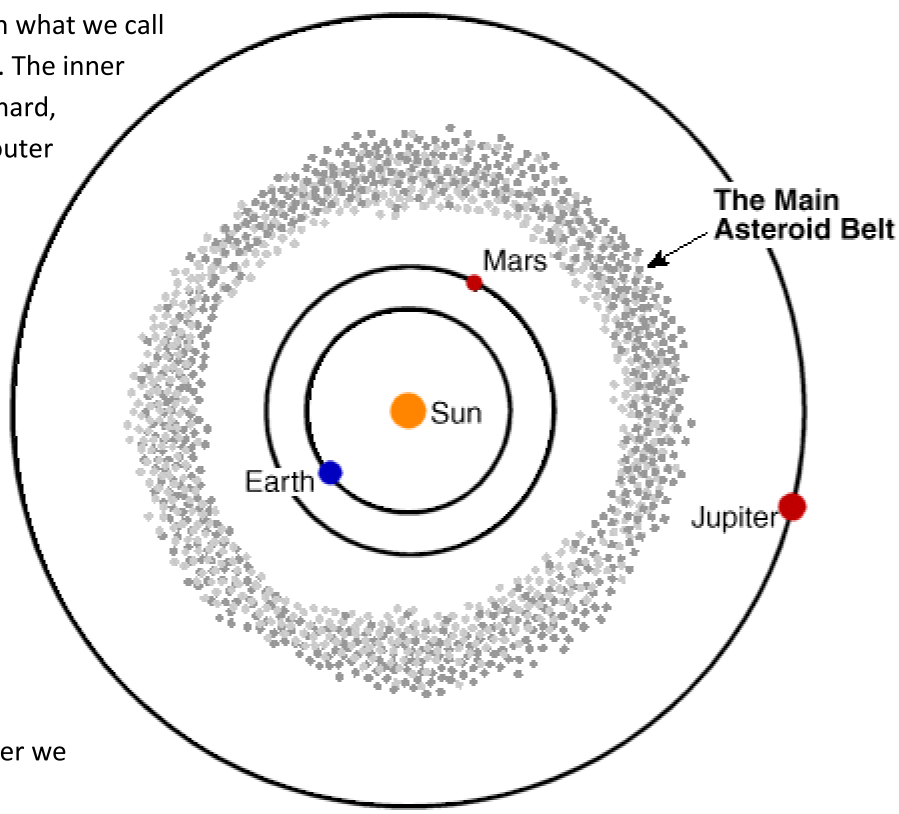
If it took about 3 days to cross the 2.4 inches in our model, how long do students think would it take to cross the 14 yards to Mars?

- Note: Scientists say the time to travel to Mars is approximately 214 days or a little over 7 months just to get there. Scientists are constantly exploring ways to travel between planets in a more efficient way. Who knows when it will be possible to visit a planet and return in less than a few months?

Bridging the Gap! On to the fluid Planets!

6. Another 95 paces, yes, that's right, 95 paces to **Jupiter**

This gap marks the boundary between what we call the inner and the outer solar systems. The inner solar system contains the four small, hard, "terrestrial" (Earth-like) planets; the outer solar system contains the four large, fluid, "Jovian" (Jupiter-like) planets, with the exception of Pluto. In between Jupiter and Saturn gap is where most of the asteroids are, in the asteroid belt, **[After 47 paces have students put down a card with pepper sprinkles glued across it for the asteroid belt]** so scientists think these asteroids may be fragments of a planet which broke up or which was never able to completely form.



(Orbits drawn approximately to scale)

7. Another 112 paces from Jupiter we find **Saturn**

8. Another 249 paces. **Uranus** Where is the half-way point in the journey out to Pluto? Most people would guess Jupiter or Saturn. But the surprising answer is Uranus. So, if you need to fold the walk back on itself, because of not having space to walk a thousand yards, Uranus is the point at which to turn.
9. Another 281 paces. **Neptune**
10. Another 242 paces. **Pluto**

Once you reach Pluto, have students look back toward the Sun ball, and then look down at the pinhead Pluto. Can they see the sun? What are their thoughts about the size and distance of the solar system? Does space seem larger than they imagined? How do models help us visualize things that normally we wouldn't be able to see?

Orbits

Point out that the nine planets do not actually stay in a straight line with each other as they move around the sun. They stay about the same distances from the Sun, but circle around it (counterclockwise as seen from the north) and they go around at various speeds. The inner planets not only have smaller circles to travel but move faster.

Planetary Race

To illustrate the orbits:

1. Have students take positions at each of the locations of your solar system model, or at least at the inner planets.
2. Now have students walk in an approximately circular or elliptical (if you wish to be more realistic) orbits around the sun, allowing those in the innermost planets to walk more quickly, while the outer planets must move slowly.

Who will circle the sun the first and who has the longer year? Mercury goes all the way around the sun in about 3 months; the Earth, in a year; and Pluto? It takes Pluto about 250 years.

3. Now, have two students stop at the opposite sides of their orbits, on either side of the sun. They're much farther apart than when they started. The circling movements mean that the planets spend most of their time much farther apart even than they appear in our straight-line model.

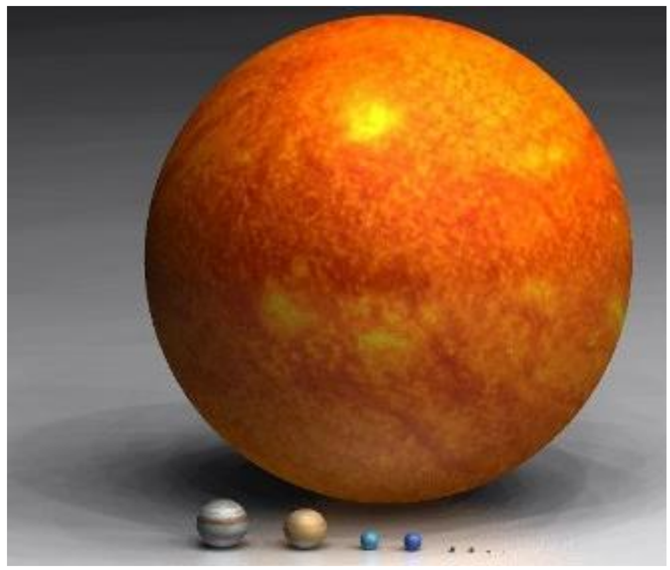
Just like between the two students, the distance between two planets can be up to the **sum** of their distances from the sun, instead of the difference, if they are on opposite sides of the sun. Jupiter and Saturn, for instance, can be as close as 95 paces as in the model, or up to 382 paces apart at times when they are on opposite sides of their orbits.

The Outer Planets

Throughout most of human history, only six planets have been known: Mercury, Venus, Earth, Mars, Jupiter, Saturn. (During most of the time in our history nobody knew what planets are or that the Earth is a planet.) Then, in the last three centuries, three new (at least to humans) planets were discovered. Uranus, though visible to the naked eye on clear nights if you know just where to look, was not officially noticed till 1718; Neptune was discovered in 1846; and Pluto? Not till 1930 after a quarter of a century of meticulous search. And now poor Pluto isn't even counted as a true planet, it's a dwarf!

The Sun Vs. the Planets, and Jupiter Vs. the Rest

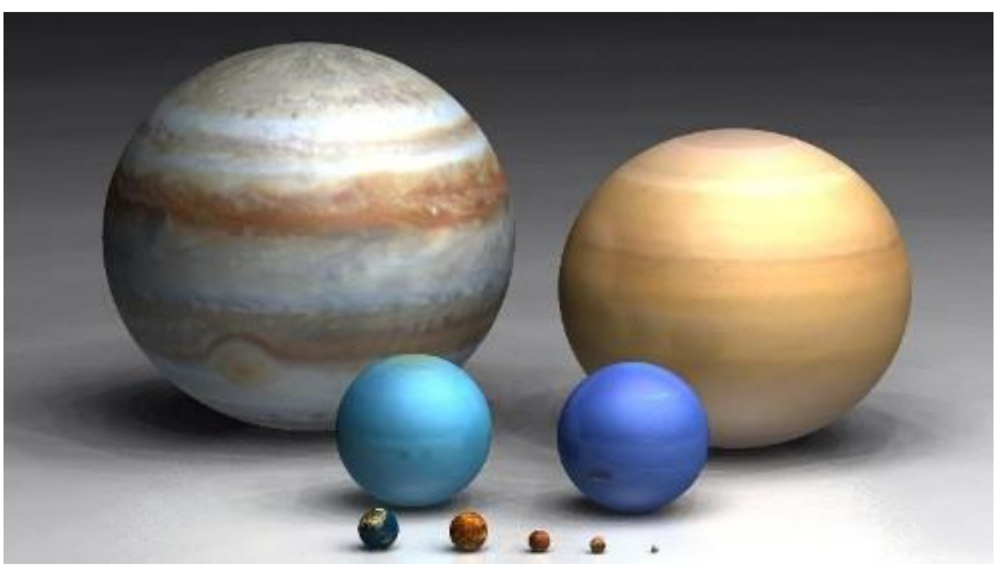
When you first laid the row of objects out on the table, there was an extreme contrast between the Sun and the rest. The word "size" is vague. **Discuss why size is vague and why scientists might not like to use it. When you talk about something's size you could mean what?** You could mean width (diameter), volume (the amount of space it takes up), or mass (amount of matter in that space). In volume, the Sun is 600 times greater than all the planets put together. As compared with the small but rather dense Earth, the Sun is 109 times greater in width; 1,300,00 times greater in volume; and 330,000 times greater in mass.



Sun (*Sol*), Jupiter, Saturn, Uranus, Neptune, Earth, Venus, Mars, Mercury...look closely, it's there.

Within the planets themselves, there is quite a contrast between Jupiter and the rest. Jupiter contains almost three times as much matter as all the other planets together-even though Saturn comes a good second to it in width.

This is partly because Saturn is the least dense of all the planets (it would float on water, if there was an ocean big enough). It is made up mostly of gas



Jupiter, Saturn, Uranus, Neptune, Earth, Venus, Mars, Mercury, the Moon...

which is less dense than liquid water. Since the gas is lighter than water, the planet could float on water. None of the other planets in our solar system can do this because they have a higher density and are heavier than water.

Greater Distances

Despite what we might think, our solar system does not really end with Pluto. Besides the planets, there is a thin haze of dust (some of it bunched into comets). Any of this dust that is nearer to the Sun than to any other star may be in the gravitational hold (pull) of the Sun and so counts as part of our solar system. So the outermost edge of such space dust may be half way to the nearest star.

On the scale of our model, Pluto is a thousand yards or rather more than a half a mile out. But this true limit of the solar system, the space dust, is two thousand miles farther out yet. You wouldn't want to have to walk that far! If the center of our model, the sun, was in downtown Nashville, its outer edge would be in San Diego, CA!

Extensions:

- They can also see the internet version. http://www.phrenopolis.com/perspective/solarsystem/ This page shows a scale model of the solar system. The planets are shown in corresponding scale. Unlike most models, which are compressed for viewing convenience, the planets here are also shown at their true-to-scale average distances from the Sun. That makes this page rather large - on an ordinary 72 dpi monitor it's just over half a mile wide, making it possibly one of the largest pages on the web. This means you'll have to do a bit of scrolling if you want to find the planets, but don't despair. They are reasonably bright and labeled, so you can probably catch them flashing by in the blackness even if you are scrolling fairly fast, though you'll most likely have to do a little backtracking if you scroll too fast.

What do you think?

Match the following space related definitions with the correct terms.

Orbit

Asteroid

Galaxy

Star

Planet

Atmosphere

Mass

Solar System

Constellation

Milky Way

Rotate

1. A system of millions or billions of stars, together with gas and dust, held together by gravity (gravitational attraction).
2. A rock, or minor planet, orbiting the Sun. There are a belt of them in our solar system.
3. The gas area surrounding a planet.
4. A group of stars that have been given names a long time ago because of the way they look.
5. How much matter an object contains.
6. Our Galaxy's name.
7. When an object spins.
8. The path one object takes around another.
9. The system of objects and planets orbiting the star Sol, which happens to be our sun.
10. A huge glowing ball of gas, with a core that is very hot and produces lots of energy.

Worlds in Comparison

What's This Activity About?

This activity allows students to develop an understanding of the relative sizes (volumes) of the planets in our solar system. Groups start with a big ball of playdough and divide it up following the steps on the instructions sheet. When they are done, they see how the planets vary in size. By the time they get to tiny Pluto, they are typically quite amazed.

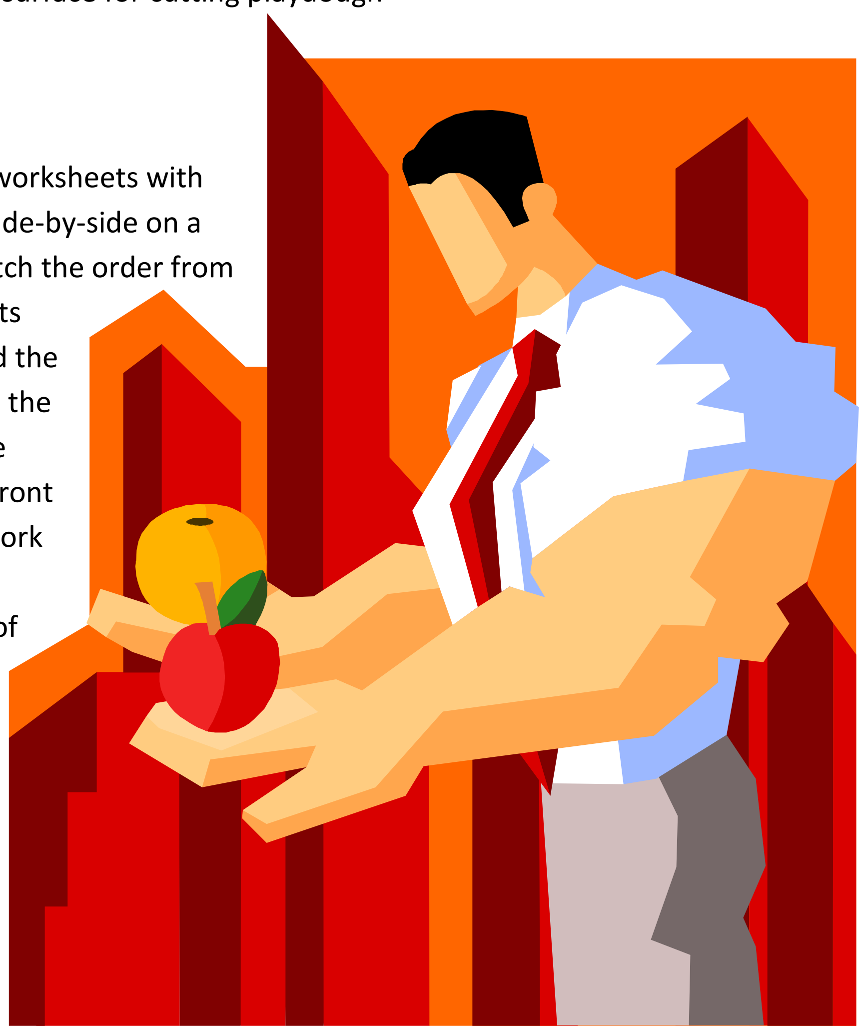
Materials:

Each group will need:

- Three **pounds** (48 oz) of store bought or homemade playdough per group
- Plastic knife
- Breadboard or wax paper as surface for cutting playdough
- Instruction sheet
- Planet name worksheets

Setting Up the Activity

This activity works best if the worksheets with the planet names are placed side-by-side on a table, and are arranged to match the order from the Sun. In front of these sheets place the instruction sheet and the playdough and plastic knife on the breadboard (or equivalent). Be sure there is enough room in front of the table for the group to work together. It is crucial to have exactly the indicated amount of playdough for each group. If there is less than three pounds (48oz), the Pluto piece will be too small to see! We recommend three pounds each and urge you to try the activity for yourself before leading it.



Suggestions for Introducing the Activity

For any of these scale model activities, it is useful to start by exploring the notion of models. Referring to playthings, such as dolls or toy cars, can be a useful reference for talking about scale models. For a more thorough exploration of this concept with ideas of how to introduce and discuss it, see the introduction to the Planet Walk.

This activity is designed as a self-guided activity. Nevertheless, if you choose to do so, it can also be a facilitated activity from the beginning. If you facilitate this activity from the start, begin by asking the participants which planet they think is the largest. Which is the smallest? For whatever planet they say is the largest (it will most likely be Jupiter), ask them the following question: If we could combine all the planets together into a big ball, what fraction of that ball would the largest planet be? Might it be 1/9 or 1/5, for example? End the introduction by telling them they will get a better idea after completing this activity.

Note: If people will be using previously used play dough of various colors, you can reassure participants that mixing colors is fine (after all, many planets are multicolored!).

Doing the Activity

Participants start by reading the instructions handout, but they should get into working with the play dough as quickly as possible. They should follow the instructions as to how to divide up their play dough, placing the parts in the proper planet boxes. Each time the play dough is divided up and parts are combined to make a planet, be sure participants roll the combined parts around in their hands until the planet has a ball shape.

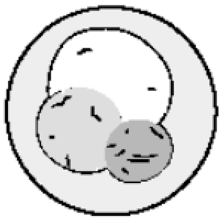
Discussion:

Start by asking the group about some of the discoveries they made regarding the sizes of the planets. Were there any surprises? Ultimately direct the discussion so that they realize the smaller planets (except Pluto) are the inner planets, while the larger planets are the outer planets. You may also want to note that more than 96% of the combined volume of the planets is in Jupiter and Saturn (approximately 60% in Jupiter and 36% in Saturn). Those giant planets really are giants!

Worlds in Comparison

By Dennis Schatz (*Pacific Science Center*)

390 Ashton Avenue, San Francisco, CA 94112 ~~~ www.astrosociety.org/afgu



What's This About?

This activity demonstrates the different sizes of the nine planets in our solar system. Follow the steps outlined below to see the relative size (volume) of each planet. Start with a big 3-pound ball of playdough, which represents the volume of all the planets combined.

1. Divide the Entire Ball of Playdough into 10 Equal Parts

You may find it easiest to start by rolling the ball into one big hot dog shape.

- Combine 6 parts together, roll them into a ball, and put the ball into the Jupiter box.
- Similarly combine 3 parts and put them into the Saturn box.

2. Cut the Remaining Part Into 10 Equal Parts

- Take 5 parts and combine them with the ball in the Saturn box.
- Combine 2 parts to put into the Neptune box.
- Put 2 parts into the Uranus box.

3. Cut the Remaining Part Into 4 Equal Parts

- Take 3 parts and combine them with the ball in the Saturn box.

4. Cut the Remaining Part Into 10 Equal Parts

- Put 2 parts into the Earth box.
- Put 2 parts into the Venus box.
- Take 4 parts and combine them with the ball in the Uranus box.

5. Combine the Remaining 2 Parts and Cut Into 10 Equal Parts

- Put 1 part into the Mars box.
- Take 4 parts and combine them with the ball in the Neptune box.
- Take 4 parts and combine them with the ball in the Uranus box.

6. Cut the Remaining Part Into 10 Equal Parts

- Put 7 parts into the Mercury box.
- Take 2 parts and combine them with the ball in the Uranus box.

7. Cut the Remaining Part Into 10 Equal Parts

- Take 9 parts and combine them with the ball in the Uranus box.
- Put 1 part into the Pluto box.

And Now...

Now that you have divided the playdough to represent the planets by volume, roll the pieces in each planet's box into balls to best represent the shapes of the planets.

Mercury

Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune

Pluto

Toilet Paper Solar System

 Based on an idea by the late Gerald Mallon, a planetarium educator who spent his life helping students understand the Universe.

Materials:

- One roll of toilet paper, 201 sheets or more, per student group.
- Felt-tip marker(s) or gel pen, preferably 10 colors; but one pen per student group will do.
- Clear tape for repairs
- Table of distances to give to participants (Two to choose from. The longer [200 sheets] requires 85 ft., the shorter [100 sheets] requires 42 ft. of space).

Even in our own "cosmic neighborhood," distances in space are so vast that they are difficult to imagine. In this activity, participants will build a scale model of the distances in the solar system using a roll of toilet paper.

Representing both the sizes of the planets and the distances between them with the same model is very difficult unless you have 1000 yards to work with. This model only shows the relative distances between the planets and still requires approximately 85 feet to complete. If you have just completed the Worlds in Comparison activity before starting this one, note that at the scale used here, Jupiter would be the size of a grain of salt. You will want to mention to the students that the scales on the different activities are different. You can also remind the students that planetary orbits are ellipses, so the numbers here represent the average distance from Sun. Also, the planets will never all be in a straight line going out from Sun, as they are represented in this model.

Preparation:

- Select either the 200 or 100 sheet model and photocopy the handout.
- Pass out pens, table of distances, tape dispenser and roll of toilet paper to each student team.

- Pen Tips: If pens are very liquid they may bleed through too much or tear the paper. Gel pens work well.
- Toilet Paper Tips: Cheap, flat toilet paper generally works best. Textured paper is okay; printed paper can be distracting.

Doing the Activity

Take one sheet of toilet paper as a test sheet for the pens. Make sure the ink is not too wet, that the pens don't easily tear the paper. Also, have students practice writing on the delicate paper with one test sheet. After they have learned the best way to write on toilet paper, throw away the test sheet.

Suggest they make a dot on the seam between the first two sheets of toilet paper. This is the Sun. Write the word Sun beside the dot.

Then they can use the table of numbers provided to mark off the distances to each of the planets. The number in the table is the number of sheets of toilet paper needed to reach the orbit of each planet. Note: It is important to tell participants that the counts in the table are starting from the **Sun**, not from the previous planet. (Thus, after get to Mercury, you need 1.7 more sheets to get to Venus.) They should make a dot and write the appropriate planet name on the toilet paper at the distance indicated. Ceres, the largest asteroid, is used to represent the asteroid belt.

If you don't have the time or space to complete the model, try to get to Jupiter and note that Saturn nearly doubles the distance. The same is true of going from Saturn to Uranus. Or, try using the short version of the scale in the third column below (Note that we have included two student handouts, one for each version).

Toss the toilet paper in recycling to clean up.

Planet	Distance from Sun (km)	Squares of Toilet Paper Out to Planet's Orbit (short version)	Squares of Toilet Paper Out to Planet's Orbit (long version)
Mercury	57,910,000 km	1.0	2.0
Venus	108,200,000 km	1.8	3.7
Earth	149,600,000 km	2.5	5.1
Mars	227,940,000 km	3.8	7.7
Ceres	414,436,363 km	7.0	14.0
Jupiter	778,330,000 km	13.2	26.4
Saturn	1,429,400,000 km	24.2	48.4
Uranus	2,870,990,000 km	48.6	97.3
Neptune	4,504,000,000 km	76.3	152.5
Pluto	5,913,520,000 km	100.0	200.0

Student Challenge:

Astronomers believe there is a vast cloud of frozen comets called the Oort Cloud that surrounds our solar system. It lies roughly 50,000 times farther from the Sun than the Earth is. Ask families how many squares of toilet paper you would need to put the cloud on the longer scale model? (Answer: 50,000 x 5.1 = 255,000 squares).

200 SHEET MODEL

Note:
Keep a running count as you work on this. Each distance is from your starting point, the Sun

PLANET	SQUARES OF TOILET PAPER FROM THE SUN
Mercury	2.0
Venus	3.7
Earth	5.1
Mars	7.7
Ceres	14.0
Jupiter	26.4
Saturn	48.4
Uranus	97.3
Neptune	152.5
Pluto	200.0

Note:

- 200 sheets of toilet paper stretch out to nearly 84 feet. Make sure you have room for your model before you start.
- Use colored pens to mark the distance to the planet's orbit from the Sun and label the orbit with the planet's name on the toilet paper.

Note:
Keep a running count as you work on this. Each distance is from your starting point, the Sun

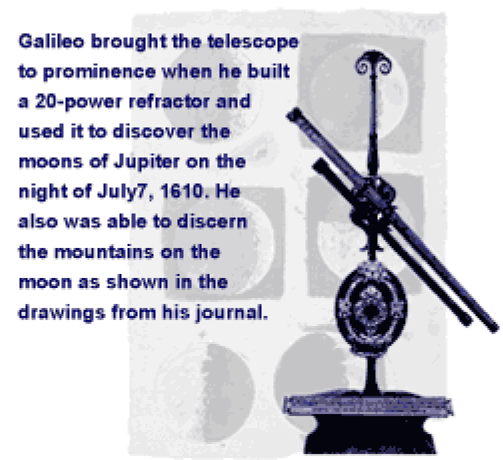
Planet	Squares of Toilet Paper from the Sun
Mercury	1.0
Venus	1.8
Earth	2.5
Mars	3.8
Ceres	7.0
Jupiter	13.2
Saturn	24.2
Uranus	48.6
Neptune	76.3
Pluto	100.0

Note:

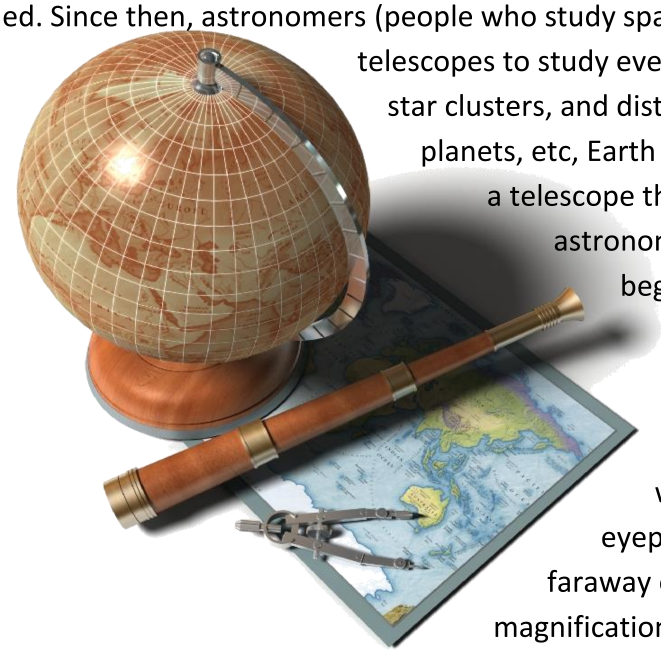
- 100 sheets of toilet paper stretch out to nearly 42 feet. Make sure you have room for your model before you start.
- Use colored pens to mark the distance to the planet's orbit from the Sun and label the orbit with the planet's name on the toilet paper.

How do we know ? Telescopes

Credit for inventing the telescope usually goes to Hans Lippershey, a Dutch optician, eye doctor, Lippershey, who revealed his device for seeing things at a distance in 1608, probably intending that it would be used primarily by sailors. Word of the instrument traveled to the famous scientist Galileo Galilei in Italy, who decided to make his own. One night in 1609, Galileo turned his telescope to the heavens—and changed astronomy forever. (Astronomy is the study of space and anything in it. It's more than just Earth and our Solar System. The study of astronomy covers every planet, object, and bit of energy flowing through the universe.) Telescopes, even very early ones, revealed information about the celestial entities (planets, moon, etc) that no one had previously imagined. Since then, astronomers (people who study space and everything in it) have used telescopes to study everything from our moon to comets, star clusters, and distant galaxies (huge groups of stars and planets, etc, Earth is in the Milky Way Galaxy). And with a telescope that's currently in the planning stages, astronomers hope someday to see to the very beginning of the universe.



Galileo brought the telescope to prominence when he built a 20-power refractor and used it to discover the moons of Jupiter on the night of July7, 1610. He also was able to discern the mountains on the moon as shown in the drawings from his journal.



Most telescopes work in basically the same way, producing an image of a distant object inside a tube and then we look at that image through an eyepiece. A telescope helps us to see faraway objects, not mainly through magnification (making something look larger than it is), as commonly believed, magnification actually does not mean much at all. A telescope actually helps through its ability to collect light. The amount of light collected by a telescope determines the level of detail we can recognize and is related to the size of its light-collecting part, commonly either a lens or a mirror (referred to as the telescope's "primary optics"). The larger the light-collecting component (piece), the greater the telescope's ability to gather light and, therefore, the bigger its "resolving power." Resolving power is the ability of the telescope to show two adjacent objects (ones next to each other), such as "double" stars or a planet and its moon, as separate, distinct (clear) images rather than as just one big fuzzy blob.

The eyepiece, which is usually made of two or more lenses mounted (set) in a cylindrical metal barrel, acts like a magnifying glass held up to the image made, or captured, by the light gathering primary optics. The magnifying power of a telescope (for example, 20X or 20-power) can be altered (changed) by simply changing the eyepiece, which will magnify the image, more or less than before.

If you simply want to use a telescope to enjoy the beauty and mystery of space, you can view the four largest moons of Jupiter and the rings of Saturn through most commercially available telescopes. With respect to constellations, the seasonal skies provide a changing light show. During the winter in the Northern Hemisphere, Orion is a prominent constellation, containing the red star Betelgeuse and the spectacular greenish clouds of the Orion nebula. The Ursa Major or "Great Bear" constellation, whose seven brightest stars form the Big Dipper, is brightly glowing in the Northern Hemisphere's summer sky. Also starring in each evening's performance are planets, nebulae (an interstellar cloud of dust and gas), and our moon. Stars and planets get most of the attention when we're talking about space. But there's lots of other cool stuff up there, too. Grab a telescope, some binoculars, or even just your own eyes and enjoy the show!

Tubeless Telescope

There are a lot of different types of telescope from the simplest set, to orbital telescopes, like the Hubble telescope, which travels around the Earth at a speed of 5 miles per second taking amazing images of outer space, undistorted (unchanged) by Earth's atmosphere. Show students photos from Hubble's gallery of images [at http://amazing-space.stsci.edu/] like the Butterfly Nebu la, colliding galaxies, images of where stars are really born, and much more. It may look like science fiction, but it's simply science!

We can't make a new Hubble, but there are some we can make and the absolute simplest one is made up of just two lenses. One large lens called an objective and a second smaller lens called an eyepiece and if you follow the directions a point will be reached where everything comes into focus. It is as simple as that. You have a telescope.

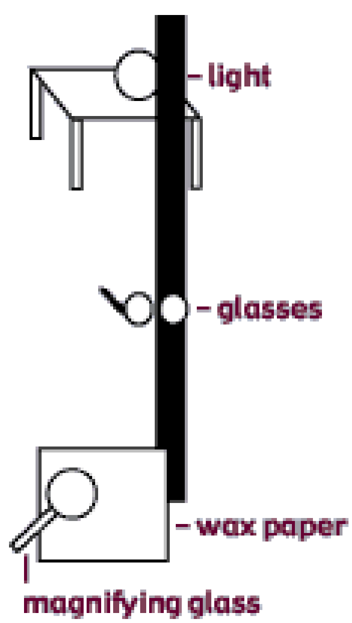
Activity modified from one found at:

http://www.exploratorium.edu/exploring/space/activity.html.

Materials:

- A pair of "drugstore" reading glasses ("Weak" glasses—those with low numbers—will work the best)
- A magnifying glass
- A flashlight
- Masking tape
- A piece of waxed paper or thin typing or tissue paper

One lens of the reading glasses will serve as the objective lens of the telescope—the lens that gathers light from stars or other objects. The magnifying glass will be the eyepiece. This telescope won't have a tube—that's so students can see how an image is formed inside a telescope.



1. Divide students into small groups or pairs, if possible, and pass out the supplies needed for the project.
2. To keep their "objective lens" steady, have students tape the glasses to a coat rack, the back of a chair, or any other object, making sure that one lens sticks out into space.
3. Have another student set the flashlight on a table four meters (approximately thirteen feet) or more from the glasses. Turn the flashlight on and shine it at the lens.

4. Have students hold the paper in front of the lens on the side opposite from the flashlight.
5. Now, have students slowly walk away from the lens, perhaps as far as a meter (approximately 3 feet), until they see a small image of the flashlight on the paper.

Normally, this image is formed inside the tube of the telescope and can't be seen directly. This is the focal point of their objective lens.

6. Have one partner hold the paper at the focal point while the other student faces the back side of the paper and looks at the image through their magnifying glass and adjusts the position of the magnifying glass until the flashlight image is magnified.
7. Have their partner take the paper away, but continue looking through the eyepiece of your telescope. The image should be a lot brighter since the paper won't be diffusing (spreading out) the light.
8. Extension: Have students try looking at other objects that are near the flashlight by slightly moving the eyepiece up, down, and from side to side.

Tubular!

Now students can make a better telescope by creating a tube around it by following the following plans. Plans and images modified from projects found at:
http://www.stormthecastle.com/little-wonders/Star-gazing-book/star-gazing8-making-a-telescope.htm

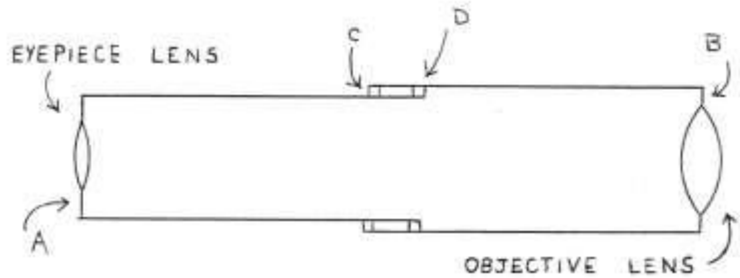
Materials (per telescope)

- 2 cardboard tubes with one a little bit wider than the other (these can be constructed from cardstock or poster board and tape as an alternative, though you may need to double layer the cardstock for strength.)
- 2 convex lenses
- (optional) 1 concave lens
- cardboard to mount the lenses
- craft glue

Notes on lenses:

Inexpensive lenses are available from a variety of surplus and online stores, at photography shops, or at optics centers, and they generally will only cost a couple of dollars each.

- The diameter of the convex objective lens should be approximately two inches and its focal length should be approximately 18 inches (at least 50 millimeters in diameter and a focal length of between 200 and 300 millimeters.)



- The eyepiece lens should be smaller than two inches in diameter and have a focal length of approximately two inches (A convex lens that is between 10 and 25 millimeters wide with a focal length of less than 75 millimeters.)
- You can test the focal length of a lens by focusing an image of the sun or lamp onto a white piece of paper, like in the previous project. When the image of the lamp is sharp the distance the lens is away from the paper is the focal length.

Focal Length: The focal length is the distance it takes the objective (mirror or lens) to bring the light from what the telescope is pointed at into focus. This is usually measured in millimeters. Note: Eyepieces also have a focal length. This also is measured in millimeters.

The size of the objective: The size of the lens or mirror is usually measured in inches or millimeters. This is important because the size of the objective determines what can be seen and how bright the image will be.

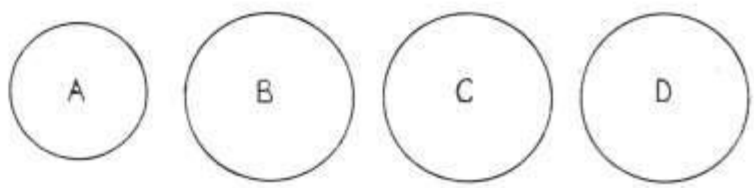
Limiting Magnification: Every telescope has a limited range of useful magnifications. The limiting magnification is quite simply based on the size of the objective lens or mirror. As a rule of thumb the average telescope can handle between 50x and 70x per inch of aperture (opening). So for example a small telescope purchased in a store can really only handle about 100x to 144x magnification. Only 100x! But on my box it says it will work up to 500x? Sorry, but at 500x in a small telescope you would be lucky to see anything at all. The problem is that the telescope does not collect enough light to magnify an image that much. As the magnification powers increase the brightness of the image seen in the telescope will decrease.

Examples: An average telescope with a 60mm (2.4 inch) objective will work up to about 144x2.4 inch objective x 60 magnification per inch = 144x magnification. An average telescope with a 150mm (6 inch) objective will work up to about 360x.6.0 inch objective x 60 magnification per inch = 360x magnification. So as you see a larger telescope that collects more light allows for a higher magnification.

Have students:

Get (or construct) two cardboard tubes with one that can slide in and out of the other.

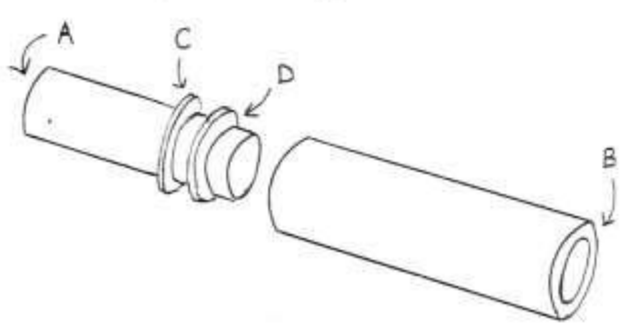
Step 1: Cut from cardboard four circular rings. Make 1 of the rings the inside diameter of the small tube (A) and make three of them the inside diameter of the large tube (B,C, & D).



Step 2: Have students cut a hole in the center of ring A and glue or tape the eyepiece lens into it. Remind them to keep the tape or glue at the edges of the lens. Make sure there is no glue or tape in the middle of the lens; this could obscure your vision and cause the telescope to not work properly.

Step 3: Cut a hole in the center of ring B and glue the large objective lens into it. Again, make sure there is no glue or tape in the middle of the lens.

Step 4: Cut holes in rings C and D so they will snugly slide over the thin tube and glue them in place as shown below.



Step 5: Glue the ring/lens assemblies onto the corresponding tubes.

Step 6: After the glue has dried, if glue was used, have students insert the end of the paper tube (the end without the lens) into the end of the cardboard tube (the end without the lens), the eyepiece tube should snugly slide into the objective tube.

Using the Telescope

Have students Look through their telescope at a distant object and slide the tube in and out in order to focus on the object they want to view. Note that this simple telescope will show objects to be upside down. Remind students: Do not look at the sun or any other extremely bright light through the telescope.

Improving the Design:

How do students think they could improve the telescope design? Have students evaluate the telescope and determine ways to improve the design and then develop an adaptive design and test its effectiveness.
SAMPLE Hypotheses: There are several things you can do to make this telescope even better. First off you could make a tube out of something more durable than cardboard tubes.

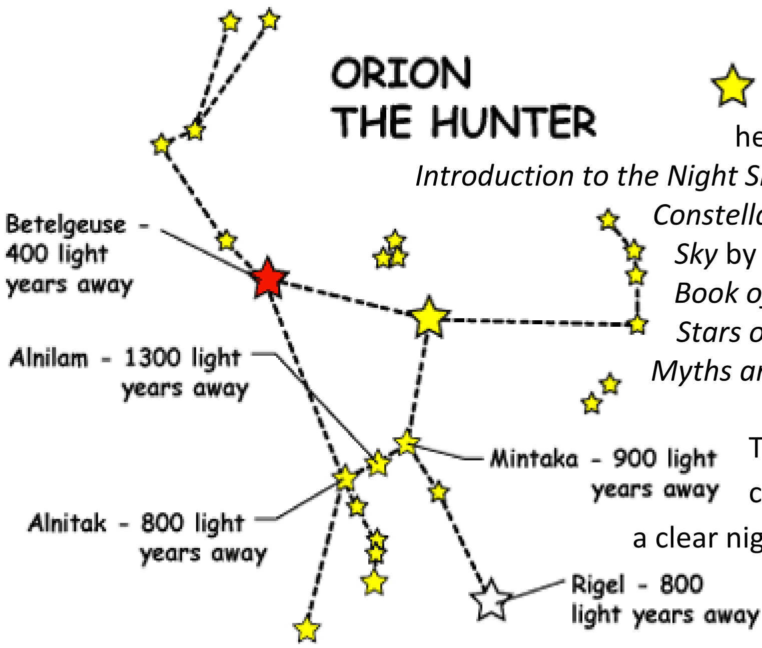
Issue: Inverted Images:

This type of telescope will invert images so everything appears upside down which is ok for viewing the sky but is very awkward for viewing things on the earth.

How could students solve this problem?

SAMPLE Hypothesis: You can solve this by using a concave lens for the eyepiece rather than a convex lens.

Constellations



There are many excellent books available to help introduce this topic, such as *A Child's Introduction to the Night Sky: The Story of the Stars, Planets, and Constellations--and How You Can Find Them in the Sky* by Michael Driscoll, *Once Upon a Starry Night: A Book of Constellations* by Jacqueline Mitton and *Stars of the First People: Native American Star Myths and Constellations* - Dorcas S. Miller

To the naked eye it is estimated that a person can see approximately two thousand stars on a clear night. The vast majority of these stars are part of a light band that crosses the sky called the Milky Way galaxy. The Milky Way can be seen on a clear night at different times of every night of the year. A small telescope or binoculars will reveal the Milky Way to be composed even further of an innumerable number of stars not usually visible to our naked eyes.

Stars are loosely grouped together into patterns called constellations, though scientists call them asterisms now

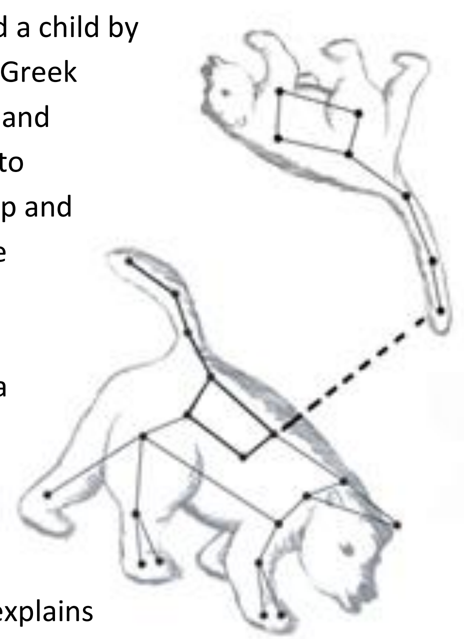
What ARE Constellations Anyway?

A constellation is group of stars that looks like a dot-to-dot puzzle. If you join the dots—stars, that is—and use lots of imagination, the picture would look like an object, animal, or person. There are 88 generally accepted constellations and the 48 we can see from North America are the same as they were catalogued by an ancient Greek scientist named Ptolemy who lived almost two thousand years ago. These constellations were named after mythological heroes and animals such as Orion the mighty hunter and Taurus the great bull.

For example, Orion is a group of stars that the Greeks thought looked like a giant hunter with a sword attached to his belt. Many of the 88 constellations were named after mythological characters by the Greeks centuries ago.

Students are probably familiar with the Big Dipper and the Little Dipper. They may even be able to identify them. Many people mistakenly think that the Big Dipper is a constellation but it isn't, it is something called an asterism. An asterism is a small easily recognizable formation of stars that is usually part of a larger constellation. In this case, the Big Dipper is part of the constellation Ursa Major. But did they know that the big and little dippers are also called Ursa Major (The Big Bear) and Ursa Minor (The Little Bear)? There are interesting myths about these two bears in the sky.

The Greek Tale of Callisto and Arcas

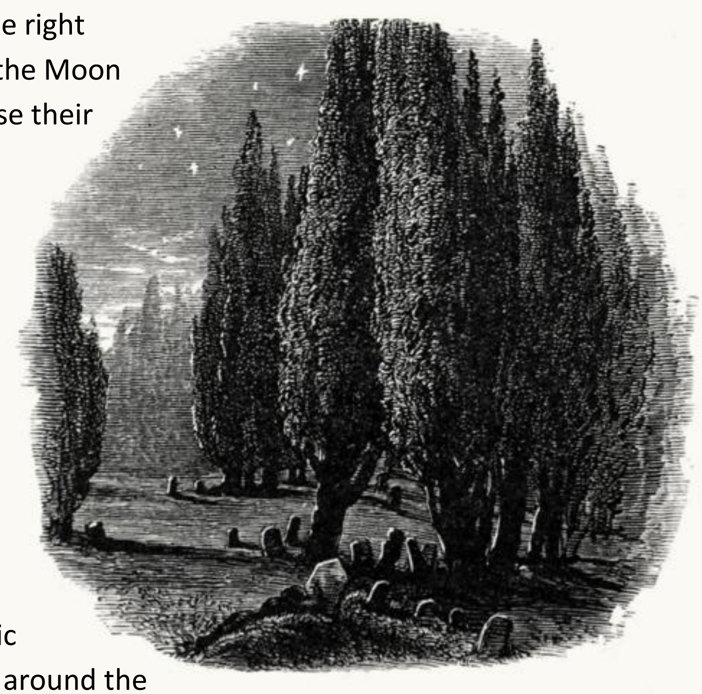


There was a beautiful Arcadian nymph called Callisto who had a child by the god Jupiter/Zeus (Greek name). The Goddess Juno/Hera (Greek name), Zeus' wife, was jealous of Callista's beauty, and baby, and punished her by turning her into a bear and condemning her to roam alone in the forests forever. Callistos son, Arcas, grew up and become a hunter. One day as he was hunting in the forest the bear Callisto heard Arcas' voice and rushed to greet her son. Arcas, not knowing the bear was his mother was about to kill her. Just as Arcas was about to shoot, Jupiter (Zeus) realized a tragedy was going to happen and he prevented it by turning Arcas into a bear and by placing both bears into the sky to roam forever, out of reach of Juno (Hera). When you look at the constellations you might wonder why they have such long tails, for bears. The way Zeus got the bears into the sky explains why their tails are so long, apparently Zeus grabbed them by their tails and swung them around over his head and finally flung them into the sky, and that is why these two bears have long tails!

While conventional Greek constellations still map our sky for professional astronomers, the Greeks weren't the only ones who made stories from the stars. People have always tried to impose (put/force) patterns on seemingly random groupings. Both the Greeks and our First Peoples (Native Americans) filled their skies with peoples and animals. Some interesting similarities come out - for example, the Big Dipper is a bear in standard Greek and Roman and in many Native American myths, and Sirius is a dog or wolf star in standard and in Native American myths.

Other than making a pattern in Earth's sky, these stars may not be related at all. For example, Alnitak, the star at the left side of Orion's belt, is 817 light years away. (A *light year* is the *distance* light travels in one Earth year, almost 6 trillion miles!) Alnilam, the star in the middle of the belt, is 1340 light years away. And Mintaka at the right side of the belt is 916 light years away. Yet they all appear from Earth to have the same brightness.

Even the closest star is almost unimaginably far away. Because they are so far away, the shapes and positions of the constellations in Earth's sky change very, very slowly. During one human lifetime, they change hardly at all. So, since humans first noticed the night sky they have navigated (guided themselves) by the stars. Sailors have steered their ships by the stars. Star patterns are also very helpful for navigating (guiding) a spacecraft. Most spacecraft have steered by the stars—or at least checked the stars once in a while to make sure the spacecraft was still on course and pointed in the right direction. Even the Apollo astronauts going to the Moon had to know how to navigate by the stars in case their navigation instruments failed.

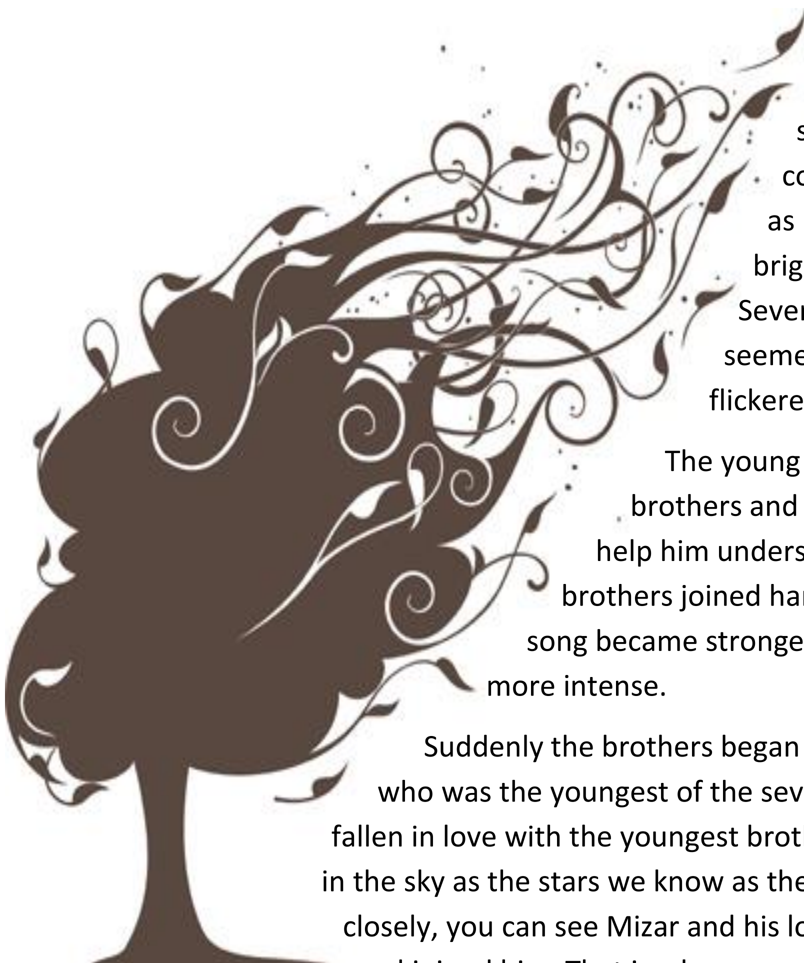


Shining Stars and Ancient Stories

Read several stories about the origins of specific constellations, comparing cultural stories from around the world like the following.

For the Big and Little Dippers, the Greeks tell the tale of Callista and Zeus. In Mongolia, a different tale is told.

One day when the Earth was very young, a father sent his seven sons into the forest to learn how to read the winds. They entered the woods and silently walked about while listening to every sound of the wind. When night fell, the sons set up a camp and gazed up at the brilliant stars above.



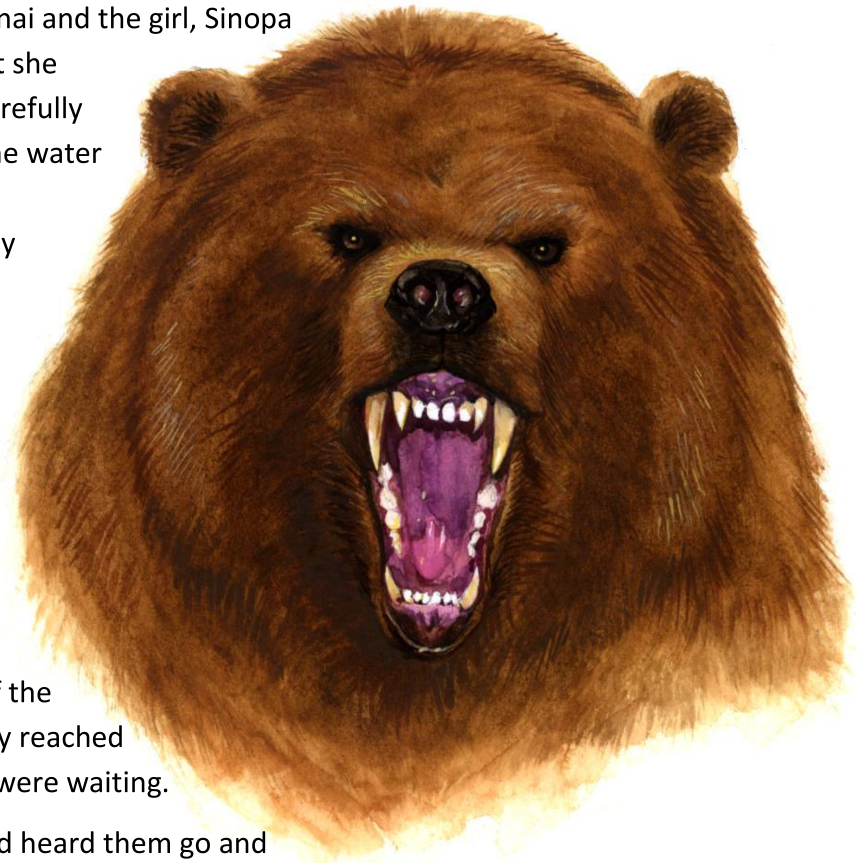
During the night, the eldest brother was awakened by a strange sound. The wind was singing. He could not understand the words but as he looked to the stars, he saw a bright flickering in the Pleiades (The Seven Sister Constellation). This light seemed to be beckoning to him and it flickered in rhythm with the wind song.

The young man immediately awoke his brothers and told them to listen to the song and help him understand what the wind was saying. The brothers joined hands and began to dance. The wind song became stronger and the brother's dance became more intense.

Suddenly the brothers began to rise toward the flickering star who was the youngest of the seven sisters of the Pleiades. She had fallen in love with the youngest brother, Mizar. The brothers remained in the sky as the stars we know as the Big Dipper and if you look very closely, you can see Mizar and his love, for she had left her other sisters and joined him. That is why you only now see six stars in the Pleiades (from the Seven Sisters myth).

Native American - Blackfoot

In a camp there once lived a family of the father, mother, seven brothers and two sisters. The brothers and sisters were all grown up except for one small brother, and one little sister. One day, the six older brothers went on a long hunting trip. While they were away, the eldest sister fell in love with a bear and married him. The girl's father was very unhappy and with the help from other men in the tribe, they chased and killed the bear. Then the girl changed herself into a bear and avenged her husband's death by killing everyone in the village but her youngest brother and sister who had hidden in their home. The little brother had enough magic that he was able to make it so their sister could not enter their home. The bear-woman promised that she would get them.



The two young children, the boy Okinai and the girl, Sinopa knew they had to be very careful lest she catch them. One day, little Sinopa carefully snuck down to the river to fetch some water when she saw her six older brothers returning from their hunt. She quickly told them everything that had happened and they told her they knew of a way for them all to escape. They collected up a large number of prickly pears and told Sinopa to go home and scatter the pears all around their home, leaving only a very narrow path along which she could find her way out. Late that night, Sinopa and Okinai crept out of the tent following the tiny path until they reached the spot where their older brothers were waiting.

But their sister, the bear-woman, had heard them go and as she rushed after them she became caught amongst the prickly pears. Bear-woman howled with pain and anger but quickly transformed herself back into a bear so that she could run right through the prickly pears after her siblings.

Little Okanai saw the bear coming and shot an arrow which immediately put them all as far ahead of their sister as the arrow had flown. But still the bear was gaining on them. Then Okanai waved a feather and at once, thick, tangled bushes sprang up behind them, but the bear's magic cleared a path through them.

Finally, Okanai waved his hand and a huge tree shot up from the dirt beside them. The eight terrified siblings scrambled quickly up into the branches but they soon found they were not safe yet! The bear climbed the tree herself and quickly dragged four of her brothers down when Okanai called on his very strongest magic! One by one, Okanai shot eight arrows into the sky and with each shot, one of the children soared up into the sky. First was little Sinopa, then the six older brothers and finally Okanai himself.

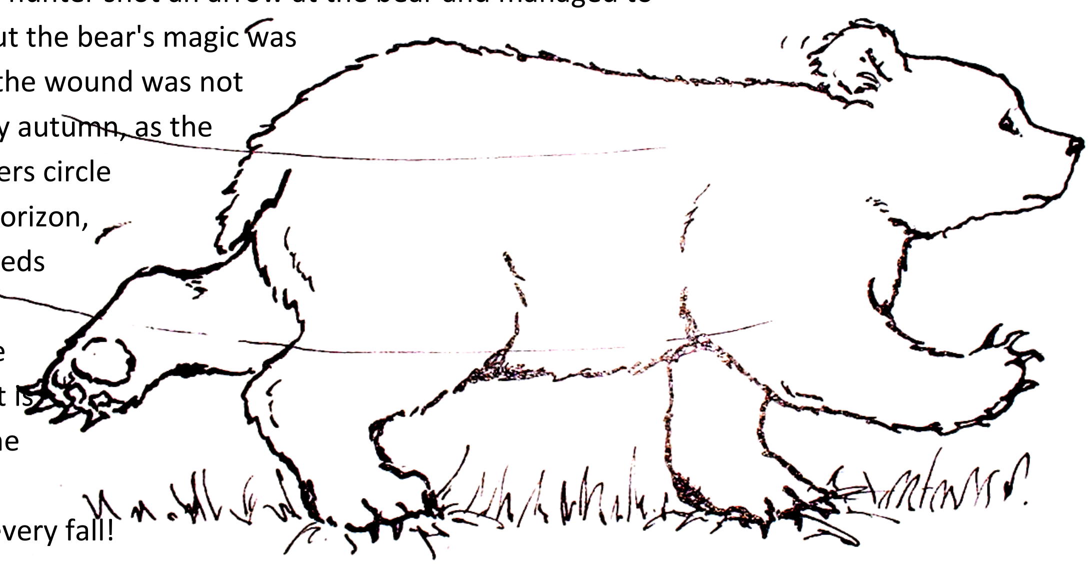
As they reached the sky, they each turned into a star and there they are today as the group of stars we call the Big Dipper. The four stars which make up the bowl of the dipper are the four that the bear-woman had pulled from the tree. The three stars in the handle are those who are still hanging in the branches and the tiny companion star to Mizar is little Sinopa, huddling close to one of her brothers!

Native American - Algonquin

There once was a very large and mean spirited old bear whose greatest happiness came from destroying villages. Everyone was afraid of the bear Finally, the elders from three villages met to discuss what could be done. After they had talked for a long time they decided they would each bring their best and most brave warriors together to hunt the bear.

When the bear realized just who was after him, he decided to run away because he was really a coward at heart. The bear ran and the hunters chased him. The hunt went on for many moons and the bear began to tire, but no matter what he did, he could not escape the hunters. Finally, in desperation, he ran right up into the sky and the hunters went right after him! Around and around they went, circling the north star.

Once, the lead hunter shot an arrow at the bear and managed to wound him, but the bear's magic was powerful and the wound was not fatal. But every autumn, as the bear and hunters circle low over the horizon, the wound bleeds a few drops of blood onto the Earth, and that is what makes the trees leaves change color every fall!



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Catch a Falling Star

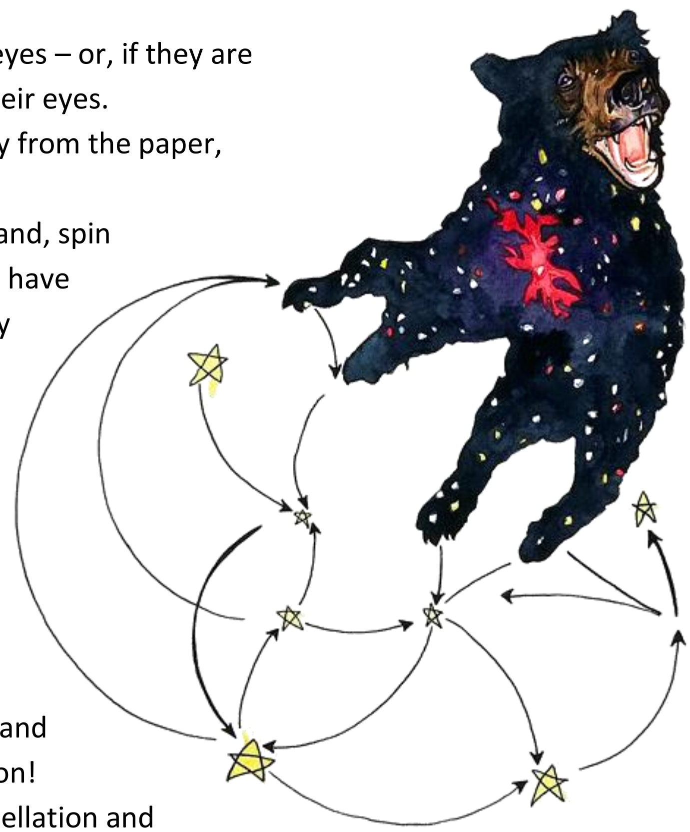
The following activity will help your students understand that constellations are groupings of stars that appear to form a pattern or picture in the night sky.

By creating their own constellations the students will also learn about the process of how these star groupings were identified long ago!

Materials:

- Star stickers
- Blindfold (optional)
- Sheets of large white paper (approximately 2 x 3 feet if possible)
- Masking tape
- Various craft items such as colored glitter, glue, crayons, paint, sequins, etc.

1. Using masking tape, tape a sheet of white paper to an area on the wall about the child's chest height, if this is not possible, students can do this project at their desks or on the floor.
2. Ask your students to close his or her eyes – or, if they are comfortable, place a blindfold over their eyes.
3. Have the child stand several feet away from the paper, or sit at their desk with the paper.
4. Place a star sticker in your students hand, spin your student around a few times, and have him or her walk to the paper (you may help!) and place the 'sticky star' on the paper.
5. Repeat the process for several more star stickers (5-10 should do it!)
6. Remove blindfold
7. Ask your student to use their imagination to connect the stars to form a design, or to create a constellation around the stars. Color and use craft items to decorate the creation!
8. Have your child name his or her constellation and create a story about the object represented in the constellation using the graphic organizer to begin organizing their ideas.



Constellation Wanted/missing Poster

Have students create a "Wanted" or "Missing" poster for their constellation and/or a different character from their myth. The name of their character must be clearly visible on their poster. Anyone who glances at their poster should be able to tell what their constellation looks like.

The "Wanted" or "Missing" poster theme must be followed. Meaning, their poster should read like the following Example Wanted/Missing: Coyote

If following the Wanted format, include a short description of what its "crime" is. And what the reward is.

Have the students pick 3 or more of the following to include on their wanted poster:

1. Description of the character
2. A quote about the sky by your character, or a character from your myth.
3. Additional pictures of your constellation character.
4. Where they were last seen.
5. What they were last seen doing.
6. Family information. Provide names of parents, spouses, children, brothers, sisters, etc. when applicable.
7. List 3 events that happened in the process of their character becoming a constellation.
8. The name(s) of other characters that your constellation worked with, possibly as fellow outlaws.

What is the purpose of your myth?

Main Character's name and purpose/goal:

List any Gods, Goddesses, Demi-Gods (part gods) in your story and their roles:

List any Animals or Mortals in your story and their roles:

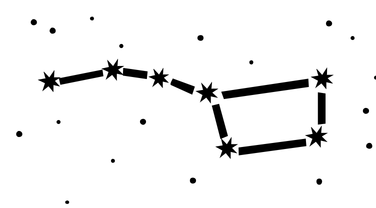
Why was your constellation put in the sky? What is its name?

Why is the constellation visible during that time of the year? Why did you place it where you did?

Star Light, Orion Bright, First Constellation I See Tonight

Students build a Starfinder, learn the basic technique for finding constellations in the night sky, practice using the Starfinder indoors, and be prepared to do a Celestial Treasure Hunt

If you live where big city lights drown out the beauty of the stars, you may see only a few of the brightest stars and planets. How sad! But see if you can find at least one or two constellations on a clear, moonless night.



Materials:

- Scissors (one pair per person)
- Starfinder Templates
- Stapler (one per table)
- A box of extra staples
- Masking tape to tape items to wall (painter's tape is gentler on painted surfaces)
- Poster or flip chart paper
- Markers

Set Up:

1. Place scissors and staplers on tables where students will build the Starfinders.
2. Have Starfinder templates ready to distribute, but do not distribute until the group is ready to work on them.
3. Have cards with cardinal directions ready to use as needed.
4. See instructions at end of this section for how to make constellations on poster paper for use with this activity

We see different views of the Universe from where we live as Earth makes its yearly trip around the solar system and depending on where we live on the planet and what direction we're facing.

Ask the students to help you identify the cardinal directions. Ask for suggestions of how to determine which direction is North, West, East, and South. You may want to remind the students that the Sun sets roughly in the West and rises roughly in the East. Or get one of the participating kids to use a compass. Once you have determined the directions, tape cards or sheets of paper with cardinal directions to the walls of the room.

Before distributing materials for students to build their own Starfinder, build one while talking them through the instructions, so that they can see exactly what they need to do.

Then have students follow the instructions on the Starfinder template to construct the Starfinder. While they are being built, move around the room to ensure they are assembled properly.

Use the simple star field to begin with, and be sure everyone has it facing the right direction.

After all the Starfinders are assembled, use the following steps to give students practice using the Starfinder before going outside:

■ Have them align the current date on the wheel with the time on the holder for when they will go out to observe (don't forget to have them correct for Daylight Savings Time, if needed, by subtracting one hour from the time on their watches).

■ Have them hold the Starfinder over their heads so that the "North" designation on the Starfinder points North in the room. Point out that the stars showing in the oval opening are those that can be seen overhead at the time and date set on the Starfinder. The edge of the oval represents the horizon.

The center of the oval is the point directly overhead when they look up in the night sky. This point is called the zenith. Stars near the center of the oval will be high overhead when they observe.

■ Have them identify a constellation that is near the horizon and one that will be high overhead when they go outside at the time set on the Starfinder.

■ Have them find Ursa Major (Big Dipper) on the Starfinder and then determine the following three things:

1. What direction along the horizon is the constellation above (e.g. east, southwest, north-northeast, etc.)?
2. How far above the horizon it is? (e.g. one half, one third, etc.)
3. How many stars in Ursa Major are visible on the Starfinder and what is its shape?

Use this information to have them point at the direction they should look to see the constellation when they go outside. If possible, tape a poster paper showing Ursa Major to the wall in the proper location for where you would see it from the center of the room if you were outside at night. *See instructions at the end of this section for how to make constellations on poster paper for use with this activity. Be sure to point out that the constellation patterns look bigger in the night sky than on our little Starfinder.*

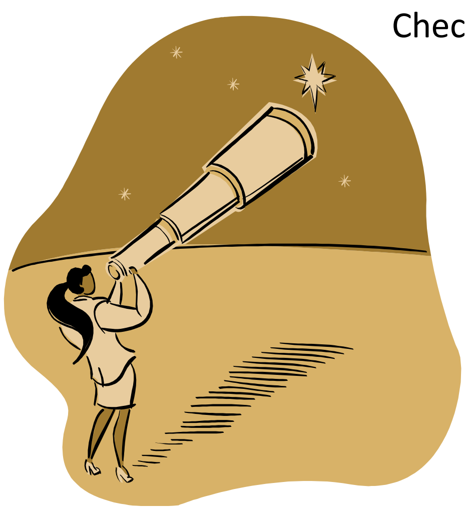
Repeat this process for the key constellation(s) for the current season, so that they will have a mental idea of where to look when they go outside to do a Celestial Treasure Hunt. If Ursa Major is the key constellation, then use the Cassiopeia outline to have students find a second constellation.

■ If time permits have them locate on their Starfinders the other constellations for the current season and determine what direction they will need to look when they go out at night. You may want to make poster paper patterns for these constellations ahead of time to place on the wall.

■ Point out that the simple star field shows the bright stars visible in the major constellations. These stars are easily found, especially when viewing from a city where the many lights make it difficult to see faint stars. Once they are experienced at finding the bright stars on this side of the star wheel, they can insert the complex star wheel and attempt to find the fainter stars and constellations. Note that some of these will not be visible until observed from a location well away from city lights.

■ You may also want to note that once they become familiar with some of the brighter constellations, they can use them as guides to find their way across the sky. For example, they can use the two outer stars of the Big Dipper's cup to help find the North Star.

Now they are ready for constellation finding in the night sky and ready to embark on a Celestial Treasure Hunt. Remind them to have a flashlight with appropriate red covering and warm enough clothing before going outside to use the Starfinder.



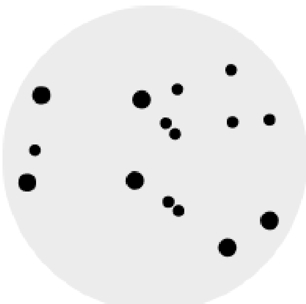
Checklist for Star gazing:

- Is the sky clear and cloud free?
- Have you found a dark spot shielded from bright lights?
- Are you dressed appropriately for the weather?
- Do you have your star maps and accessories?

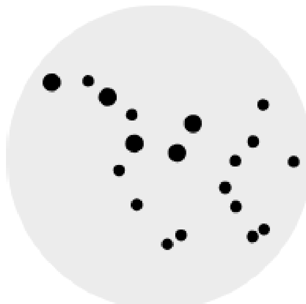
- Is your flashlight lens covered with a red material like cellophane? A flashlight is an important addition to your stargazing so you can read your star charts or books. But a regular flashlight is not good. When you do stargazing you have to take some time in the darkness to allow your eyes to adjust to the dark. This way you can see the most in the sky. But the bright beam from a flashlight could ruin this quickly and it will take another half hour for your eyes to adjust. So you need to cover the beam end of your flashlight with some type of red translucent (see-through) material so it will give off a dull red light. Red light will not affect your night vision.

Making Poster Paper Constellations:

It helps to put poster paper with the constellation outline on it up on the wall or ceiling to show what direction a person standing in the middle of the room must look at the time and date indicated on the Starfinder. Use the following patterns and markers to transfer each of the key constellations to poster paper sheets for use in this activity.



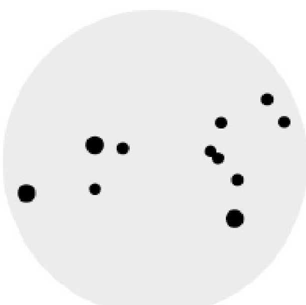
Pegasus



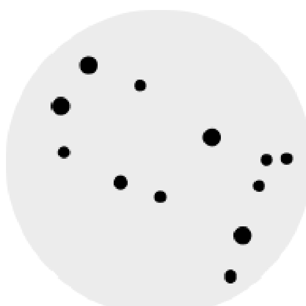
The Big Dipper
in the constellation
URSA MAJOR
(The Great Bear)

Cassiopeia

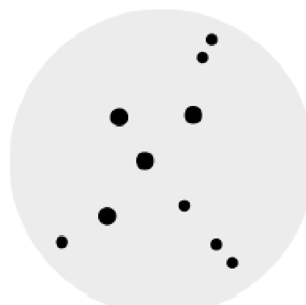
Orion



Leo
(The Lion)

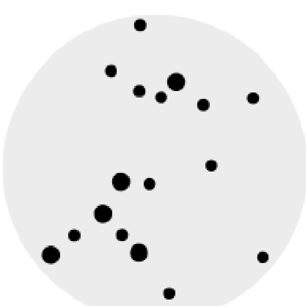


Gemini
(The Twins)

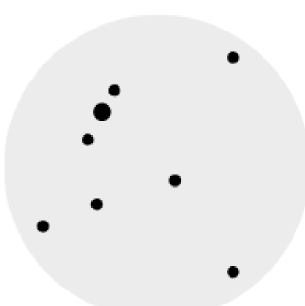


Cygnus
(The Swan)

Taurus
(The Bull)



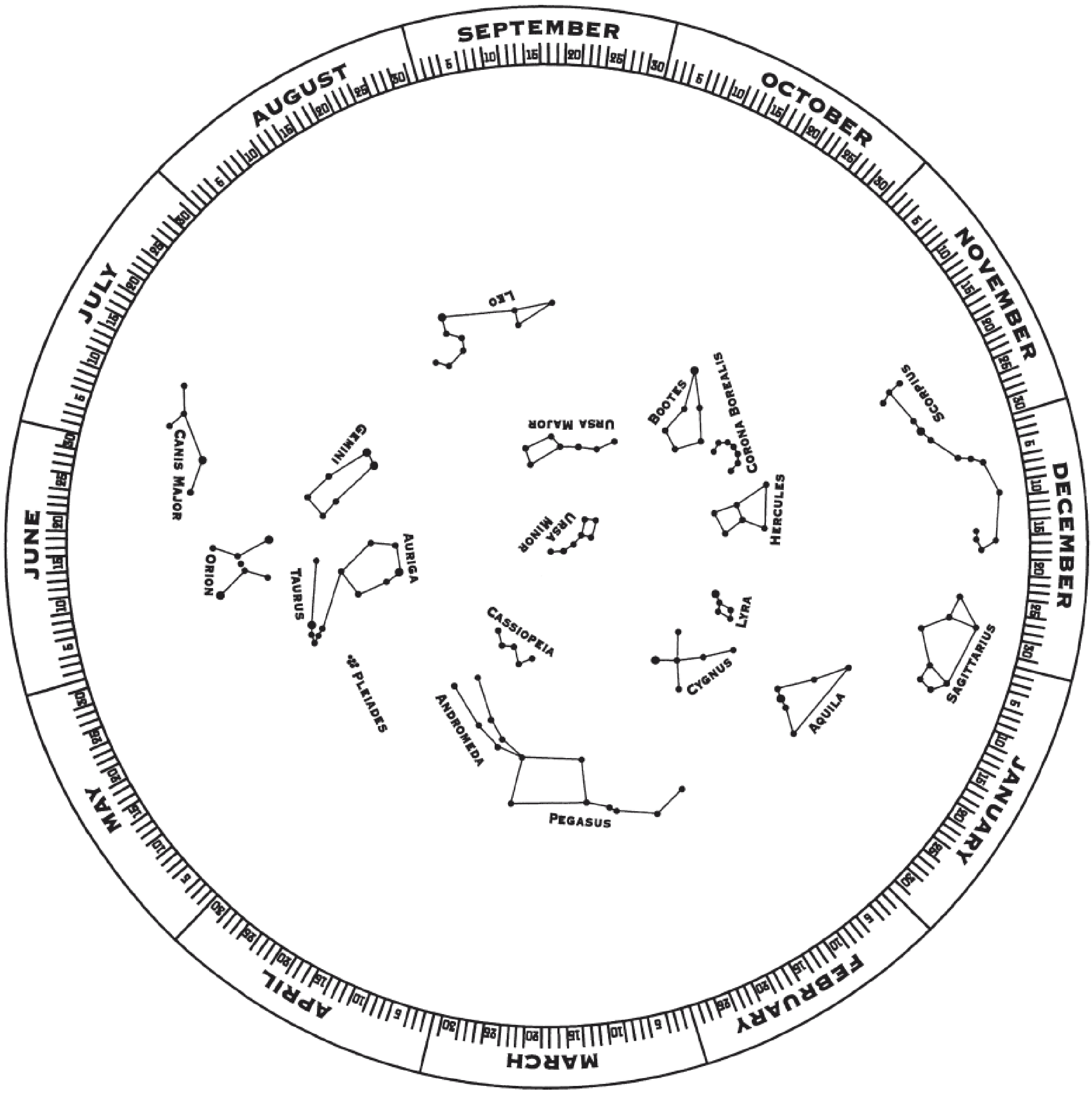
Canis Major
(The Great Dog)



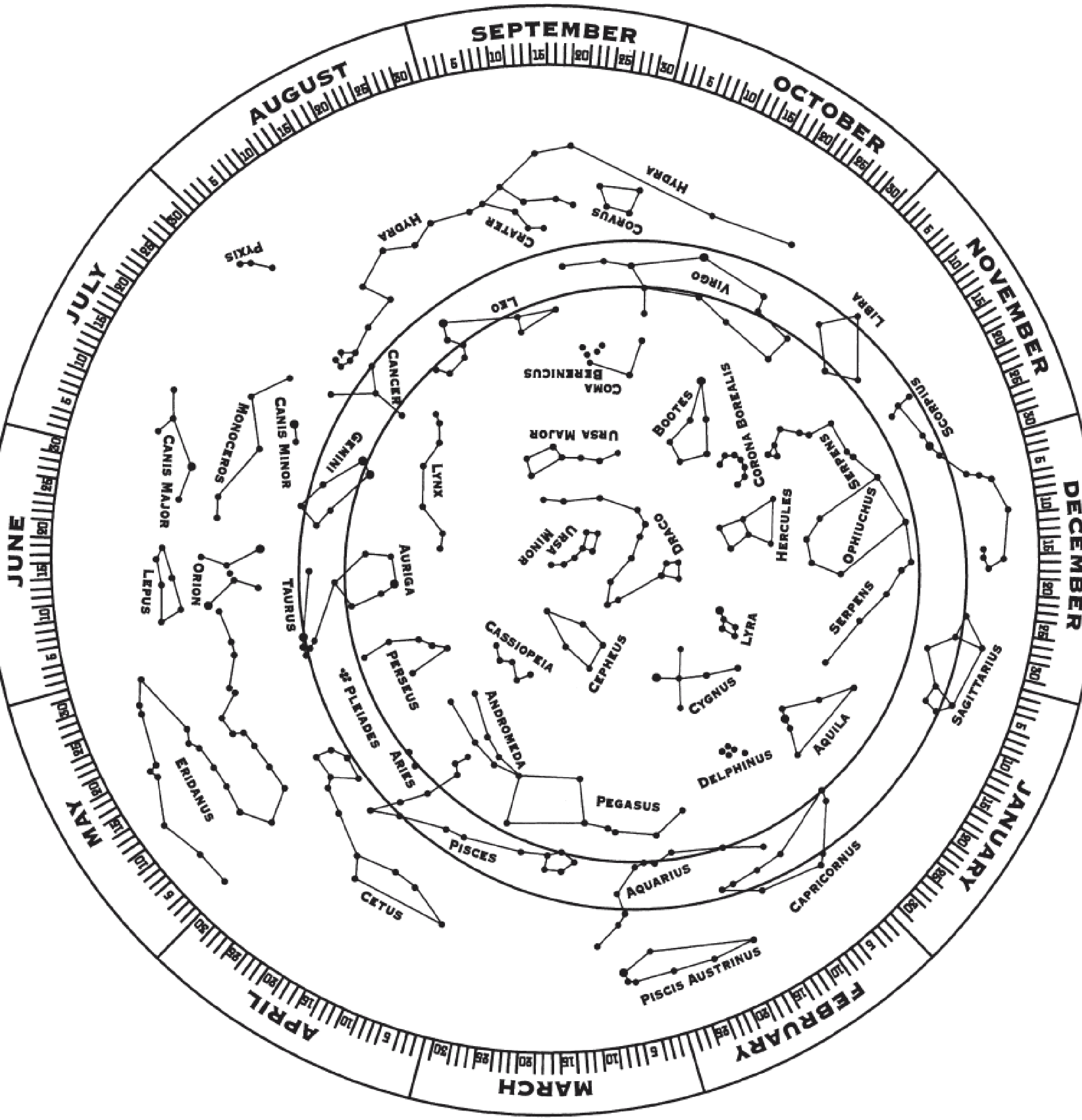
Aquila
(The Eagle)

Starfinder Holder

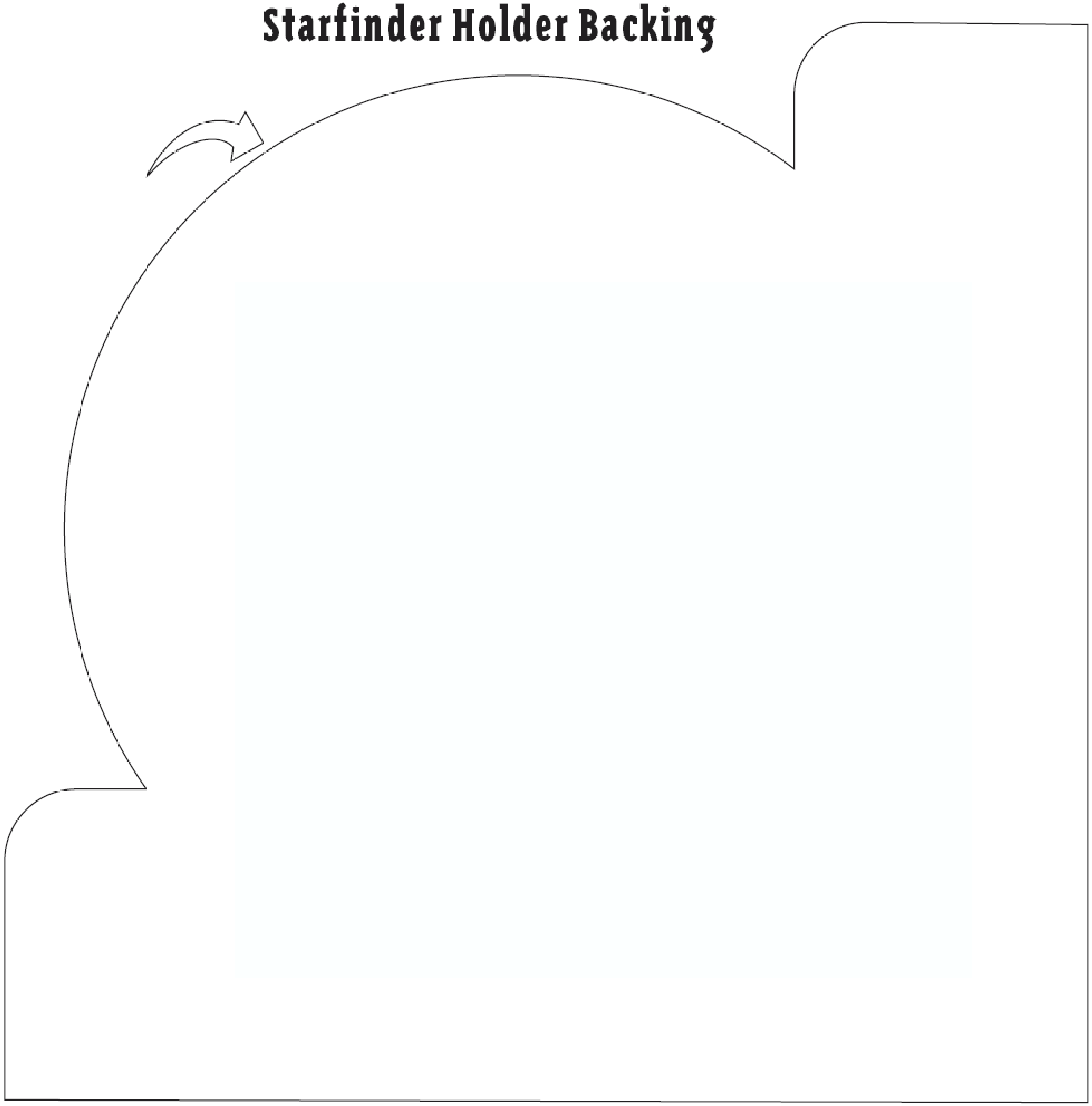
Star Wheel
Simple Star Field



Star Wheel
Complex Star Field

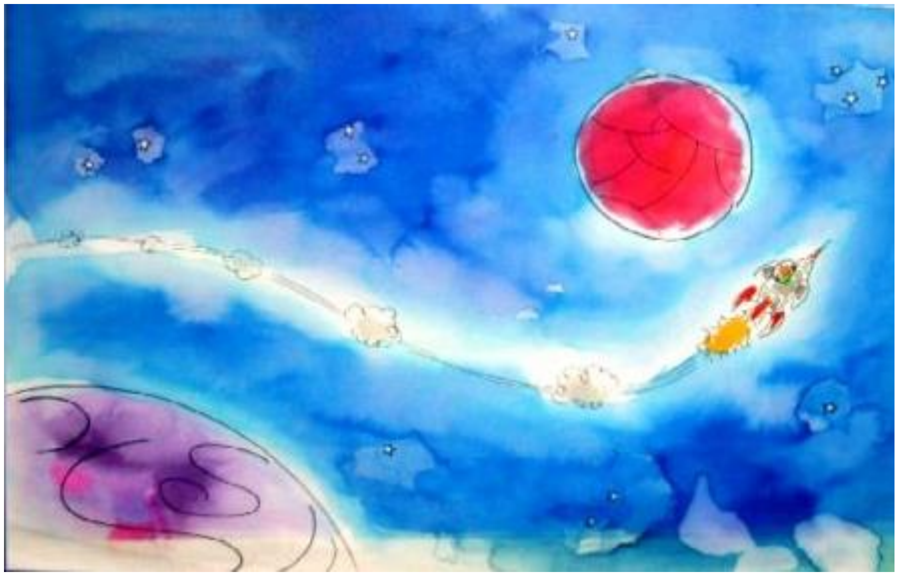


Starfinder Holder Backing



The Wild Blue Yonder

This lesson is very fluid, watercolor is a hugely variable, flexible, and fun medium and there are many different techniques which students can use to add interest to their space paintings. In the following project outline are several varied techniques, which means children can build upon previous experiences and continue to learn new ways of working with the materials. Have examples of each technique prepared and then have students experiment and combine to see which technique they like best for their own art.



Materials:

- Liquid, tube, or pan/cake watercolors
- Brushes
- Cheap Watercolor Paper (construction paper, drawing paper, or printer paper will not work well)
- Salt
- Paper Towels
- Cups
- Water
- Oil Pastels or Wax Crayons
- Pipettes (small droppers)
- Rubbing Alcohol
- Optional: small condiment (salsa cup) containers with plastic lids or baby food jars

Note on Paper: You can use the standard 12" x 18" drawing paper for most projects but if you cut that paper in half, children can complete the project in much less

Teacher Tip!

Ban pencils and erasers.

Sounds harsh, right? It's not being mean, the reason is purely practical: small pencil leads encourage small drawings. If a kinder is drawing a portrait and then is required to paint that very portrait, using a pencil will surely lead to frustration. It's hard to paint teeny tiny eyes! There is another reason: pencil markings can be erased, which leads to second guessing, which leads to lots of eraser action, which leads to class being over before the child has anything on his paper. Using oil pastels, crayons, and/or markers allows the artist to move quickly, commit to the drawing and forgive their "mistakes". This is a big part of creating art; giving into the process and not worrying about the details.

time. Not only does it save time, but it saves on supplies as well.

1. Start with a directed line drawing. It's important to note that even though you may use, "directed line drawing", it's rare that you want to give your students just one option, most of the time you'll end up with many drawings on the white board. Look at pictures and brainstorm together what a planet, black hole, moon, or rocket can look like, and create sketches up on the board. Give lots of examples! Draw a few different ones; some realistic, some silly, some animated, then talk with students how you could change the wings, the shape, that sort of thing. This technique works well, as you want the children to learn to draw but also want them to be as individual as possible.

2. In the process of drawing on the white board, always incorporate mistakes. **Always**. Laugh at your "mistakes", tell the kids to expect them and then show them how to turn mistakes into something else. It's critical that you show your artistic side, no matter what you privately think of it, and inspire your students.

3. Have students sketch out their own drawing. After instructions are given, the paper handed out and the children are engaged in their project, begin a ten-minute quiet time. This is their time; the chance to reflect on their work, the opportunity to lose themselves in their art, and perhaps the most important of all, the permission *not* to speak to their best friend.

    - *Oil Pastel/Wax Crayon Resist*: If they want their outlines to show through, oil pastel will repel the paint, create clear outlines, and allow the drawing to show through the paint. Note: Wax crayons can also work for this, but aren't quite as clear, though they are less messy.

4. When they're ready to paint, have students paint the background and its details first. If they used oil pastels or wax crayons, students don't need to avoid painting near or on the outlines, as the watercolor paint will bead off the oil pastel/crayon. If they paint the background first, they don't have to worry about accidentally painting the background colors into the main figure/subject's colors later on. Encourage the children to mix paints on their paper, not in paint palettes, and use the double-loading technique when you can. It produces very cool results and clean-up is much easier!

- *Wet-On-Dry Technique:* First, students dilute their pain with water and placing it onto the dry paper. The color lies on solid **without** gradient (Gradient is blending of shades from light to dark or from one color to another).

- W*et-On-Wet Technique*: Which is painting a wash of water (or paint), and then painting on top of that area while it's still wet. The result is a blotchy and clouded effect with gradient.

- *Salty Stars:* Yep, you read right. It takes a bit of (fun) experimenting, but using salt on wet paint can result in some amazing and fun effects. On the sky have students sprinkle some salt and let it set for 2-3 minutes until the paint completely dries. The salt absorbs paint and moisture leaving a unique texture. wait until it is completely dry and brush off any remaining salt crystals before resuming painting. (They do not want to get salt on their paint brushes or transfer the salt back to their palette-- it will make all of their paint come out blotchy!)Voila, star filled space!

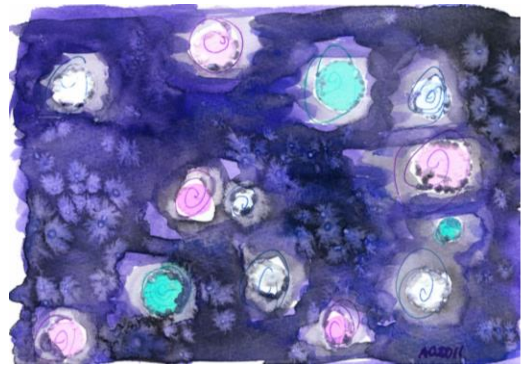


Image Credit: Innocent Stars by Amy Crook. Available at antemortemarts.com.

- *Rubbery/Scaly Effects:* While the paint is wet, have students used pipettes to drop some rubbing alcohol onto different sections to create a "scaly" or "rubbery" texture. Perfect for any rockets or aliens.

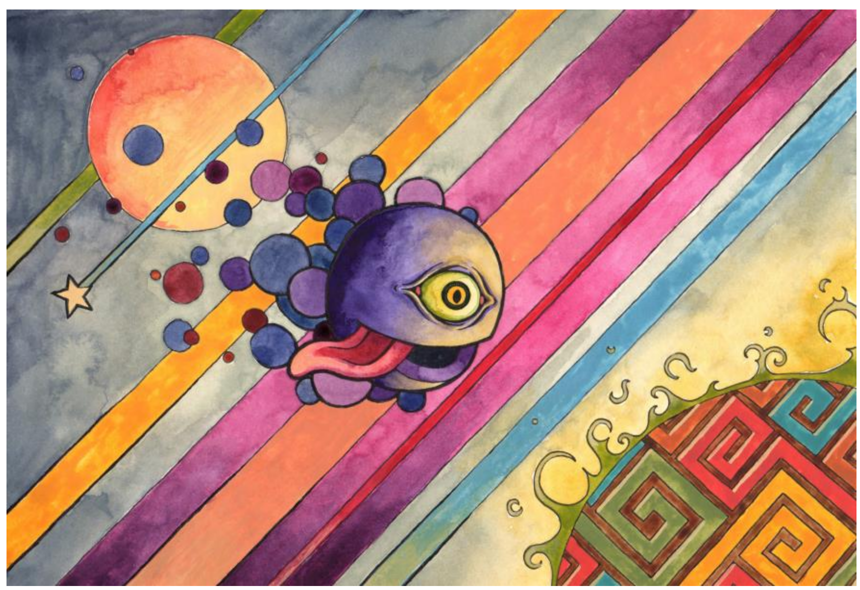
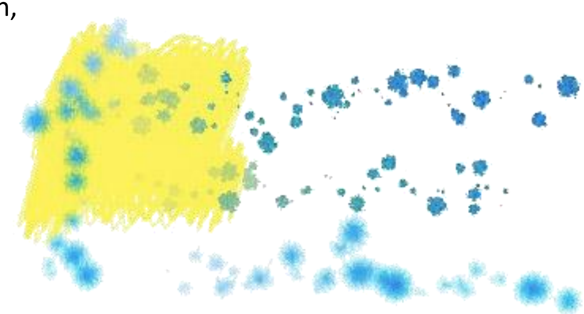


Image Credit: Water color painting by Niklas Åkerblad . http://eriksvedang.com/

- *Depth*: To make space even deeper and more dimensional have students use a less diluted blue or other color on top of the more diluted area already painted to bring the area to life, ex: make circular blotches around the stars, and blotches on some stars. The effect makes for a more celestial sky.

- *Erasing/Creating a Glow*: It's space and you want things to glow. When first starting to use watercolors students always tend to resort to their white paint to create shine, or think they can't have shine without white paint. Don't this. There is a better way. Applying diluted white paint can muddle colors, so use the erasing technique. SAMPLE: For a glowing moon students could paint a light wash of yellow on the moon, keeping it light to reflect the moon's brightness. But, as a moon, it must cast a glow. So, have students get their paper towel ready, and wet an inch and a half around its outside. They don't have to press hard, just brush some water on the paper. Then, have them take their paper towel and gently rub off the water which removes some blue paint to reveal the original yellow wash. Now, the moon glows. This also works if an area is too dark, erase = wetting down the spot and wiping excess paint away with a paper towel.



- *Spitter Spatter Splatter Paint*: using a brush loaded with color, run your fingers along the bristle to create large and small splatters.

Finalizing: Have students finish up their projects, practice additional techniques, and discover their own methods. If a student has extra time, and didn't use oil pastels, have them go the extra step and outline. It really makes the art piece pop. If you are doing a drawing in pencil and then decide to paint with watercolors, it's really hard to keep the contrast unless there is a dark line in there somewhere. On a fully dry painting use a sharpie waterproof black marker, oil pastel or even black paint and a small brush. It really makes a difference. And it doesn't always have to be black…they can try a blue or even a red.

Teacher Tip: Don't throw your liquid watercolors away. Use a dropper (think half-size turkey baster) to recycle any left over paint and store them in small condiment containers with plastic lids or baby food jars. This keeps the watercolors well. If a color, like yellow, gets too muddy, toss it, but mostly the colors stay true. This way you can go about a year and a half before you start to run out of basic colors like red, yellow and blue.

The Family of the Sun

Folk Song of uncertain origin, but the first time I heard it Joan Baez was the singer,
Uranus and Neptune written by Harold Williams and his AS101 class
Asteroid and Pluto by Stephanie Williams, daughter of Harold Williams
Tune *"Famer and The Dell"*

The family of the Sun
The family of the Sun
Here are ~~nine~~ eight planets in
The family of the Sun.

Mercury is hot
And Mercury is small
Mercury has no atmosphere
It's just a rocky ball.

Mercury has no atmosphere
It's just a rocky ball

Venus has thick clouds
That hide what is below
The air is foul the ground is hot
It rotates very slow.

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We love the Earth our home
Its oceans and its trees
We eat its food we breathe its air
So no pollution please.

We eat its food we breathe its air
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Mars is very red
It's also growing cold
Some day you might visit Mars
If you are really **Bold**.

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Spread out over Distance
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Great Jupiter is big.
We've studied it a lot.
We found that it has sixteen moons
And a big red spot.

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Saturn has great rings
We wondered what they were
Now we know they're icy rocks
Which we saw as a blur.

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Here are ~~three~~ two more planets in
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Uranus is colder still
And rotates with a tilt
Discovered by accident
It has an icy built

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Neptune is blue
And very far away
It has a moon called Triton
That orbits backwards way

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We only have one ~~planet~~ dwarf left
As far as we have done.

Pluto is small and cold
Its usually furthest out
Though whether it's a planet
Is in doubt

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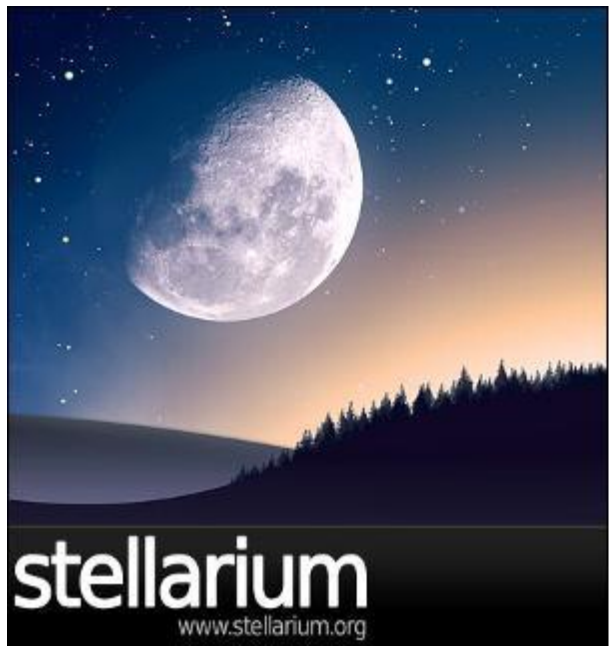
There are ~~nine~~ eight planets
And then our journey's done

Research and Project Extension: Stellarium Program

Take your class to the stars! Just set your coordinates and go.

Note: This resource could be used to assist throughout the lesson, ex. in student research, with the planet brochures, with constellations, art project inspiration, etc. If you work with early elementary level students, using Stellarium directly might be too difficult for many of those kids, though they may surprise you with their computer savvy. But using it to generate images like the sun seen from Mars is a way for a teacher to prepare a set of images from which could help students formulate their plans, improve their brochures, etc.



Stellarium is a free open source planetarium for your computer. It shows a realistic sky in 3D, just like what you see with the naked eye, binoculars or a telescope. It is being used in planetarium projectors, but it's also totally amazing on your computer screen. There are versions for Windows, Macintosh, and Linux (the source code).

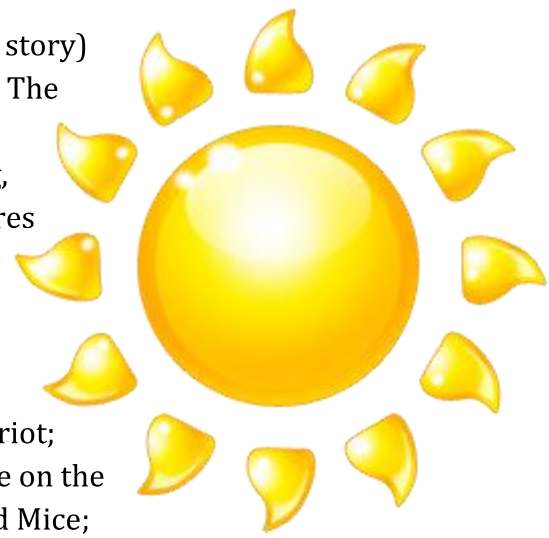
Some features of note:

- Exploration
  - Once the program is installed, start exploring the universe. Everything is moving in real time, so if left it in the evening and looked at in the morning, the sun will be rising. When anything is click on, the information about the object is displayed immediately.
  - Set it to center on a selected object and zoom in smoothly. Alternately, zoom in any direction and watch the stars and planets move. Go about halfway out to Saturn, and the planet and all its moons visibly move swiftly past against a slower but moving field of stars.

    - Stellarium has vast numbers of stars, nebulae, and the planets, so it's like a real interstellar journey, with more and more stars coming into view as you zoom into the sky. The basic Stellarium file has 600,000 stars, but if that's not enough, you can download some add-on star catalogs to bring it up to 210 million stars!
- Deep Space Photos
    - As they close in, students are rewarded with beautiful deep-space photos. The planets and nebulae are favorites, but it's a lot of fun to zoom toward what seems to be a single star and see it resolve into two stars once they are closer.
- Many Viewing Options
    - There are endless options with this software. Students can turn the atmosphere on and off, to compare the clarity of observing from a planet or in outer space. Of course, with the atmosphere turned off, they can see the stars at noon! They can have a realistic horizon, as if they were outdoors at night, or turn off the ground and feel like they are suspended in the void.
- Star Mythology From Many Cultures
    - Students can outline and label the constellations (they call them asterisms now), or turn on star art to see the mythological figures people once imagined. And they aren't restricted to the Greek constellation myths we are familiar with. There is a section on star lore and constellation stories from just about every culture on earth!
- Go To Another Planet
    - Students can also set the observation location to another planet, ex: see what the sky looks like from Mars or look at Saturn's ring from inside it.

Download the Stellarium software for your operating system, plus the User's Guide, from: http://www.stellarium.org/

singin' 'round the Sun



A folk song is a narrative song (tells a story) that often uses traditional melodies (ex. The Farmer in the Dell), tends to have a repetitive melody, has several versions that locals (people that live in an area) sing, and often gets stuck in your head. Folk songs can include genres like spirituals, cowboy songs, sea chanteys, work songs, children's songs, love ballads, protest songs, and more.

Do your students know any folk songs? [ex: She'll Be Coming Round the Mountain; Yankee Doodle; Swing Low, Sweet Chariot; Hush Little Baby; When Johnny Comes Marching Home; Home on the Range; Row Your Boat, The Farmer in the Dell; Three Blind Mice; Clementine, etc] Read the included poem/folk song about the solar system re-written by teacher and his class.

Things to consider/discuss:

- How is each planet described in the folk song?
- How would your students have described each planet?
- What other space objects could have/should have been in the song? (ex. black holes, asteroids, moons, space ships, aliens)
- If students like a verse, or don't, have them think about what verbs or adjectives might make the song more even more interesting or completely change it?

Now, work together as a group and write a collaborative folk song based on what students know now about the planets.

What melody do students like

Work with your students to add in descriptive adjectives, additional nouns, and vivid verbs to the song as a group. Guide students and work together to use vivid verbs, adjectives, and adverbs to change their song and add additonal verses.

Option: Students can pick a favorite planet or space object, and work individually or in pairs work cooperatively on creating a verse, and you can add them all up into a class song.

Help students who do not know what to do by singing their versions as works in progress and make recommendations for editing.

Play the melody as they are creating the verses. As a group, listen to the versions, as sung by the teacher, or the students, and make recommendations.

Editing becomes a real and valid experience when one hears one's verse sung, so it's always good to sing through them, and use a familiar melody. The student can immediately sense what fits the rhythm of the song and what does not.

Note: After students have learned more about the solar system go back and revisit your song as a class. As you revisit, have students determine how accurate they were and if any changes need to be made or additional verses added

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