beetles
Science and Teaching for Field Instructors

Student Activity Guide

Night Hike Scavenger Hunt

It can be hard to make learning about the night sky student-centered, but that's what this activity does: students trade and discuss cards, then take charge of finding and pointing out the different objects. When an object is found, the instructor may share some interesting information to feed students' curiosity, but the primary focus is on students finding, wondering about, and discussing different objects.

During this activity, students try to find and discuss a variety of items during a night hike, such as, "evidence of an amphibian (frog croaks)," puzzlers that they're challenged to figure out, such as "the fastest thing in the Universe" (light), and items from the night sky, such as "a natural satellite of Earth" (the Moon), or "something bigger than our Sun," (other stars).

Students will...

- **Think about, notice, discuss, and identify objects in the night.**
- **Become familiar with some night sky features and nocturnal organisms.**
- **Discuss sizes and distances of different space objects, through comparison.**

Grade Level:
Grades 3-8. Adaptable for younger or older students.

Timing:
This activity is meant to "run in the background." Introducing and concluding is about 20 minutes total, and time during the hike is about 15-25 minutes.

Setting:
Choose a well-lit area for the introduction. While hiking, a mostly clear sky with views of the stars is ideal.

Materials:
See Preparation on page 3

Tips:
To ensure a successful experience, review the teaching tips found on page 2 and throughout this guide.

Related Activities:
How Big & How Far, Double Take, Moon Balls

NEXT GENERATION SCIENCE STANDARDS

FEATURED PRACTICE	FEATURED CROSSCUTTING CONCEPT	DISCIPLINARY CORE IDEAS
Constructing Explanations	Scale, Proportion, & Quantity	The Universe and Its Stars

For additional information about NGSS, go to page 11 of this guide.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Night Hike Scavenger Hunt

ACTIVITY OVERVIEW

Night Hike Scavenger Hunt	Learning Cycle Stages	Estimated Time
Introducing the Activity	Invitation, Exploration	15 mins.
During the Hike	Concept Invention, Application	15-25 mins.
Wrapping Up	Reflection	5 mins.
TOTAL		40+ minutes

TEACHING TIPS

Field Card. On page 38 of this guide, you will find a condensed, pocket-sized version of the lesson that you can carry along on the hike.

Read the Instructor Support Section. Beginning on page 8, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Keep it student-centered. The point of this activity is not to drown students with facts. It's to ignite their curiosity, to give them time to talk about ideas, to find night phenomena themselves, and to see the night outdoors as a friendly and interesting place to be. Let students find things themselves. Be a co-investigator, and wonder with them. Provide them with occasional information (read and choose some from the Night Objects Information Chart on page 14) you think will make them more curious. Let them develop a relationship with the night.

Strong Suggestion: Do *How Big & How Far* just before this activity. We strongly suggest that immediately before leading this activity, you do the quick activity, *How Near & How Far* with your group. In astronomy, scale is a big stumbling block for many students. They may have heard about planets, moons, stars, and galaxies, but if they don't understand relative sizes and distances of these objects, and how distance affects our perception of sizes, they can't understand space. How Big & How Far quickly gives them a different perspective on scale.

All materials created by BEETLES™ at The Lawrence Hall of Science.
Find the latest activities and information at http://beetlesproject.org.

PREPARATION

1. **Choose which cards to use.** You need one for every person on your hike, including adults. Choose which cards you think will work best in your conditions; the cards are split into three categories (and marked with a symbol in the upper right corner): those that require a clear night sky (stars symbol), those that are sky-related but don't require a clear sky (cloudy moon symbol), and those that are not sky related (windy tree symbol). Some are more challenging than others, so keep the level of your group in mind. The point is not to find every item on the hunt. It's to think about a bunch of them, find and discuss some, and look forward to finding others when they return home.
2. **Prepare the cards:**
   - Print out the student cards beginning on page 20or draw your own. Just printing or drawing on paper tends to get wrinkled quickly, so laminate, glue on to cardboard, or use manila folders to create sturdier cards.
   - Punch a hole in each of the top corners and use p-cord or string to create a loop large enough to fit around your students' heads.
3. **Choose to focus on Orion or the Big Dipper.** Most students have little familiarity with constellations and can be overwhelmed if a bunch of constellations are pointed out at once. Focusing on one major and obvious constellation beforehand, then letting students discover it outside, gives them one recognizable "friend" in the sky to take away. The Big Dipper is easier to find during night hike hours in Spring and Summer, while Orion is easier to find in Fall and Winter. Check out the night sky a night or two before you lead your hike, at around the same time you'll be outside with students, to see which option is best.
4. **Read and memorize some information from the Night Objects Information Chart.** Because it can be hard to look at your notes during a night hike, it's helpful to memorize any information you plan to share with students. If possible, use a red light to look at notes in the dark.

TEACHING NOTES

Introducing the Activity

1. **In a well-lit area, tell students they'll be looking for objects in the night.** Gather students in an area with light, either outdoors before it gets dark, in a lighted outdoor area, or indoors with lights. Tell students they'll be doing a Night Hike Scavenger Hunt. They'll look for specific items in or under the night sky.

2. **Tell students that with some of the items in the Scavenger Hunt it will be clear what they should look for, but some are like puzzles that they have to figure out, e.g.,** "Something bigger than the Sun."

3. **Explain the procedure.** Tell students that you will pass out cards, one to each pair. Pairs will discuss the item on the card (what they've heard about it, and their prediction of whether or not they think the group will see it). Then they'll trade cards with another pair, discuss the new card, and keep trading cards until the instructor calls time.

4. **Model how to discuss an item with another adult.** With another adult or chaperon, model how to discuss one of the items. For example (airplane card):

   Instructor: reads card out loud.

   Adult #2: I've seen airplanes at night before with flashing red lights.

   Instructor: Yeah, me too, but sometimes I've seen them when they also look like the lights aren't flashing and the light looks only white.

   Adult #2: I think we'll see one tonight.

   Instructor: Maybe. But there's no airport near here, so maybe not.

5. **Ask students to find a partner they think they can work well with; pass out cards & tell students to begin.** If necessary, remind students what to discuss: What it is, what they've heard, and a prediction of whether or not they'll see it. Any extra cards you have, you can hold and/or trade with students to put them in circulation. Facilitate the trading so all students get to look at most or all of the cards.

6. **After ~10 minutes, or when you notice declining interest, tell the students to set the cards face up on the ground in a circle, and ask the group to stand around the cards.**

7. **Show the group the constellation you've chosen to focus on.** Draw students' attention to the constellation card you've chosen (Orion or the Big Dipper, whichever is most visible in that season and time of night). Hold up a large image of that constellation, and help students become familiar with its shape so they can recognize it outdoors. (It's important to also show the image of the Dipper upside down, because that's how it often appears in the sky).

8. **Explain that students (and adults) will choose a card to wear around their neck; they will remind the group about that item.** Tell the group that each student (and each adult) will choose one card to be responsible for. It doesn't mean they have to be the person to find that item—everyone in the group will be looking for all the items—but they'll be responsible for

TEACHING NOTES

Take the time to model how to discuss cards. Modeling how to discuss an item can help support students who are unfamiliar with discussion, or who are struggling with language to understand the task more clearly.

Informal Assessment Opportunity. As students discuss, get a sense of what your students know or don't know, and use that information to make a decision about what content or questions you might share with students when you encounter those objects later.

Don't share your ideas about the puzzling items. Avoid telling students your ideas of what the "puzzling" items are (like "water in the sky"). Allow students the opportunity to struggle with and discuss their own ideas about the cards, and ask questions to learn more about students' thinking.

Why have students wear cards around their necks? Although they probably won't be able to see what's on the card around their neck in the dark, having a card in their care helps engage and invest students while giving each student some responsibility and a role to play in the group. Taking the time to familiarize students with the variety of cards in a lighted space can make their nighttime exploration more engaging.

reminding the group about it, or for saying something like, "Hey, that's water in the sky, that's my item we just found."

9. **Model how not to be competitive over choosing cards.** Explain that there's no reason to get competitive over which card to pick up because there are plenty of cards, and the whole group will be searching for all items during the hike. Explain that if someone else picks up the card they had their eye on, they can simply shift to another card, e.g. "Oh, I was going to pick up the natural satellite card, but she picked it up, so I guess I'll pick up water in the sky."

10. **Put away any cards that weren't picked up, carry some yourself, or see if any students want to carry two cards.**

During the Hike

1. **As much as possible, let students discover items for themselves.** While you lead the field experience, avoid pointing out scavenger hunt items to students. Instead, wait for them to point things out to each other, allowing them to take charge and experience the thrill of discovery and ownership of learning.

2. **Provide times of silence, use quiet voices for discussion & provide signals students can use when they find something.** Students will notice more things if they have times when the group is silent, and it also adds to the special feel of being outdoors at night. During discussions, ask students to use quiet voices or whisper at times for a more "magical" experience, and to not disturb other groups. Be clear with students what you expect of them in terms of talking and volume at different parts of the hike. Let them know how to point out something they've found when the group is silent (pantomime?) and when it's not.

3. **Help students see something others have pointed out.** When someone points out an object, help other students see it too, ideally by having the finder point it out and describe its location. Ask for students' descriptions of it, e.g. "What do you notice about it?"

4. **Keep up a discussion about size & distance of objects throughout the activity, challenging them to compare objects.** When students find an object, ask questions to engage them in discussion about it. Eg: Compared to that other object (is it bigger, smaller, much bigger, etc.), about how big does it look from here, and how big do you think it really is? Compared to that other object, how far away do you think it might be?

5. **Share information tidbits to encourage discussion & wonder.** Use some information from the Content Knowledge section of Instructor Support and from the Night Objects Information Chart to blow your students' minds, but continue to encourage wonder and discussion by asking questions and providing time for peer-to-peer conversation after you share information. Don't share too much, and watch out for and adjust if students seem to be becoming mostly passive listeners.

TEACHING NOTES

Modeling how to deal with competitiveness in selecting cards. By modeling or asking student advice on how to avoid competitiveness, you are bringing the idea into their consciousness, and likely warding off some negative behaviors before they occur.

Quote from a field tester. "I'm glad I didn't point out the Big Dipper. The first time I led this activity with kids, we began walking in the darkness with the Big Dipper clearly right above us in all its' glory, but the kids didn't notice. It was hard to not say anything, but I held back. Finally, a student said, "look, the Big Dipper!" They were so excited to find it. I'm so glad I held back from pointing it out to them." - Field Instructor

Don't share everything you know about a subject. When you know more about a subject than others do, it's tempting to share everything you know (and expect students to remember everything you say). But for true interest and engagement in a subject, the most productive goal is to engage students in the process of trying to learn about the topic. Students generally enjoy enjoy solving mysteries and figuring things out. Share just enough information to make them more curious. Engage students actively in the learning process by giving them the space to discuss ideas and wonder instead of sharing everything you know about a subject.

TEACHING NOTES

6. **Choose to focus on a few subjects.** Depending on your location, the time of year, and your learning goals for your students, here are some options for focus items:
   - **Focus on light**. The concept of Light Years is super interesting. It's the most useful way of understanding vast distances in space, but a little tricky conceptually. Try building up to light years by starting with Light Seconds (the Moon is ~1.5 light seconds away) and Light Minutes (the Sun is ~8 light minutes away). When you look at starlight, you're looking back in time (mind-blower alert!). Point out that Sirius (the brightest star—see entry in Night Objects Information Chart) is "only" ~8 light years away, and ask students how old they were when the light they see now left Sirius [~8 years ago]. How old will they be when the light leaving Sirius now reaches Earth? [~8 years from now].
   - **Focus on the Moon**. Ask students what they notice about the Moon. Explain that the white parts of the Moon are the older rock and the dark spots on the Moon are "newer" (but still over a billion years old) lava rock. Much of the lava flowed to fill up pre-existing round craters, which is why some of the dark parts look roundish. Ask students to point out to each other where the older and younger parts of the Moon are. Choose from these questions:
     - ▶ *The moonlight you see is actually sunlight reflected off the Moon. Why do you think it isn't as bright as direct sunlight?*
     - ▶ *The same side of the Moon always faces Earth. What explanations can you think of for that?*
     - ▶ *Over billions of years, the Earth has been hit by as many space objects as the Moon. Why do you think you can see so many craters on the Moon, but not on Earth?*
     - ▶ *What are some different explanations you can think of for how the Moon might have formed?*
   - **Focus on a constellation**. See Night Objects Information Chart for information on the Big Dipper or Orion.
7. **Challenge the group to find un-found items.** At some point you might want to ask students who have items that have not been found yet to remind the group of these items, and challenge the group to try to find them.

Wrapping Up

1. **Ask students with cards of found objects to raise their hands and explain they can look for them again other nights.** Ask the students who have cards that feature items that were found to raise their hands. Call on them one by one, and ask them to say the name of their item. (If you're in a lighted space, they can also hold up the picture for others to see again.) Point out how many items the group found together. Tell the group that they now know how to recognize all these items, and they can keep looking for them on other nights while at your program, and anytime in their lives that they are outdoors at night.

See the Night Objects Information Chart in the Instructor Support Section. Use the chart in the Instructor Support Section for little tidbits/questions to prompt student thinking, learning, and discussion with each object- but don't share everything in the chart. As students discuss the cards, pay attention to what they know and don't know, and share enough to stoke their curiosity.

2. **Ask students with cards of objects not found to raise their hands, and explain they can keep looking for them other nights.** Ask the students who have cards that feature items that were not found to raise their hands. Call on them one by one, and ask them to say the name of their item. Point out that everyone in the group can keep looking for these other items while at your program, or anytime in their lives that they're outdoors at night. (And perhaps point out that it's not the fault of the students holding the cards that the objects weren't found).

3. **Group moves to stand in a line ranking biggest to smallest objects, sharing reasoning.** Challenge the group to try to sort the cards they're wearing from biggest to smallest by arranging themselves in a line and discussing their reasoning for their placement (some, like "direction wind is coming from," may not be able to be ranked this way). Let students struggle with and discuss this, and it's fine if they're not exactly right, but occasionally it may be helpful to correct any glaring errors. To help you coach students, here's a rough ranking of many of the objects from smallest to largest: Most meteors (not counting the trail of light), droplet of water, animals, artificial satellite, airplanes, most clouds, natural satellite (the Moon), the Planets, red stars (Betelgeuse), our nearest star (the Sun), blue stars (Rigel), nebula, constellations, galaxy.

4. **Do a similar ranking based on how far away each object is.** Depending on focus of the group, you might then challenge them to do the same thing for how far away each object is.

5. **Point out to students that because we can't see as much in the dark, we often assume there's not much to see- but the things they looked for during the scavenger hunt are things they could probably see anywhere, on many nights.**

6. **Choose from Walk & Talk questions to ask as students are walking back to wherever you're taking them:**
   - *What's something that surprised you?*
   - *What are some interesting things you'd like to share with someone not here?*
   - *What are some questions you wonder about night objects?*

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See Walk & Talk write-up for directions. See BEETLES activity, *Walk & Talk* for directions on how to lead this discussion routine.

TEACHING NOTES

Instructor Support

Teaching Knowledge:

The scavenger hunt makes astronomy on night hikes more student-centered. A lot of what you can see in the sky on a night hike is far away, so, it can be challenging to keep the learning student-centered. And with daytime objects, a leader can encourage students to make more observations, but it's hard to do that with night objects, because it's hard to observe a star without special tools. Give students an active role in their learning with this activity, which allows students time to explore through peer discussion before heading out, then challenges them to find the object. When students see a star, they will have already "explored" it a bit via the scavenger hunt cards. When students see a tiny slow moving dot in the sky, they will have already seen a picture of a satellite, and will better be able to conceptualize what they're seeing.

Spirit of Inquiry & Investigation. It's important to give students time to observe, wonder, think, and discuss ideas during any outdoor learning experience, including night hikes. It's fun and awe-inspiring to be overwhelmed by distances, sizes and quantities of objects in space, and to ponder our place in the universe, and other deep questions. But when instructors primarily deliver information, they deprive students of these crucial components to deep learning. The facts often fly in one ear and out the other, and students may slip into passive mode. That said, on an astronomy night hike where the objects are so far away and many are not directly observable to students, and where the sizes, distances, and ideas are kind of MIND-BLOWING, a small amount of information about things like the Moon, light, and stars can inspire a lot of observing, wondering, thinking, and discussion. Waiting until after students have made their own observations and explanations and have generated questions of their own will often make students more receptive to hearing interesting facts about an object.

Sense of awe: Sharing a sense of awe is a natural team builder. The night sky may be the most consistently awe-inspiring nature experience available. Studies have shown that people who experience awe in nature together are more primed for collaboration. As one article put it, "... a state of awe, an emotion that, psychologists are coming to understand, can have profoundly positive effects on people...In its wake, people act more generously and ethically, think more critically when encountering persuasive stimuli, like arguments or advertisements, and often feel a deeper connection to others and the world in general. Awe prompts people to redirect concern away from the self and toward everything else. And about three-quarters of the time, it's elicited by nature." From the article, "The Science of Awe," by Jake Abrahamson: http://greatergood.berkeley.edu/news_events/in_the_news_item/the_science_of_awe

Content Knowledge:

In this activity, content knowledge will be different depending on whatever you see that night, what the students are interested in, and what the instructor knows. It's helpful to have a variety of information about night objects so you can choose what to share with each group, and so you can guide students toward more accurate understandings. But keep in mind that the scavenger hunt can be very successful even if the instructor doesn't have much content knowledge. Encouraging students to make observations, ask questions, come up with explanations, and dialogue with one another are the more important goals of this activity. Sharing your knowledge or facts about a particular object is optional, and should only be done after students have found and discussed an item.

If you look at the Night Objects Information Chart on page 14, you'll find lots of accurate content you can use both to increase your own understanding, and also to share strategic questions and bits of information with your students during the hike. In addition, below is some general background info.

Stars. Every star is a sun. Our nearest star is the Sun. It's a medium-sized star, although it looks much larger than other stars/suns because it's much closer to us. The temperature of a star determines its' color. The hottest stars are called blue stars, the coldest and smallest are red stars, and yellow stars, like the Earth, are in-between. The colors of stars are not strong, most of them appearing white. Sometimes the only way to notice the color of a star is to compare it to another star of similar brightness. Stars change over time as their fuel burns. Our Sun will eventually likely become a red giant, then a very dense white dwarf. When we see a red star in the sky, we're seeing what used to be a yellow star that is in the red giant phase of its' "life cycle" (though stars are not alive). At the end of the 'lifespan' of a blue star, the star may explode as a supernova, and if it's really large it may become a black hole. It might also become a neutron star, a very compact star with the mass of several Suns, and a diameter of only a few miles. Our star is "single," but more than half of stars have one or more companions.

Black holes. Contrary to how they're often shown in films, black holes don't travel around sucking up everything in their path, and they are not pathways to different dimensions. They are the evolutionary endpoints of massive stars. They are the most dense and massive singular objects in the Universe, and matter in a black hole is pressed together inconceivably tight by gravity. Gravity near a black hole is so strong that not even light can escape, which is why we can't "see" a black hole. A black hole made from a massive star that has collapsed is about the size of a city, but in the center of many galaxies there is evidence that that there are black holes bigger than the solar system.

Other Space Objects. Moons orbit planets, and planets orbit suns. A star system, like our Solar System, is a system of one or more stars, along with the stuff orbiting it, such as planets, moons, asteroids, comets, and dwarf planets. The Solar System is part of the Milky Way Galaxy. A galaxy is much bigger than the Sun, and much bigger than the Solar System (those are vast understatements). The Milky Way Galaxy has ~200 billion to ~400 billion stars, and is ~100,000 light years across in diameter, and ~3,000 light years "thick." Most other galaxies are smaller. There are many, many galaxies, but they are so far away that they are hard for us to see. On moonless nights, we can see the Andromeda galaxy with the naked eye. Nebulae are clouds of gas and dust in space where stars are born. We can see the Orion nebula as the middle "star" in the middle of the "sword" of the constellation Orion. Meteors ("shooting

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stars") are not stars, but dust or small rocks that burn up in the atmosphere as they fall to Earth. Comets are balls of ice, dust and rock that travel around the Sun in elliptical orbits. There may be trillions of comets orbiting our Sun, but we only see the ones whose orbits sometimes bring them in "close" to the Sun. As a comet gets closer to the Sun, it's solid surface turns to vapor, and leaves a long trail of gas and dust behind it. As Earth passes through the orbit of a comet, the leftover dust burns up in Earth's atmosphere as a shower of meteors ("shooting stars"). Every August, for example, Earth passes through the orbit of the Swift-Tuttle comet, causing the Perseid meteor shower.

Light. In common speech, "light" is used to describe only visible light. But scientists use the term to describe any part of the electromagnetic spectrum, including radio, microwave, infrared, visible, ultraviolet, X rays, and gamma rays. Light travels at 186,000 miles per second, and is the fastest thing in the Universe. No physical object can travel as fast as the speed of light. It takes ~1.5 seconds for light to travel to the Moon, so we describe it as ~1.5 light seconds away. We know this because Apollo 11 astronauts left a mirror on the Moon, and ever since, we've been able to accurately measure the distance to Earth by pointing a laser at it, and timing how long it takes to bounce back. It takes ~8 minutes for light to travel from the Sun to us, so we call that distance ~8 light minutes. It takes light ~4 years to travel from Earth to Alpha Centauri, our next nearest star, so we call it ~4 light years away. Because it takes light ~4 years to travel from Alpha Centauri to us, the light we are seeing when we look at it is from ~4 years ago when we see it. We are essentially looking back in time whenever we look at stars. The farther into space we're able to look, the farther back in time we're seeing. In this way, scientists have been able to look back to the early stages of the Universe, more than 10 billion years ago. How cool is that?

Distances in space and human travel. The main ingredient in space, is...(wait for it) space. Distances between objects are enormous! In science fiction, humans and extraterrestrials regularly travel between planets and star systems to interact. Many people believe this is going on in the real world too, and that Earth is frequently visited by ET's. In reality, humans have so far only traveled to one extraterrestrial location: the Moon. Unoccupied spaceships have gone much further. Our nearest star other than the Sun (Alpha Centauri), which is 100 million times farther than the Moon, is ~4 light years away - that's ~4 years traveling at 186,000 miles per second. But our current fastest spacecraft can travel ~1/18,000th the speed of light. So the fastest spacecraft we've ever sent out would take ~80,000 years to reach Alpha Centauri. At the 2008 Joint Propulsion Conference, multiple experts shared the opinion that it's improbable humans will ever travel outside the Solar System. According to Brice N. Cassenti, associate professor with the Department of Engineering and Science at Rensselaer Polytechnic Institute, at least 100 times the total energy output of the entire world in a given year would be needed to send a probe to the nearest star. These enormous distances are the main reason scientists think it's very unlikely that ET's could visit Earth. But they're sure fun to watch in movies!

Deep space communication. From what we currently understand, deep space travel is unlikely, but communication between star systems is another story. Radio waves travel at the speed of light, which is why SETI (Search for Extraterrestrial Intelligence) is conducting serious scientific searches for radio wave communications from other star systems (but so far no luck).

Common Relevant Misconceptions

- **Misconception:** The Sun is not a star, and stars are not suns.
- **Misconception:** The Sun is bigger than any other star, and all other stars are the same size.
- **Misconception:** Moonlight is light given off by the Moon.
- **Misconception:** Solar systems are galaxies (students often confuse whether a galaxy is in a solar system or the other way around).
- **Misconception:** Shooting stars are stars falling from the sky.
- **Misconception:** The dark parts of Moon phases are caused by Earth's shadow.
- **Misconception:** The Sun orbits the Earth.
- **Misconception:** Objects in space are not that far away, and it's not that hard to travel to them.
- **Misconception:** The Sun, Moon, planets, and stars are all the same distance from Earth.
- **Misconception:** The Sun and Moon are about the same size.

  More accurate information: Review the content knowledge on page 8 and the Night Objects Information Chart on page 14 to find more accurate information.

Connections to NGSS:

BEETLES student activities are designed to provide opportunities for the "three-dimensional" learning that is called for in the NGSS. To experience three-dimensional learning, students need to engage in scientific practices to learn important science content (Disciplinary Core Ideas) and relate that content to the unifying themes in science (Crosscutting Concepts). In simple terms, students should be exploring and investigating rich phenomena, trying to figure out how the natural world works.

Night Hike Scavenger Hunt engages students in the practice of Constructing Explanations to build a foundation for understanding disciplinary core ideas related to The Universe and Its Stars. and to relate those ideas to the crosscutting concept Scale, proportion, and quantity.

Featured Science and Engineering Practices

Engaging students in Constructing Explanations. According to NRC's A Framework for K-12 Science Education, a major goal of science is to deepen human understanding of the world through making explanations about it, and students should develop their understanding of science concepts through making their own explanations about natural phenomena. In Night Hike Scavenger Hunt, students construct explanations from the outset, as they attempt to explain some of the scavenger hunt "puzzlers." There are other broad questions throughout the write-up. The more you ask them broad questions that involve explanations and encourage discussion, the more constructing of explanations your students will be doing. For students to engage more deeply in this practice, it's important to ask students for alternate explanations for each phenomena in the large group, and to ask students to share the reason-

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About the Next Generation Science Standards (NGSS) The development of the Next Generation Science Standards followed closely on the movement to adopt nationwide English language arts and mathematics Common Core standards. In the case of the science standards, the National Research Council (NRC) first wrote a *Framework for K-12 Science Education* that beautifully describes an updated and comprehensive vision for proficiency in science across our nation. The *Framework*–validated by science researchers, educators and cognitive scientists–was then the basis for the development of the NGSS. As our understanding of how children learn has grown dramatically since the last science standards were published, the NGSS has pushed the science education community further towards engaging students in the practices used by scientists and engineers, and using the "big ideas" of science to actively learn about the natural world. Research shows that teaching science as a process of inquiry and explanation helps students to form a deeper understanding of science concepts and better recognize how science applies to everyday life. In order to emphasize these important aspects of science, the NGSS are organized into three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas (DCI's). The DCI's are divided into four disciplines: Life Science (LS), Physical Science (PS), Earth and Space Science (ESS) and Engineering, Technology and Applied Science (ETS).

Read more About the *Next Generation Science Standards* at http://www.nextgenscience.org/ and http://ngss.nsta.org/

ing behind their thinking.

For students to fully engage in this practice, they need awareness of how the practice of making explanations about the natural world is a part of the nature of science and how scientists learn about the world. Be sure to share with students the idea that the explanations for what we see in the sky (and much of scientific knowledge) was built over many years by scientists observing the natural world, making possible explanations, and changing their minds in the face of more evidence or new ideas.

Featured Crosscutting Concepts

Learning science through the lens of Scale, Proportion, and Quantity. According to the NRC's A Framework for K-12 Science Education, it's important that students understand that systems and processes vary in size, and that some systems or processes are too large to be observed directly. Sizes, distances, and quantities in space can be mind-boggling and awe-inspiring. When looking at night sky objects, scale, in terms of both size and distance, can be a significant obstacle to student understanding. Something that is enormous, like a star, can appear miniscule, and something small like a moth can appear larger than a star! Very confusing! To help students grapple with scale, we strongly suggest that you use the activity, How Big and How Far immediately before Night Hike Scavenger Hunt, and keep up an on-going discussion about size and distance of objects throughout the activity.

To fully apply this crosscutting concept, students need to know they're applying the "big idea" of scale, proportion, and quantity. If you choose to emphasize this crosscutting concept in your field experience point out to students that they are applying the "big idea" of scale, proportion, and quantity, point out that it's a useful thinking tool they can use in any part of science, and give them multiple opportunities to relate what they learn to that idea.

Featured Disciplinary Core Ideas

Building a foundation for understanding Disciplinary Core Ideas. The NGSS make it clear that students need multiple learning experiences to build their understanding of disciplinary core ideas. Night Hike Scavenger Hunt provides students with opportunities to build understanding of disciplinary core ideas related to the following topics within Earth and Space Sciences: ESS1.A: The Universe and Its Stars.

As students search for objects "bigger than our Sun," and as they struggle with the sizes of red stars, blue stars, etc. , students build some understanding of the idea that the Sun is just one of many stars in the Milky Way galaxy. Stars range greatly in their size and distance from the Earth. (ESS1.A). Also that the Sun appears larger and brighter than other stars because it is closer (ESS1.A). Students also develop understanding of the idea that stars vary in their size and distance from Earth (ESS1.A).

Students also begin to understand that some objects in the Solar System can be seen with the naked eye. Planets in the night sky change position and are not always visible from Earth as they orbit the sun. Stars appear in patterns called constellations, which can be used for navigation.

TEACHING NOTES

Importance of teaching science practices. "Engaging in the practices of science helps students understand how scientific knowledge develops...It can also pique students' curiosity, capture their interest, and motivate their continued study..." -National Research Council, *A Framework for K-12 Science Education*. Focus on these science practices will help to ensure a more scientifically literate public who will be better able to make thoughtful decisions.

About Crosscutting Concepts in the NGSS. Crosscutting concepts are considered powerful thinking tools for how scientists make sense of the natural world. The seven "big ideas" listed as crosscutting concepts are: Patterns; Cause & Effect; Scale, Proportion & Quantity; Systems and System Models; Energy & Matter: Flows, Cycles and Conservation; Structure & Function; and Stability & Change. These concepts may sound familiar, as they are quite similar to the themes referred to in science literacy documents as being important ideas that unify all disciplines of science and engineering.

Other specific disciplinary core ideas students engage with will vary based on which night sky objects are discussed and additional information shared by the instructor.

Performance Expectations to Work Towards

When examined closely, it's clear that the NGSS represent complex knowledge and multi-faceted thinking abilities for students. No single activity can adequately prepare someone for an NGSS performance expectation. Performance expectations are examples of things students should be able to do, after engaging in multiple learning experiences or long-term instructional units, to demonstrate their understanding of important core ideas and science practices, as well as their ability to apply the crosscutting concepts. As such, they do not represent a "curriculum" to be taught to students. Below are some of the performance expectations that this activity can help students work towards.

- 5-ESS1-1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.

Activity Connections:

Choose a focus depending on your learning goals for students. *How Big and How Far* is a great predecessor to the scavenger hunt because it gets students to begin thinking about the scale and relative size of stellar objects. Other complementary night sky activities include *Moon Balls* and *Double Take*.

TEACHING NOTES

Translating the codes used in the NGSS: Each standard in the *NGSS* is organized as a collection of performance expectations (PE) for a particular science topic. Each PE has a specific code, provided here so that they can be easily referenced in the *NGSS* documents. The first number or initial refers to the grade level: K - kindergarten, 1 - first, 2 - second,etc...MS - middle school, and HS - high school. The next letters in the code refer to the science discipline for the standard: LS, PS, ESS, ETS. The number following the discipline denotes the specific core idea within the discipline that is addressed by the PE, and the last digit identifies the number of the PE itself.

So...3-LS4-4 means it's part of a third grade standard (3) for life science (LS), addressing the fourth core idea (4), *Biological Evolution: Unity and Diversity*, within the life science standards, that deals with Biodiversity and Humans. It's also the fourth performance expectation (4) that makes up the complete LS4 standard at this grade level.

Night Objects Information Chart

Night Object	Questions to Ask	Information to Share	Additional Information
Objects that require a clear sky:			
An artificial satellite	What are some things people use satellites for? That satellite doesn't have a light on it—what do you think is making it look like it's lit?	Is it a tiny, steadily moving light? Then it's a satellite orbiting the Earth, made by people. Satellites do not have lights, so what you're seeing is sunlight reflected off the satellite, and they are not visible to us when they're in Earth's shadow. A lot of them are pretty small, and the biggest is about 120 yards long (the International Space Station). It appears brighter because of its size. It can easily be mistaken for an airplane. Satellites we see are only a few hundred miles up, which is very close compared to other distances in space.	Students often confuse satellites with satellite dishes. Satellite dishes are on Earth and send and receive information from satellites in orbit around the Earth.
A natural satellite of Earth	Is there anything you can think of of that orbits Earth that people did not make?	The Moon is a natural object that orbits Earth, so it's our natural satellite. It takes about 1 month to orbit Earth.	
A Galaxy	If there are billions of galaxies and each galaxy has at least millions of stars, and if stars can have planets like ours, do you think it's likely that there's life out there?	The Milky Way is the galaxy we live in. We see it from the inside, looking out. Since it is somewhat flat like a pancake, we see more stars in some directions than in others. When we look up on a very dark night and see that dense band of star across the sky, we are looking into the center of the Milky Way.	There are probably more than 170 billion galaxies in the observable universe, most of which we can't see. Almost all galaxies are too dim to see with the naked eye. We can see the Andromeda Galaxy as a fuzzy patch in the Andromeda constellation. Each galaxy may have as few as ten million stars or as many as a hundred trillion stars.
Evidence of a Meteor (shooting star)	How big do you think the object that made that streak might have been?	A meteor/shooting star isn't really a star. It's usually a piece of dust from space entering and burning up in our atmosphere. As Earth orbits the Sun, it travels through areas in space that have more dust and other particles.	

Night Object	Questions to Ask	Information to Share	Additional Information
The Orion Constellation	Orion's left foot is a blue supergiant Rigel (see blue star entry for more information). Orion's right shoulder is a red supergiant Betelgeuse (see red star entry). Orion Nebula is the center star in his sword (see Nebula entry) Nearby is the star Sirius, below and to the left of Orion (see Brightest Star in the Sky entry)	Orion is a cool constellation because it's pretty easy to find (in winter), and because there are so many interesting sky objects in it.	
The Big Dipper Constellation		If you make a line from the 2 stars at the non-handle end of the Big Dipper, it will lead you to the North Star, which is part of the Little Dipper. The North Star is always North of us.	
The Brightest star in the sky	It takes ~9 years for light to travel from Sirius to Earth. How old were you when the light you're seeing left Sirius (~9 years ago)? How old will you be when the light leaving Sirius now reaches Earth?.	Sirius, or the Dog Star, is the brightest star in the nighttime sky (the Sun is the brightest star in the day). It's located below and to the left of Orion. It's 8.6 light years away. Because the light we see from it left the star only 8.6 years ago, it's fun for kids to think about where they were that many years ago.	Sirus is actually 2 white stars in a binary system. White stars are big and bright, but not as much as blue stars. The brightness of Sirius is due to closeness to Earth.
Evidence Earth is spinning	You've heard that the Earth spins, but what is some evidence that's true?	Moving stars, setting Sun... You can measure time with an outstretched arm: one finger width = 15 minutes. One fist = 1 hour. So if the Sun is one fist away from the horizon, then it's about 1 hour until sunset (but not at high lattitudes). If stars were revolving around the Earth, we might expect them to be moving at different speeds, but they all appear to move at the same pace, which supports the explanation that Earth is spinning.	
Something bigger than our Sun	Stars look tiny from where we see them, but how big do you think they really are?	Our Sun is a medium size star. Almost every star you can see with the naked eye is bigger than our Sun, but most stars are smaller than the Sun. How can that be? Because they're smaller, we can't see as many without a telescope. We see way more of the bigger stars.	Betelgeuse, Rigel, and Sirius are bigger than our Sun. The Milky Way galaxy is also bigger than our Sun. Much, much bigger.

Night Object	Questions to Ask	Information to Share	Additional Information
A nebula: where new stars are forming		Orion Nebula appears as the slightly blurry central "star" in Orion's sword, below Orion's Belt. There, materials like gas and dust "clump" together until they eventually become massive enough to form stars.	It's the nearest known region of massive star formation to the Solar System. Stars form there, and leftover materials are then believed to form planets and other planetary system objects.
A red star	Does anyone notice any differences between stars? Do any look slightly reddish?	Any star with a red tint. Betelgeuse, Orion's right shoulder (left to us), is a red star. It will likely explode as a supernova in the next million years. The supernova would shine brighter than the Moon and be the brightest supernova in recorded history.	Betelgeuse gives off 100,000x more light than our Sun and is ~643 light years away. It's one of the largest stars known.
A blue star	Does anyone notice any differences between stars? Do any look slightly blueish?	Any star with a blue tint. Rigel, Orion's left foot (right as we see it), is a blue supergiant. Someday it will grow into a red giant like Betelgeuse. It will eventually likely explode as a supernova.	Rigel gives off 85,000x more light than our Sun, is 17x the mass of our Sun, and 772.51 light years away. It is also a star system of 3 stars and the 6th brightest star in the sky.
The Moon's shadow	What do you think is causing that part of the Moon to be dark right now?	This is tricky for kids. This is the dark part of the Moon where the Moon is blocking sunlight from part of itself. For example, the dark part of a crescent Moon is the Moon's shadow on itself.	Many people think the dark part of the Moon is caused by Earth's shadow, which is actually only true during lunar eclipses.
Your own invented constellation	If you want, pick a group of stars you can recognize, and choose a name for them.	Kids could take turns sharing theirs with others using a laser pointer (carefully supervised!), if you have one. Laser pointers should never be pointed at anyone's eyes or at airplanes.	
Our nearest star	Which is our closest star?	Our Sun is our nearest star, and is ~8 light minutes away. The second nearest is ~4 light years away (Alpha Centauri). Traveling at 186,000 miles per second, it takes light ~4 years to travel to our second nearest star!	
A Planet	What planet do you live on?	Earth is the easiest planet for us to see - you just have to look down! Venus, Mars, Jupiter, and Saturn can all be seen with the naked eye. Venus is often called "the morning star" or "the evening star" because it's brightest then.	Since Venus is between us and the Sun, it's often most visible near sunrise and sunset. In April, Jupiter is the first "star" visible at night in the West.

Night Object	Questions to Ask	Information to Share	Additional Information
Objects that are sky-related, but don't require a clear sky:			
Evidence of an airplane	That airplane looks bigger than that star. Is it?	Sometimes people think planes are UFOs because when they are flying towards or away from you they may look like a steady white light that is hovering in one place.	
The fastest thing in the universe	What are some fast things you can think of? What do you think might be the fastest in the Universe?	Light is the fastest. Light travels 186,000 miles per second. When you look at stars, you're looking back in time, because the light took years to travel to us. Special telescopes can look billions of years into the past because they can see light from objects billions of light years away. If a star were to explode, we wouldn't know it until the light traveled to Earth. It takes light less than a second to travel across North America. It takes ~1 ½ seconds to travel to the Moon. It takes ~8 minutes to travel from the Sun to Earth.	"Light" includes radio waves, ultraviolet waves, and other parts of the electromagnetic spectrum humans can't see.
Evidence of Sunlight	This is a fun one to think about and discuss. It's a broad category, with many possible answers. You could argue that any light seen on Earth originated with a sun. We can still see sunlight reflected off of clouds etc. long after the Sun has gone down. If you can see anything, your eyes are detecting reflected light. It takes light ~8 minutes to travel from the Sun to Earth (~90 million miles).	With some reasoning, a variety of responses could be correct. For example, "even though the Sun has gone down, we can still see a little bit of sunlight at the horizon," or "the light from the Moon is reflected sunlight," or "a plant is evidence of sunlight, because it couldn't grow without it." Ask students to agree or disagree with ideas others bring up, and encourage discussion.	
Objects that are unrelated to the sky:			
Evidence of water in the sky	Can you find anything in the sky that may be formed from water?	There are many possible student responses to this question. With each student idea, ask other students what they think of the idea, and encourage discussion and polite disagreement.	
Something in the sky smaller than your fist	That airplane looks smaller than your fist. Is it?	Bat. Meteor (shooting star). Insect. See "meteor" for more information.	

Night Object	Questions to Ask	Information to Share	Additional Information
The absence of color	What color is your jacket when there's more light? What color do you think this pen might be in more light? What would it be like if you could never see color, like some animals? What if you could seem colors we can't see, like bees seeing ultraviolet?	We need enough light for the parts of our eyes that see color (cones) to work. Other parts of our eyes (rods) don't need as much light, but they can't see color. They can only see shades of black, white, and gray. When there's not much light, only our rods work, so things look like a black and white video.	
Evidence of a Bird	Can you notice anything that might be evidence of a bird around here?	There are many possible answers. Owl or owl call. Bird tracks. Etc.	
Evidence of a Mammal	Can you notice anything that might be evidence of a mammal around here?	There are many possible answers. Bat, raccoon, fox, tracks, scat, humans, etc.	
Evidence of an Amphibian	What are some amphibians you can think of? Can you notice anything that might be evidence of an amphibian around here?	Frog calls	
Evidence of an Insect	Can you notice anything that might be evidence of an insect around here?	There are many possible answers. Cricket calls, mosquitoes, moths, etc.	
The direction the wind is coming from	Can you feel the wind? Which direction does it seem to be coming from? Is that North, South, East, or West?	Wind usually moves from colder areas towards warmer areas. For example, when it's hot inland, it creates a low pressure zone, and the air from the cooler coast moves towards it.	
3 different textures you can feel with your feet	As you walk, notice how the ground feels. Soft? Hard? Bumpy? Smooth? Flat? Crunchy? Can you tell where the trail is just using your feet?	The soil on a trail is often harder and more compacted than soil around it. You can often feel a trail with your feet, and notice when you step off it with your feet.	
Evidence of city lights	Where do you think the light on those clouds is coming from? Where might the energy from those lights have originated?	Even if you're out in nature, you can often see city lights reflected off the clouds. If you can't, that's cool too!	
Evidence of wind	Can you find any evidence that wind is blowing right now? Evidence of it blowing other times?	There are many possible answers, such as plants that are short and have grown in the direction of wind, hair moving around, etc.	
North	How can you figure how which direction is North?	When the West is to your left, and the East is to your right, you are facing North. The North Star in the Little Dipper can also be your guide to North.	

Night Object	Questions to Ask	Information to Share	Additional Information
South	How can you figure how which direction is South?	When the West is to your right, and the East is to your left, you're facing South.	
West	Which direction did the Sun go down?	The Sun always sets in the West.	
East	Which direction did the Sun come up?	The Sun always rises in the East.	
The sound of plants	Let's all be as still and quiet as we can, and listen to find out what sounds we can hear.	Sometimes you can hear plants rustling in the wind, or when you brush up against them.	

Student Cards

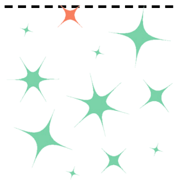
Print the following cards, cut out along the dotted line, and hole punch two holes at the top to put string through. Decide each time you lead this activity which cards to use based on students interests and setting. Cards are coded with the following icons (in the upper-right corner) to help you decide which are best to use:

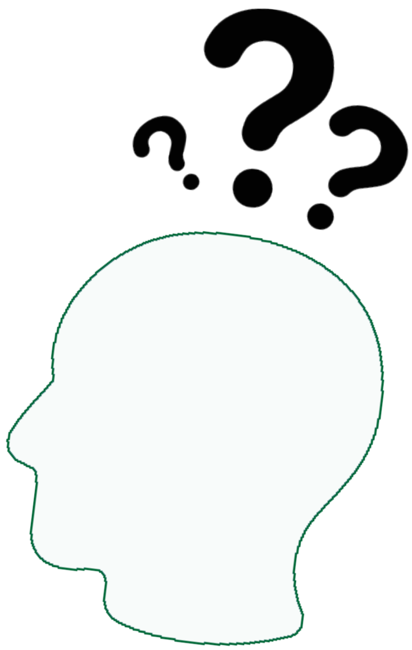
 Objects that are sky-related, but don’t require a clear sky

 Objects that are unrelated to the sky

 Require a clear night sky

A Natural Satellite Of Earth

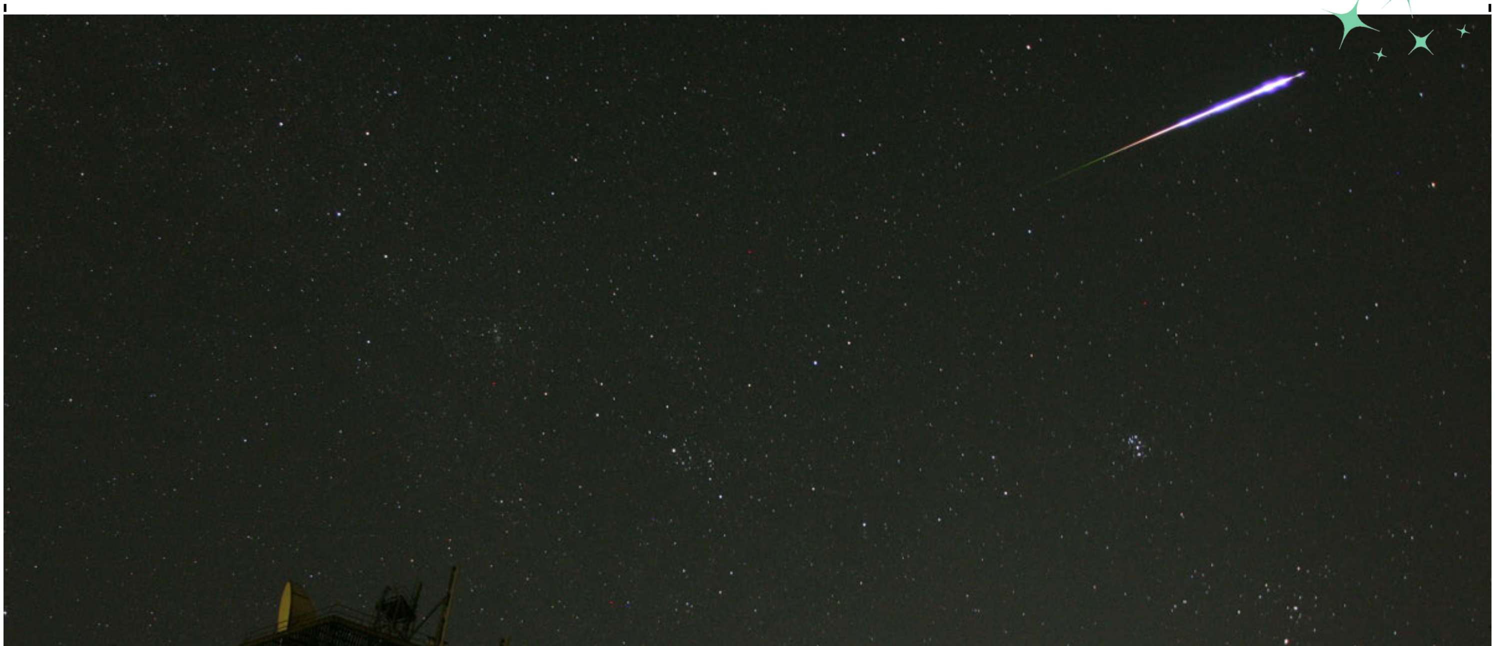




Something natural that orbits the Earth

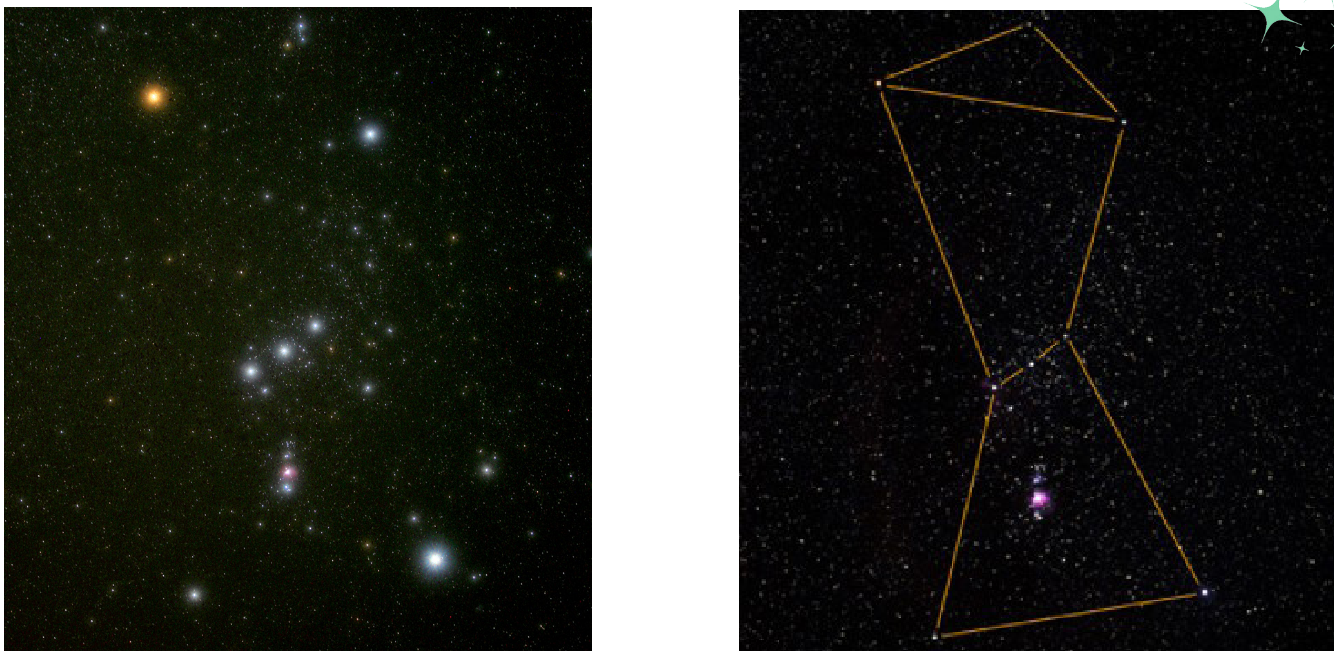
A Galaxy

Evidence Of A Meteor



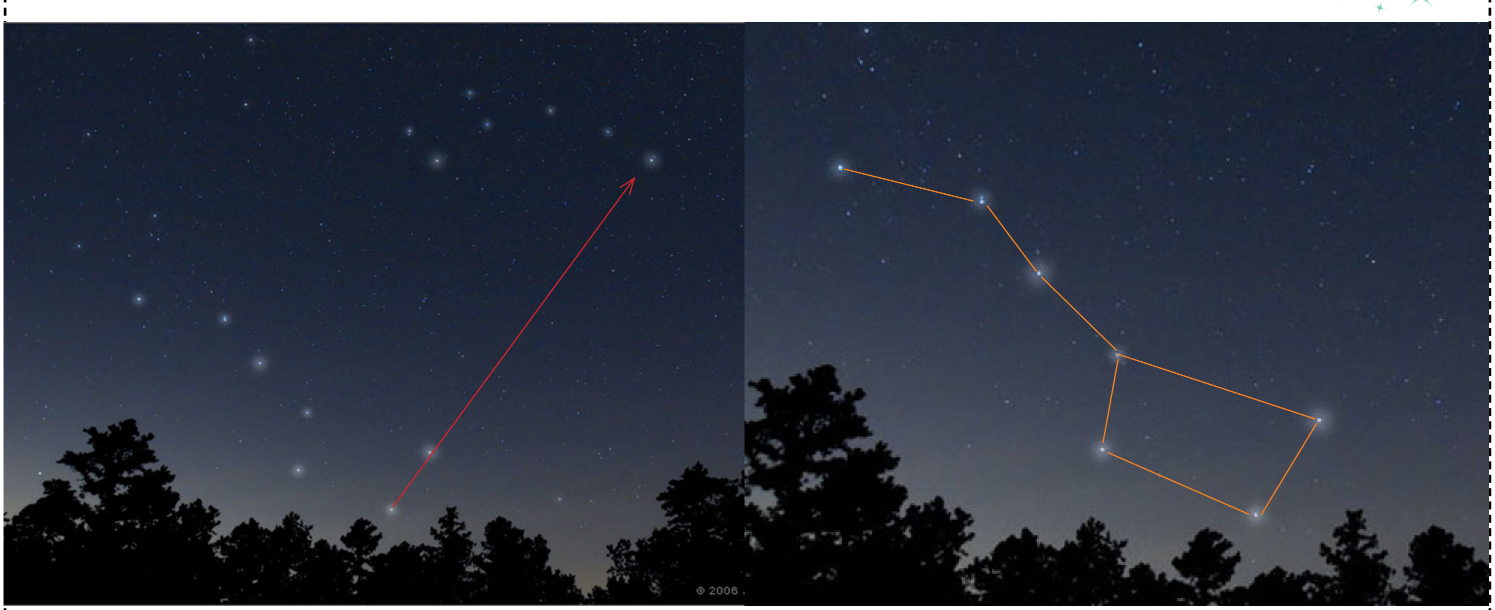
Sometimes called a "shooting star," but it's not a star. It's usually a piece of dust or small rock from space burning up as it enters Earth's atmosphere.

The Orion Constellation



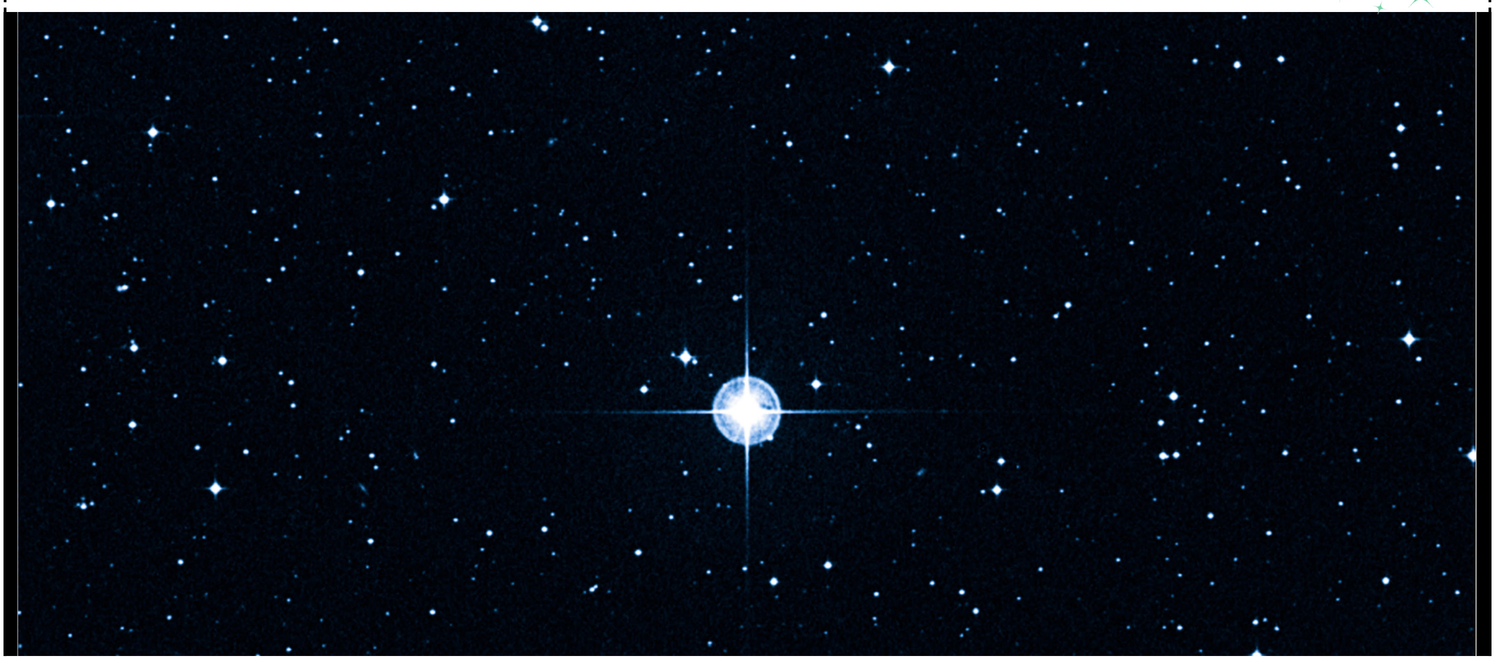
Find his belt, his sword, his right shoulder (Betelgeuse) & his left foot (Rigel).

The Big Dipper

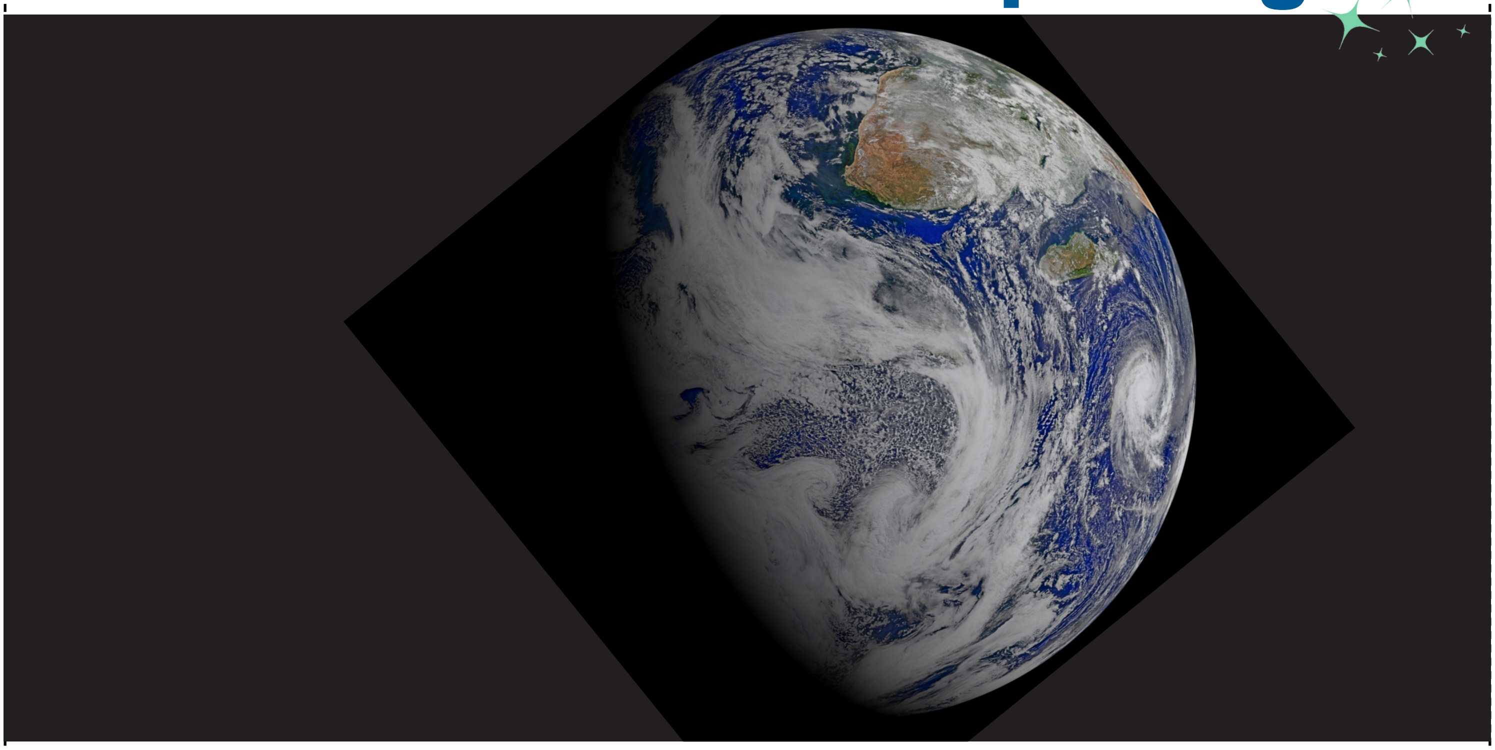


Using the front 2 stars (farthest from the handle) of the Big Dipper to find the North Star (Polaris).

The Brightest Star In The Sky



Evidence of the Earth Spinning



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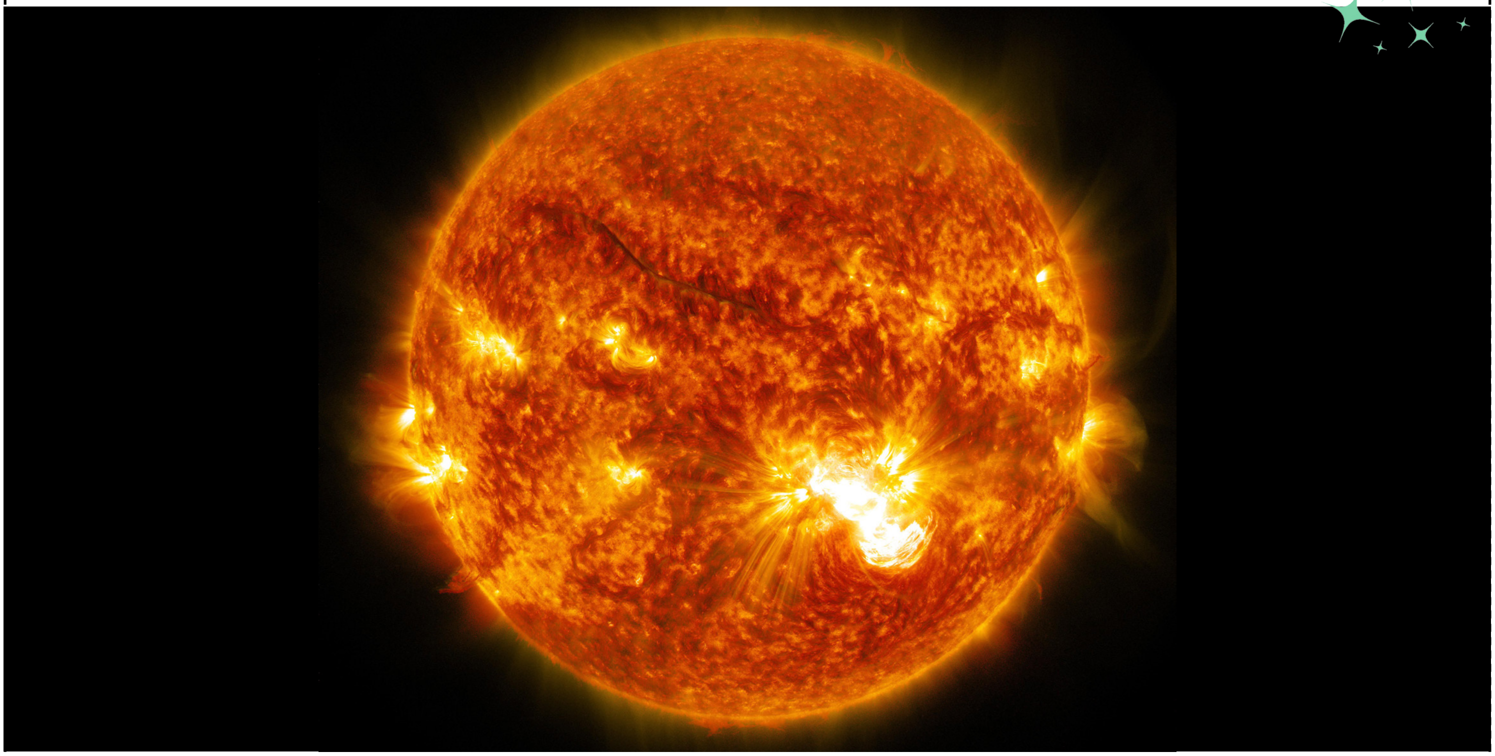
Something Bigger than the Sun



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A Nebula

Where new stars are forming

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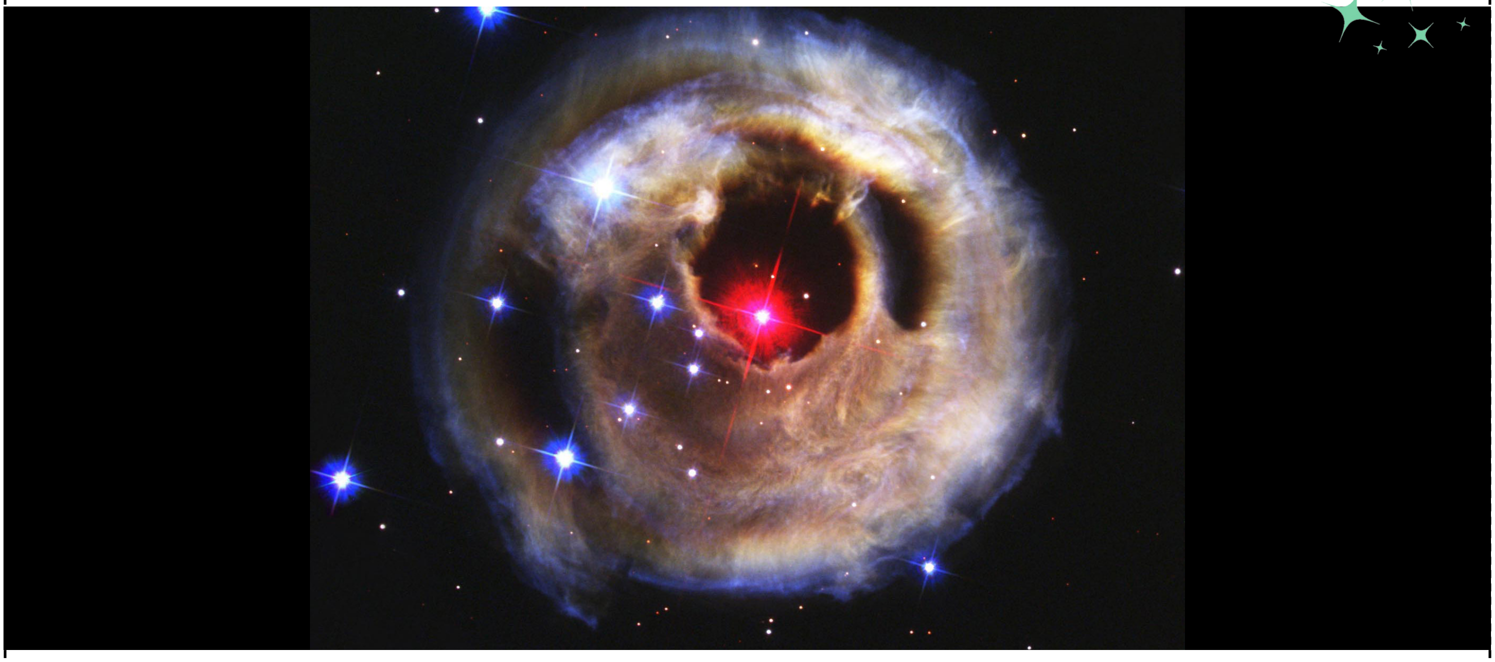
A Red Star



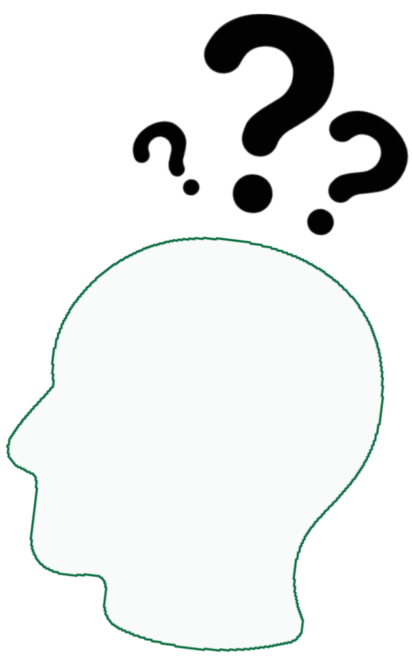
Red stars are literally the coolest stars (that is, they have lower temperatures).

A Blue Star

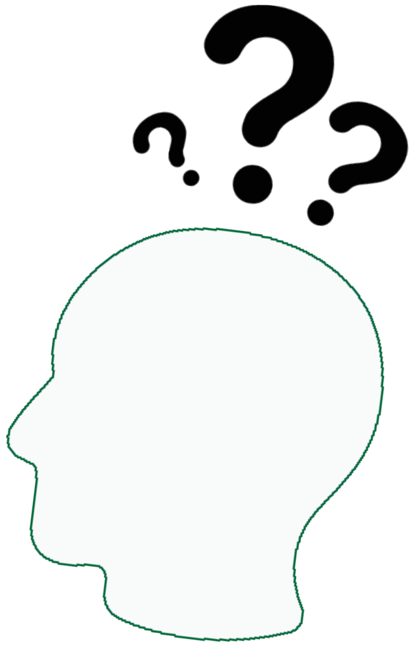
Blue stars are the hottest stars (they have hotter temperatures).

The Moon’s Shadow

Your Own Invented Constellation



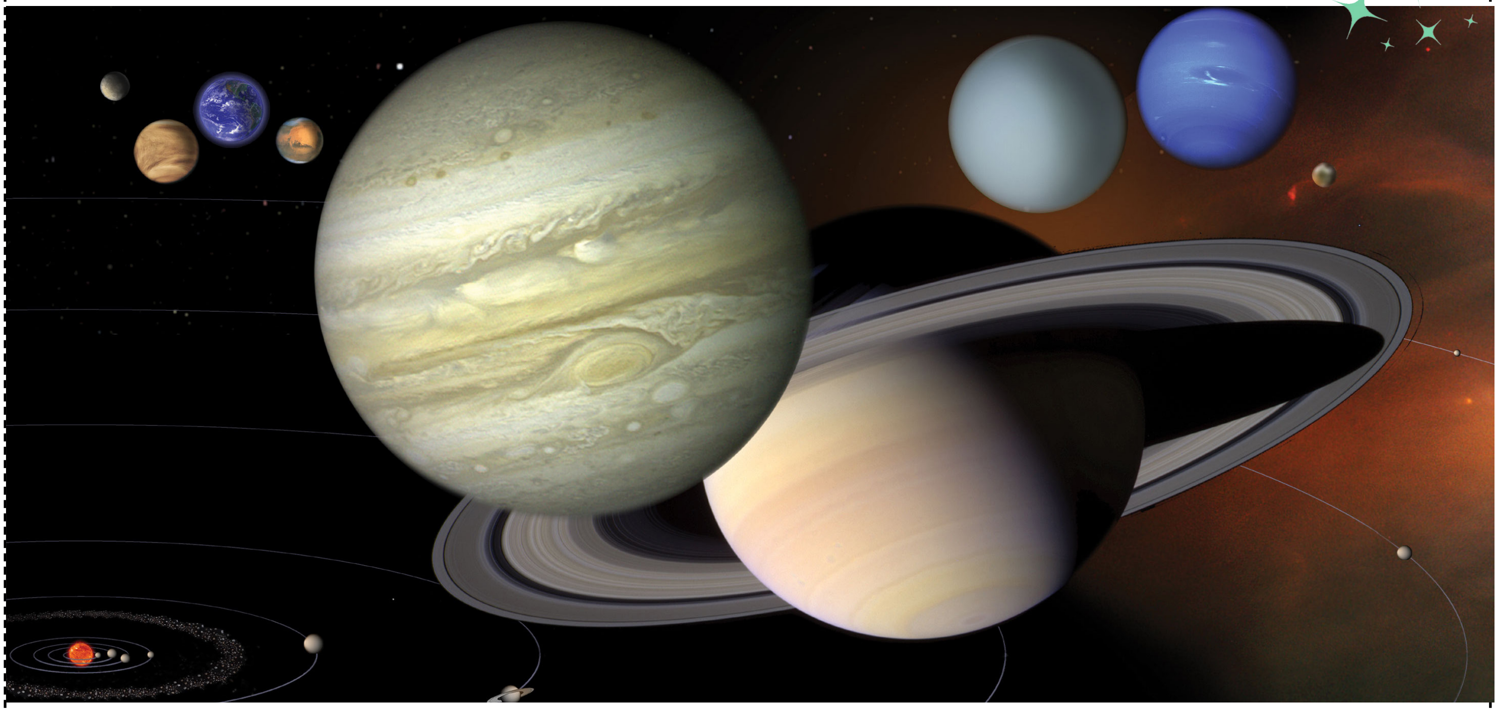
Our Nearest Star



An Artificial Satellite Of Earth

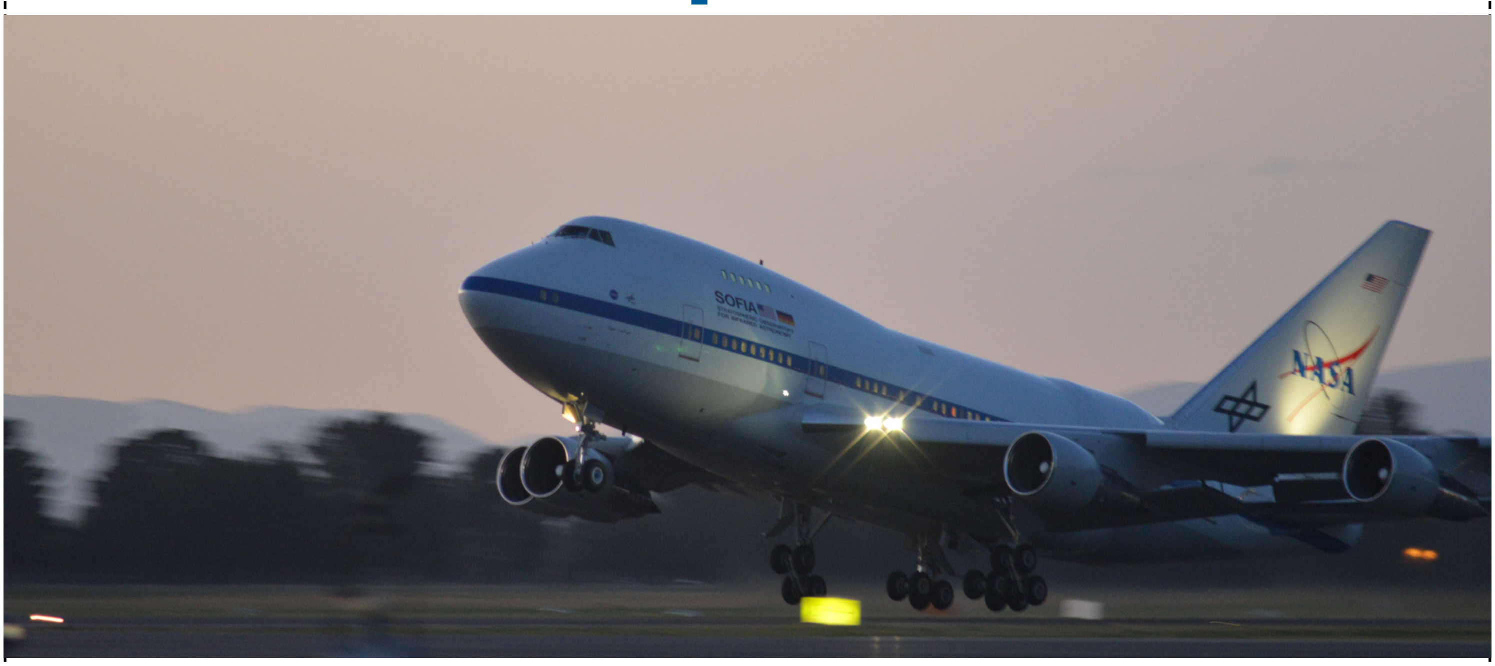
Something made by people that orbits the Earth: looks like a steadily moving tiny dot of light

A Planet



Planets are natural satellites that orbit the Sun.

An Airplane



Looks like steadily moving flashing lights of different colors (or sometimes just one color).

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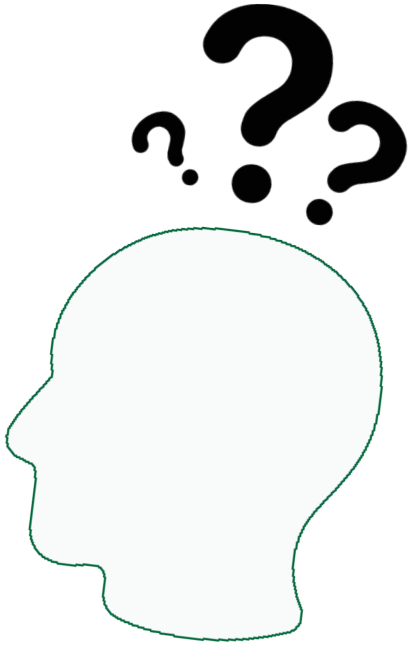
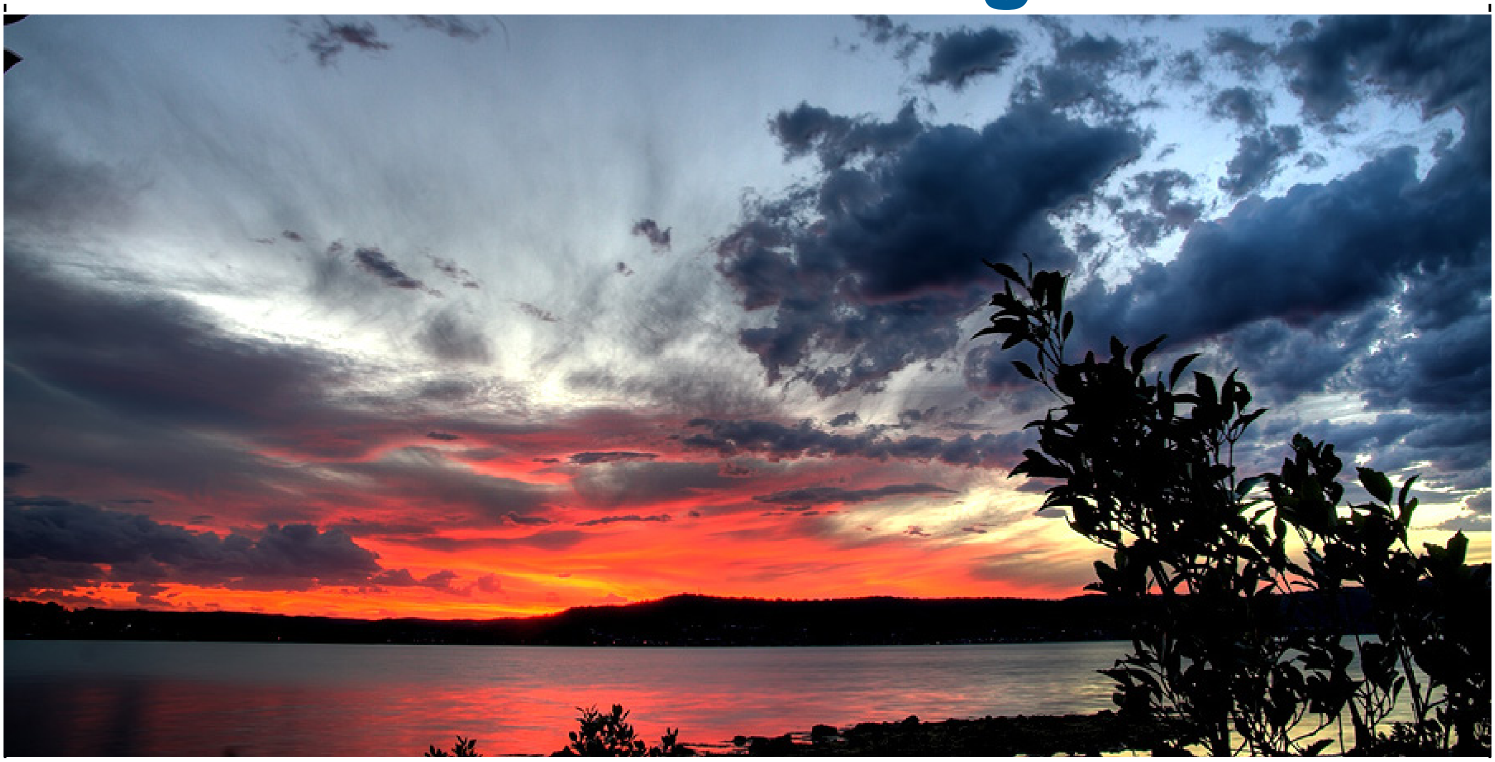
The Fastest Thing in the Universe



Evidence of Sunlight



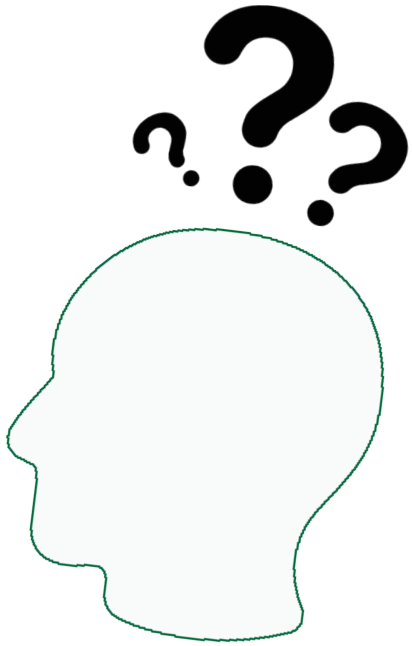
Evidence of Water in the Sky

The Absence of Color

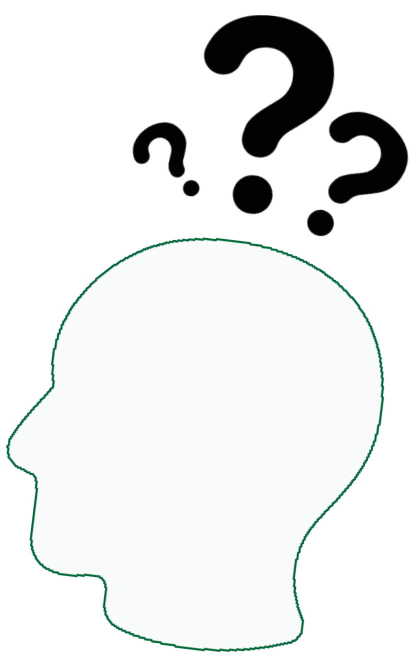
When there is enough light, our eyes can see colors.

When there is not enough light, our eyes can't see color anymore. They only see shades of black, white, and gray.

Evidence of a Mammal



Evidence of a Bird



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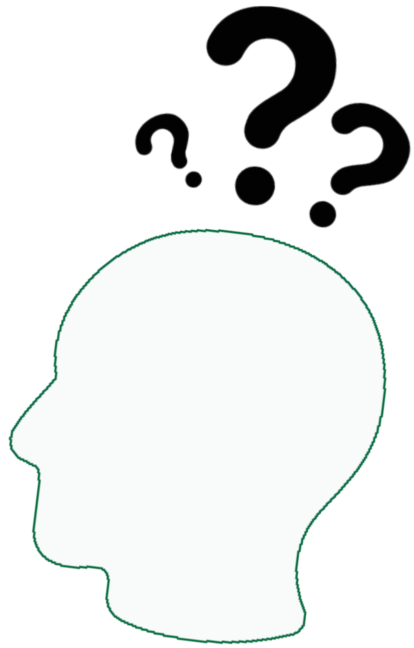
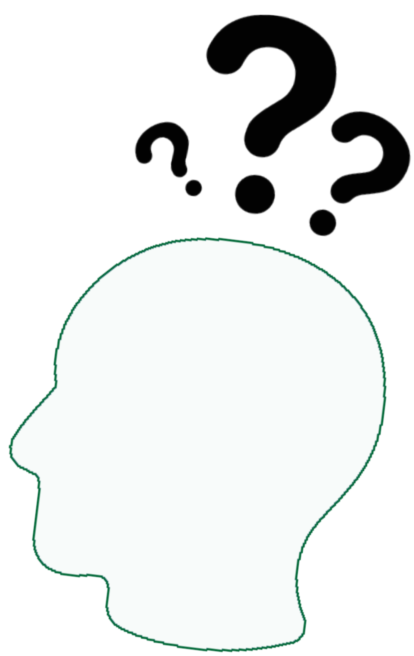
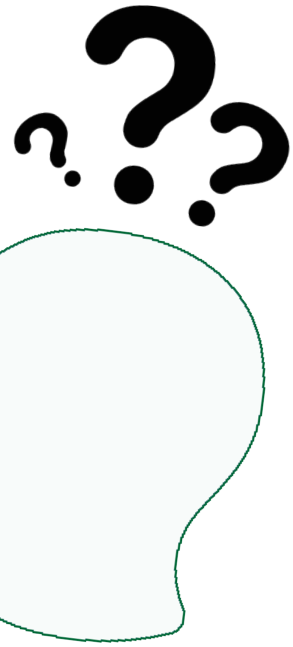
Evidence of an Amphibian



Evidence of an Insect



The Direction of the Wind



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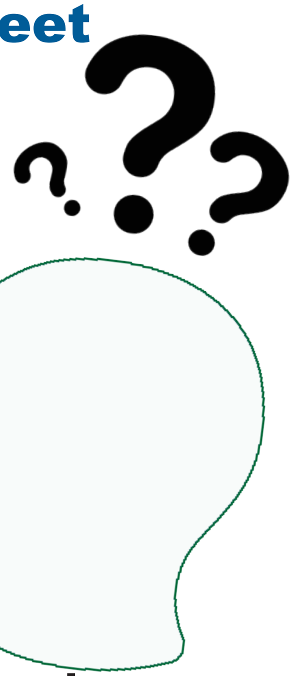
3 Different Textures You Can Feel With Your Feet



As you walk, notice how the ground feels. Soft? Hard? Bumpy? Smooth? Flat? Crunchy?

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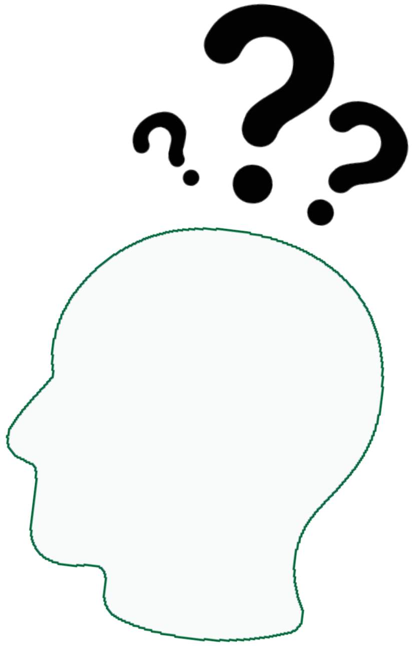
Evidence of City Lights



Evidence of Wind

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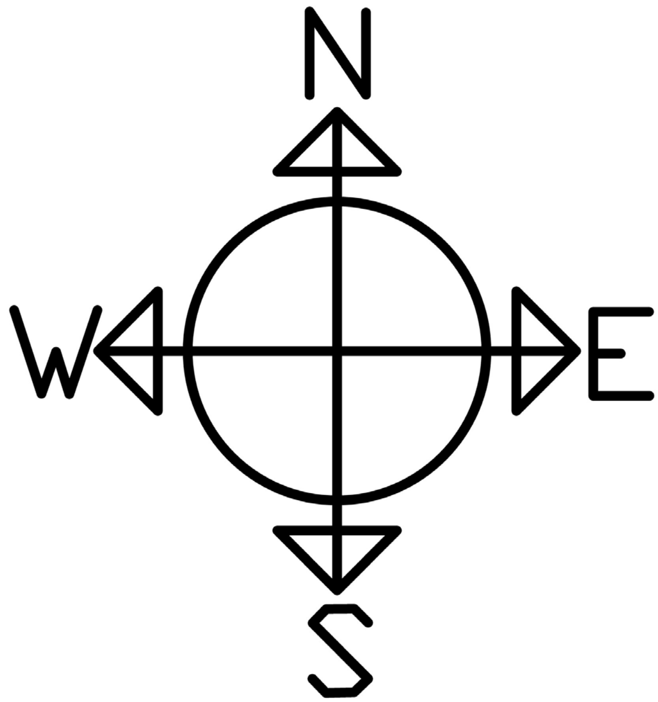
North



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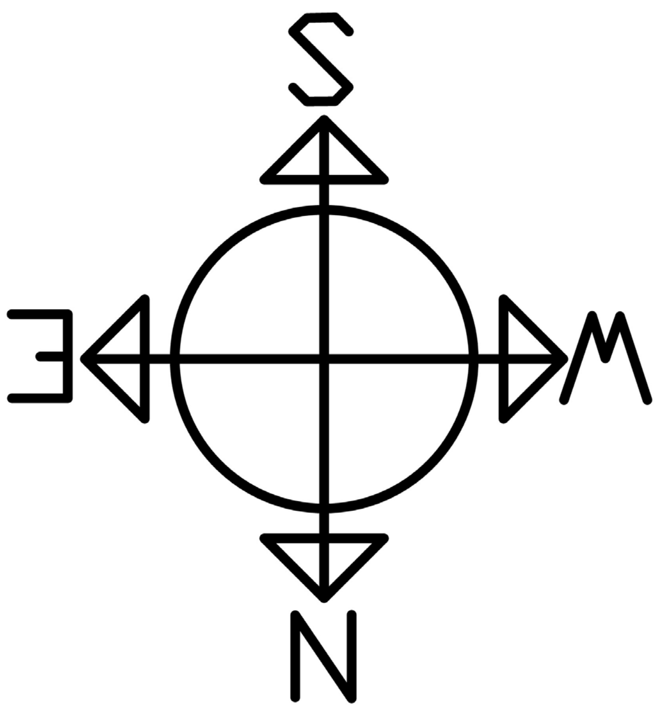
South



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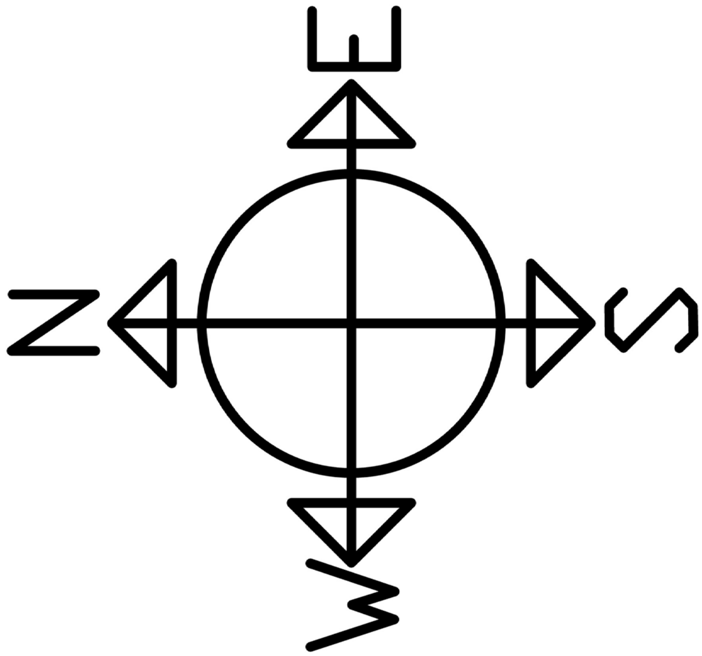
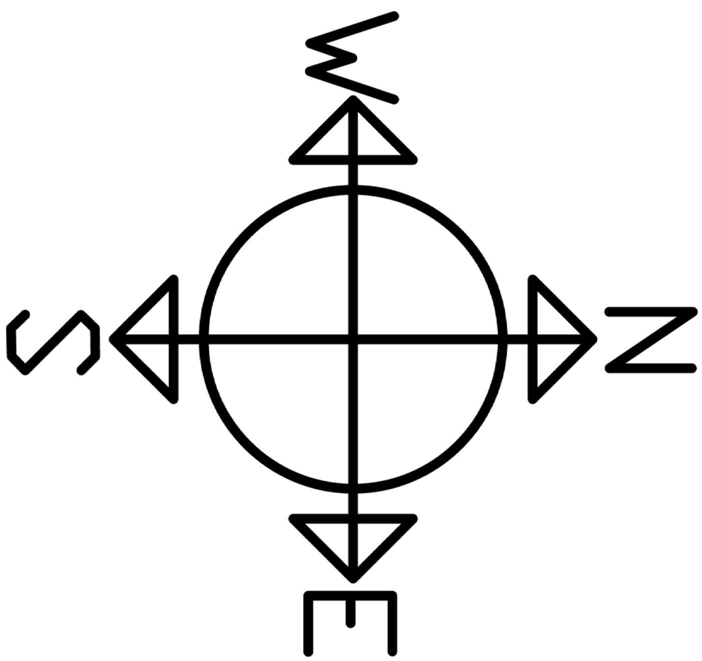
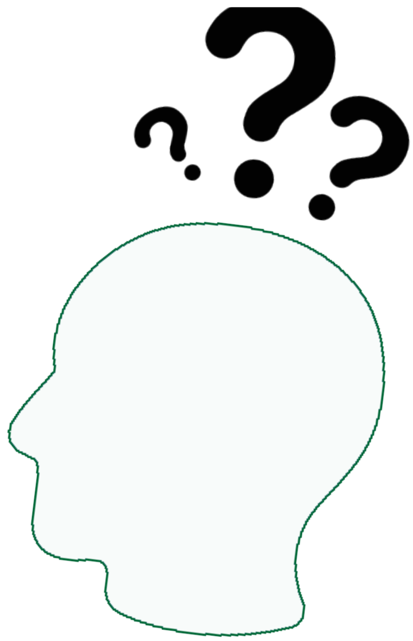
East



West

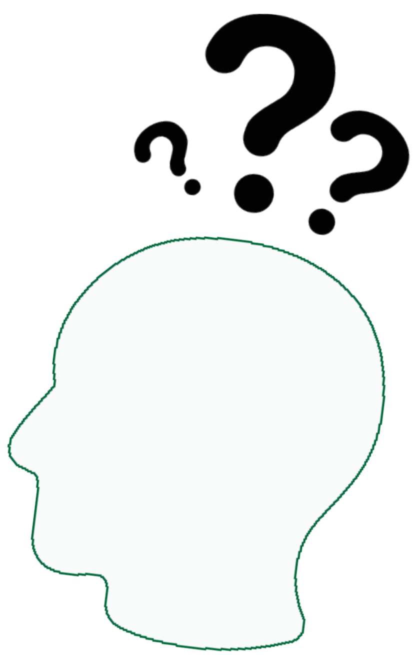


Card Title



BEETLES | Night Hike Scavenger Hunt

Something in the Sky Smaller Than Your Fist



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FIELD CARD

Cut out and fold along the centerline. Wrap the notes around either side of a 4" x 6" index card to make them sturdier. This makes a handy reference card that will fit in your pocket.

Night Hike Scavenger Hunt

Introducing the Activity

1. In lit area, tell students they'll be looking for objects in the night.
2. Explain: Some items in the scavenger hunt are obvious but others are like puzzles.
3. Explain the procedure: pairs get a card, discuss what's on the card (what it is, what they've heard about it, whether they think the group will see it), then trade cards with other pairs.
4. Model how to discuss an item with another adult.
5. Students find a partner they can work well with; pass out cards & begin.
6. After ~10 minutes, circle up & set all cards on the ground in the middle of the group.
7. Show the group the constellation you've chosen to focus on.
8. Explain: students (& adults) will choose a card to wear around their neck, & will remind the group about that item.
9. Model how not to be competitive over choosing cards.
10. Put away cards not picked up, carry some yourself, or see if any students want 2 cards.

During the Hike

1. As much as possible, let students discover items for themselves.
2. Give times of silence, use quiet voices for discussion & give signals students can use when they find something.
3. Help students see something others have pointed out.
4. Keep up a discussion about size & distance of objects throughout the activity, challenging them to compare objects.
5. Share information tidbits to encourage discussion & wonder.
6. Choose to focus on a few subjects:
   - Light. Light Seconds (Moon = ~1.5 light sec. away) Light Minutes (the Sun = ~8 light min. away). Light Years. When you look at starlight, you're looking back in time. Sirius (the brightest star) = ~9 light yrs. away. Ask:

     ▶ *How old were you when the light you see now left Sirius. How old will you be when the light leaving Sirius now reaches Earth?*
   - Moon. What do you notice? White parts = older rock, dark spots = "newer" (but still >a billion years old) lava rock. Much lava filled pre-existing round craters. Students point out to each other where older & younger parts are. Choose from these questions:

     ▶ *The moonlight you see is actually sunlight reflected off the Moon. Why do you think it isn't as bright as direct sunlight?*

     ▶ *The same side of the Moon always faces Earth. What explanations can you think of for that?*

     ▶ *Over billions of years, the Earth has been hit by as many space objects as the Moon. Why do you think you can see so many craters on the Moon, but not on Earth?*

     ▶ *What are some different explanations you can think of for how the Moon might have formed?*
   - Focus on a constellation. See Night Objects Information Chart for information on the Big Dipper or Orion.
7. Challenge group to find unfound items.

Wrapping Up

1. Students with cards of found objects raise hands. Explain: can look for them other nights.
2. Students with cards of objects not found raise hands. Explain: can keep looking for them.
3. Group forms line ranking biggest to smallest objects, sharing reasoning.
4. Optional: Group forms line ranking closest to farthest objects, sharing reasoning.
5. Explain: There's lots more to be found at night. You can find them other times.
6. Choose from Walk & Talk questions:

   ▶ *What's something that surprised you?*

   ▶ *What are some interesting things you'd like to share with someone not here?*

   ▶ *What are some questions you wonder about night objects?*

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ABOUT BEETLES™

BEETLES™ (Better Environmental Education Teaching, Learning, and Expertise Sharing) is a program of The Lawrence Hall of Science at the University of California, Berkeley, that provides professional learning sessions, student activities, and supporting resources for outdoor science program leaders and their staff. The goal is to infuse outdoor science programs everywhere with research-based approaches and tools to science teaching and learning that help them continually improve their programs.

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The Lawrence Hall of Science is the public science center of the University of California, Berkeley. *www.lawrencehallofscience.org*

Principal Investigator and Articulate Beetle: Craig Strang
Project Director, Lead Curriculum & Professional Learning Developer, and Idea Beetle: Kevin Beals
Project Manager, Professional Learning & Curriculum Developer, and Beetle Herder: Jedda Foreman
Curriculum & Professional Learning Developer and Head Fireball: Lynn Barakos
Curriculum & Professional Learning Developer and Champion-Of-All-The-Things: Emilie Lygren
Research and Evaluation Team: Bernadette Chi, Juna Snow, and Valeria Romero
Collaborator, Super Naturalist, Chief Scalawag and Brother-from-Another-Mother: John (Jack) Muir Laws
Project Consultants: Catherine Halversen, Mark Thomas, and Penny Sirota
Advisory Board: Nicole Ardoin, Kathy DiRanna, Bora Simmons, Kathryn Hayes, April Landale, John Muir Laws, Celeste Royer, Jack Shea (emeritus), Drew Talley, & Art Sussman.
Editor: Lincoln Bergman
Designer: Barbara Clinton

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To contact BEETLES™, email beetles@berkeley.edu