Fight for the Stars: Be a Knight for the Night

Level 2 Activity Handout Packet

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Sky Heroes

An Activity Reinventing the Constellations

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Ancient cultures named the patterns of bright stars in the sky after their mythological heroes and monsters. Different countries and ethnic groups had completely different stories to tell about the same groups of stars. For example, the seven stars we call the Big Dipper were seen as a plow in England, as a stretcher with a sick patient by the Skidi Pawnee tribe of North America, and as seven Watchmen guarding the pole of the sky in Siberia. What if we could start over and rename the constellations (the star patterns) today? Who are the heroes we would now put in the sky?

This is an activity that serves several purposes:

- it teaches students that the constellation patterns and stories we now use are the products of particular cultures and times;
- it gets students thinking about how arbitrary these patterns and stories are;
- it helps students think through their own values about heroes;
- it allows students to talk with one another in small groups about a topic (whom they admire) they may not usually discuss;
- it helps them develop story telling and writing skills.

Procedure:

1. First do a lesson on the constellations, or hand out the backgrounder sheet at the end of this activity.
2. Divide students into groups of 3 - 5.
3. Tell them that they are astronomers assigned to help with a very important decision. The world of astronomers has decided that the old star patterns are no longer relevant and we have to start over again, naming the constellations. We want to name at least some of them after the greatest heroes of modern times. Their job is to come up with one hero on whom the whole group can agree.
4. Here are the ground rules: The hero they select must be a real person, not a fictional character. The person can be someone alive today, or someone from history. It can, for example, be a political leader, someone from the arts, a sports figure, a scientist, a doctor, or a visionary. The group must be able to explain why the person is their hero.
5. Once the group's hero has been selected, the next step is to find a way to put him or her in the sky. Hand out one of the blank star maps that accompany this activity and ask them to make a connect-the-dots star pattern that goes with their hero. Emphasize that the pattern doesn't have to *look like* the person. It could just be a symbol. So if they select Barry Bonds, the constellation could look like a bat and a ball. If they pick Beethoven, the constellation could resemble a piano or a set of notes. They should be prepared to share their pattern with the class and explain their reasoning.

Extension Activities

1. You can assign each student or group to research one of the actual 88 constellations and write a report on the legends associated with their star pattern. For a more advanced class, ask them to list some nice astronomical objects in their constellation and then observe them with the *Seeing in the Dark* Internet Telescope.

2. You can ask each student or group to write a report with more information on the hero they have selected and then present their findings to the class.

3. You can do a variant on the activity where groups now get to nominate a favorite hero from fiction (you need to decide if the hero has to be from a novel only, or if you will allow comic books, movies, or television shows to be part of the hero pool.)

4. Another possibility is to let students (especially younger ones) invent their own hero and to create a story to go with him or her. The story can be realistic or can be fantastic, like some of the ancient sky tales. Then they need to invent a nice star pattern that fits with the hero.

The thing to notice in all these activities is that it's often hard to agree. Once people come up with their favorite hero, they don't want to give it up for someone else's. The same was true for the constellation stories of the world's cultures. It was sometimes hard to give up the sky stories people grew up with and accept one uniform set of constellations for the whole world.

Resources for Further Exploration:

- Some favorite books for learning more about the sky stories of many different cultures include:

Ed Krupp's *Beyond the Blue Horizon: Myths and Legends of the Sun, Moon, Stars, and Planets.* 1991, Harper Collins.
Lloyd Motz and Carol Nathanson's *The Constellations.* 1988, Doubleday.
Julius Staal's *The New Patterns in the Sky: Myths and Legends of the Stars.* 1988, McDonald and Woodward.
Ray Williamson and Jean Monroe's *They Dance the Sky: Native American Star Myths.* 1987, Houghton Mifflin.

- Two good web sites for exploring constellation stories further are:

Windows to the Universe Mythology Page:
http://www.windows.ucar.edu/tour/link=/mythology/mythology.html&edu=mid&back=/search/search_navigation.html
The Constellations Web Site: http://www.dibonsmith.com/menu.htm

The Constellations
Background Information

On a completely clear night, if you could see the entire sky (with no trees, hills, or buildings in the way), you could see about 3000 stars. Even if you only see half as many, that's way too many dots of light to memorize. To cope with this great throng, human civilizations have long tried to identify groups of bright stars that made interesting connect-the-dots patterns.

Each civilization placed its own patterns in the sky, telling stories about the figures they had constructed that reflected their deepest hopes and fears. Many of the ancient star patterns were named after great heroes of legend or history, or after monsters that symbolized threats to human society (such as wild animals, storms, floods, or ice.) These star patterns were called *constellations*. Sometimes, there was a distinct smaller pattern within a constellation figure, such as the Big Dipper, which is part of the ancient constellation of the Big Bear. These smaller star groupings are now called *asterisms.*

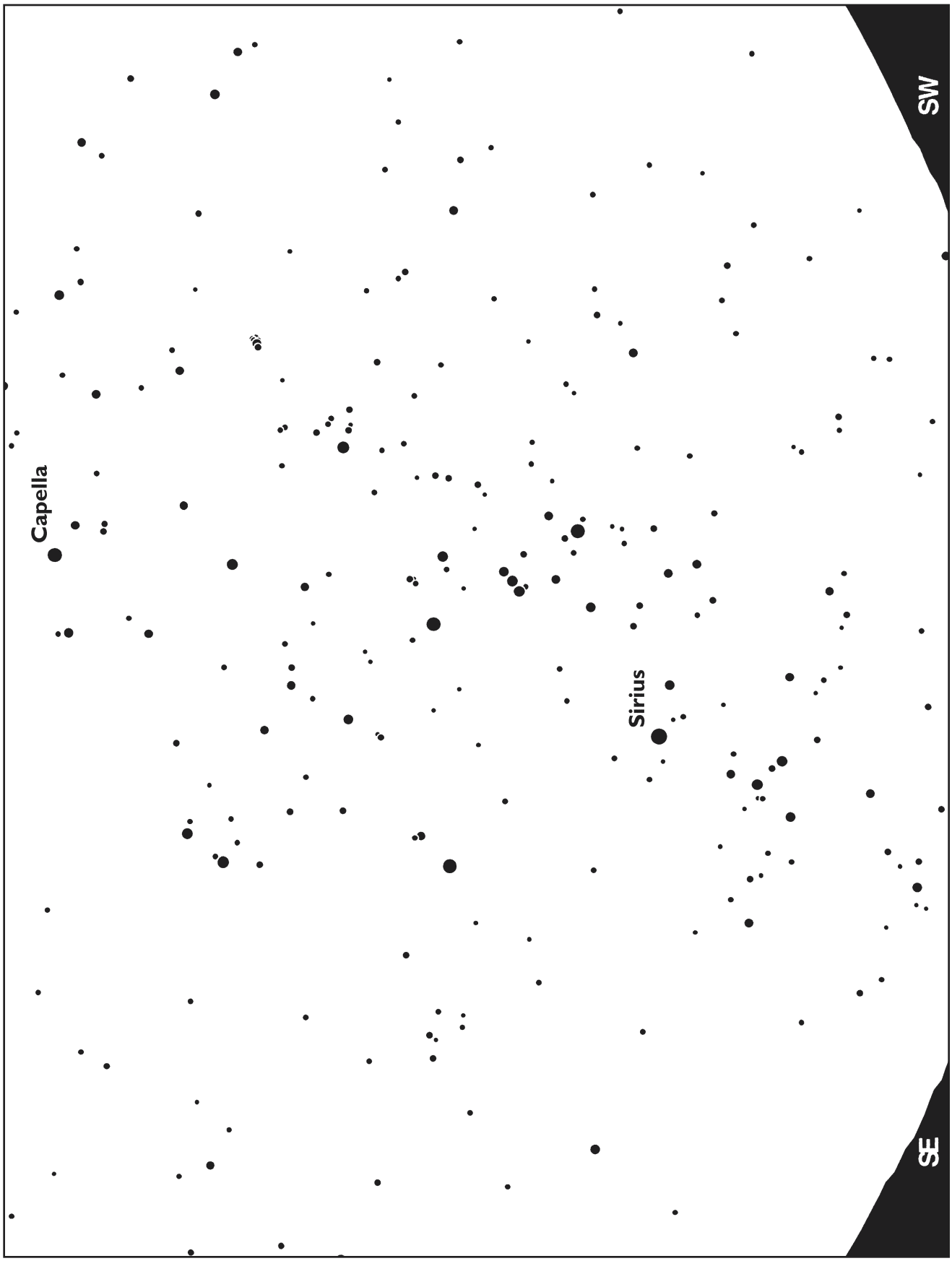
Dimmer stars that were not part of the constellation patterns were sometimes called "scattered" or "outside the image" stars. And which bright stars belonged to a constellation and which did not depended on whose constellations you adopted. The patterns and stories differed from continent to continent and culture to culture. And astronomers in the 18th and 19th century began making suggestions for additional constellations, many of which contradicted each other.

As long as astronomy was mostly a local pursuit, astronomers only needed to know the local system of identifying and naming the constellations. But by the beginning of the 20th century, as astronomy became more international, some system was needed to allow astronomers and astronomy enthusiasts around the world to understand each other's references to the sky. Astronomers from many countries formed the International Astronomical Union (IAU) to promote cooperation among the world's astronomers. In a series of discussions and resolutions between 1922 and 1930, the IAU defined a new standard system for mapping the sky.

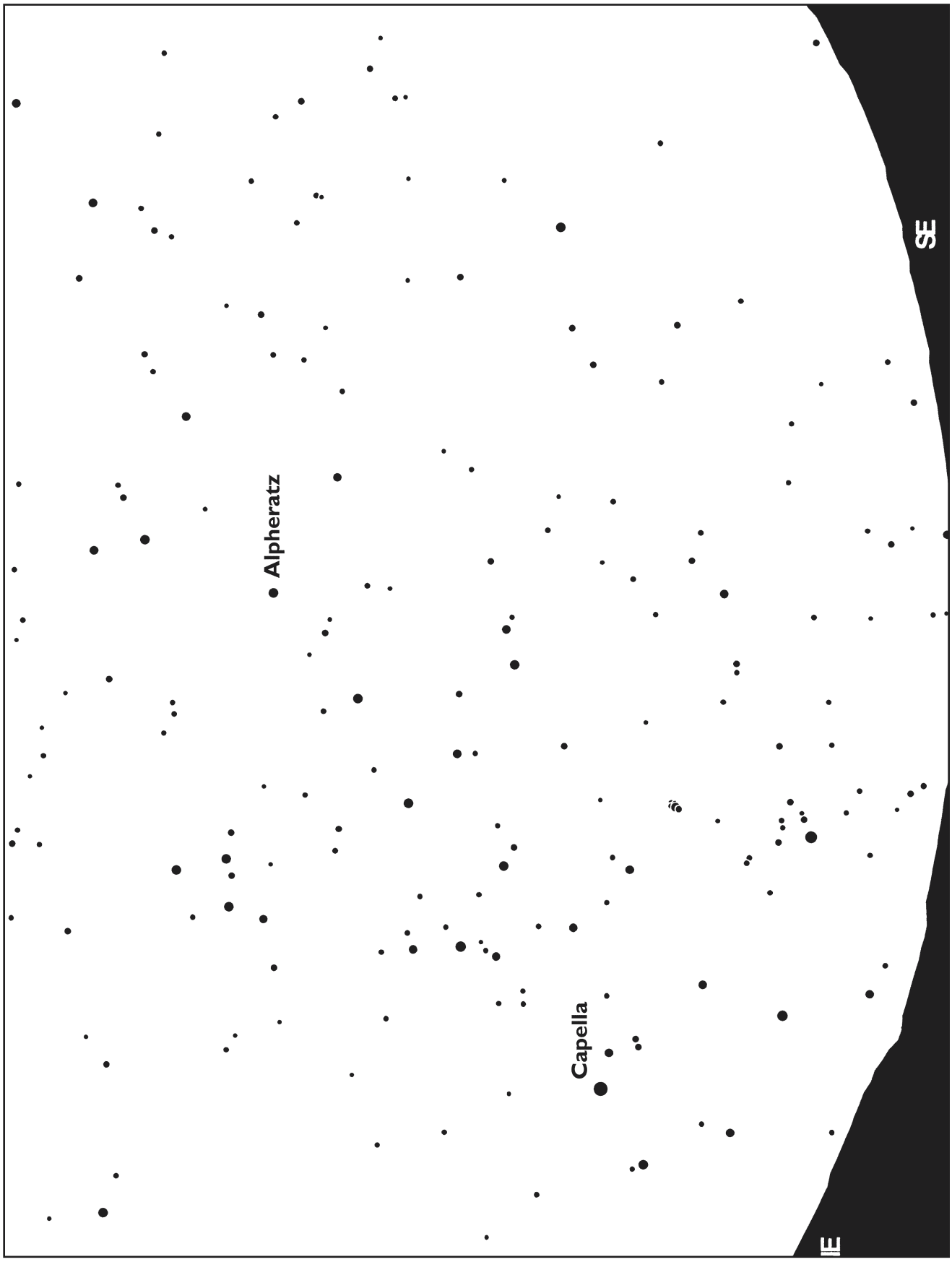
The IAU divided the sky into 88 boxes or sectors (much as the continental United States has been divided into 48 sectors called states) and called these boxes the constellations. Many of the sectors were named after a prominent ancient star pattern inside them. So the whole box with Orion the Hunter in it was now the constellation of Orion. It included not just the bright stars of the hunter's pattern, but all the stars in that box. For boxes that did not include a well-known ancient pattern, more recent suggestions were used, such as the constellations of Telescopium and Microscopium, in the Southern Hemisphere. (For more on the constellation names and how to pronounce them, see: http://www.skyandtelescope.com/howto/Constellation_Names.html)

Note that even some of the most famous star patterns don't resemble the people or creatures after whom they are named. But the state of Washington doesn't look like George Washington either! Constellations can symbolize a hero or monster as long as we agree on the symbol.

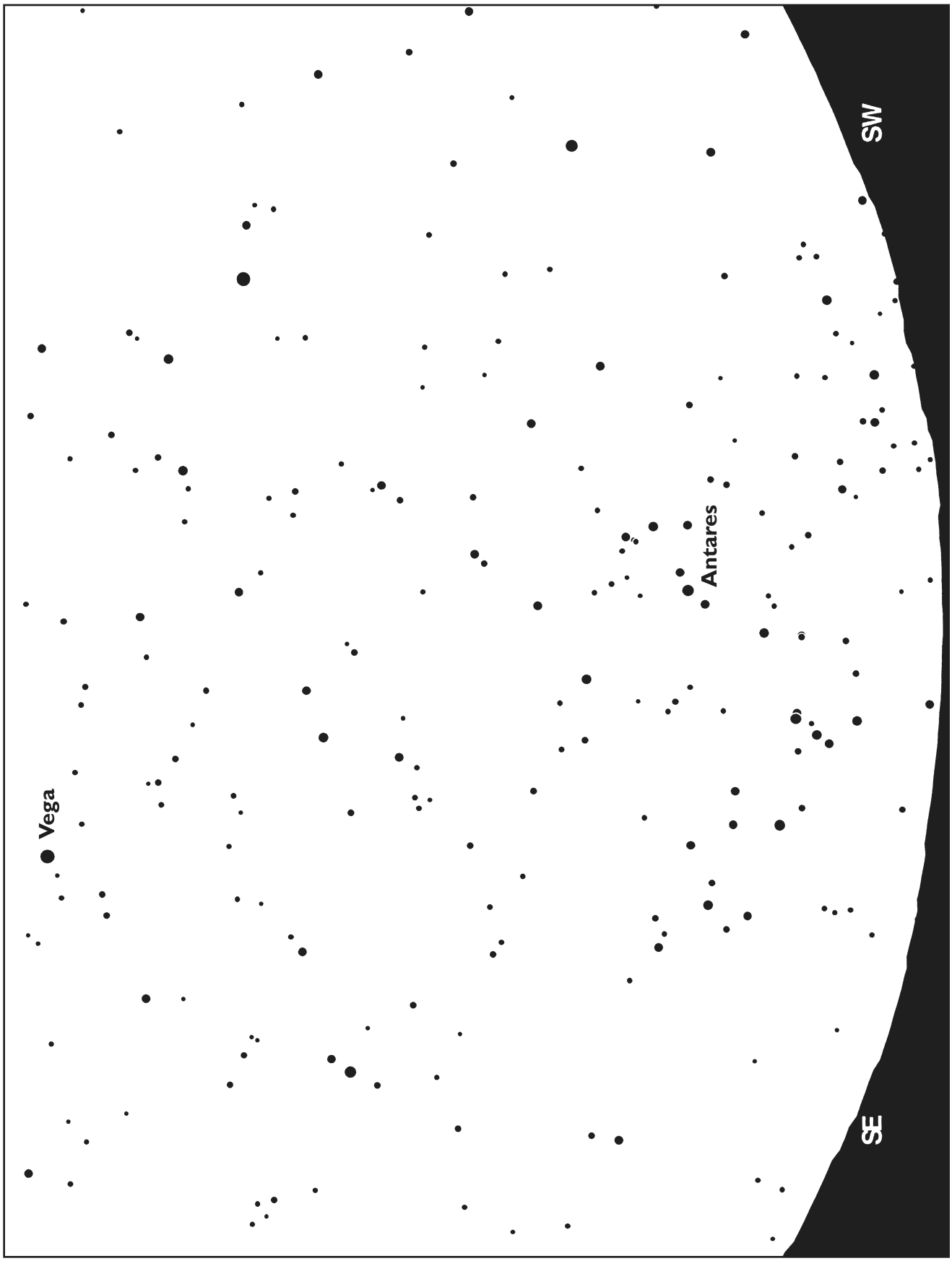
Winter Sky Heroes Star Chart



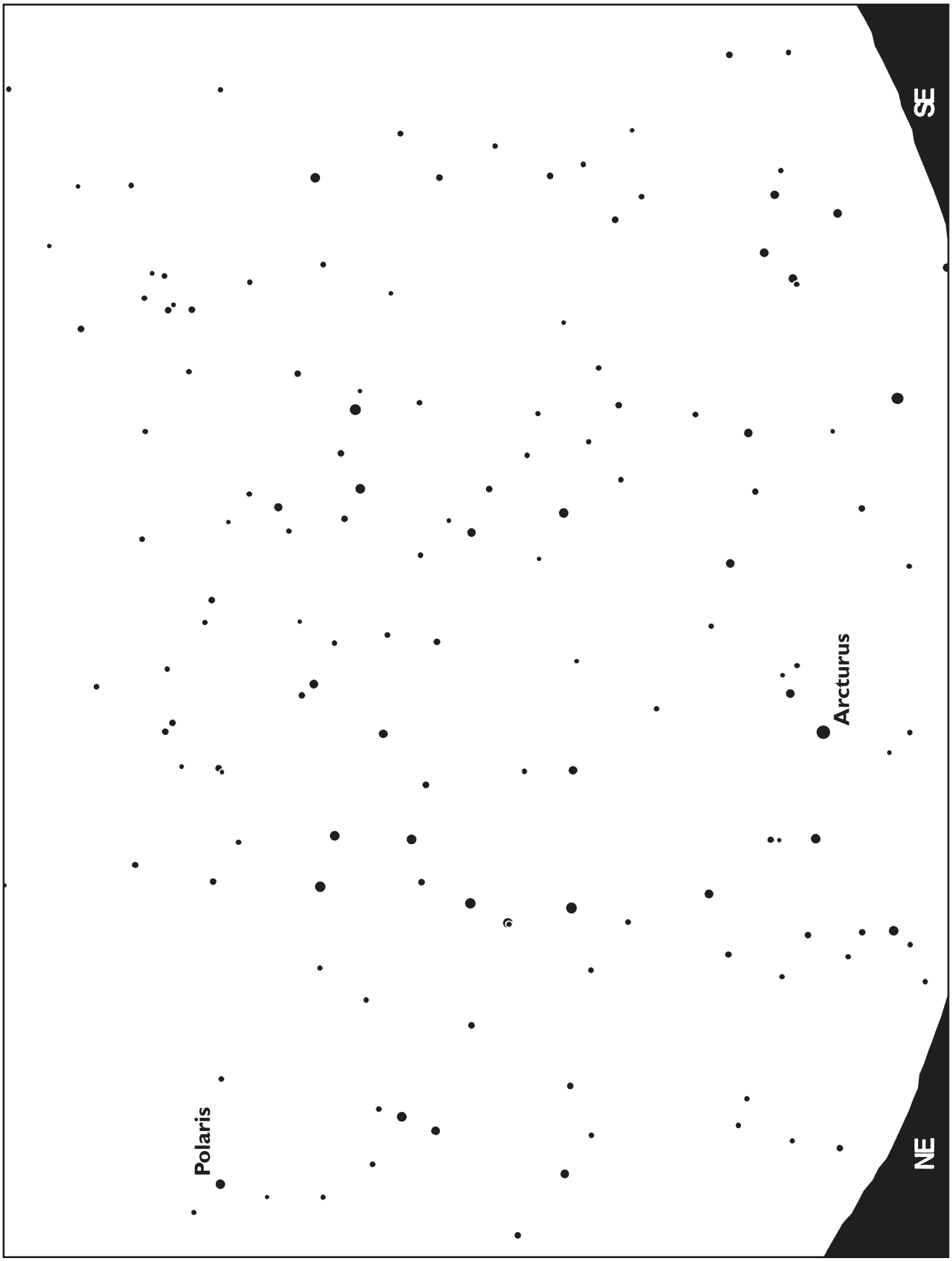
Autumn Sky Heroes Star Chart



Summer Sky Heroes Star Chart



Spring Sky Heroes Star Chart

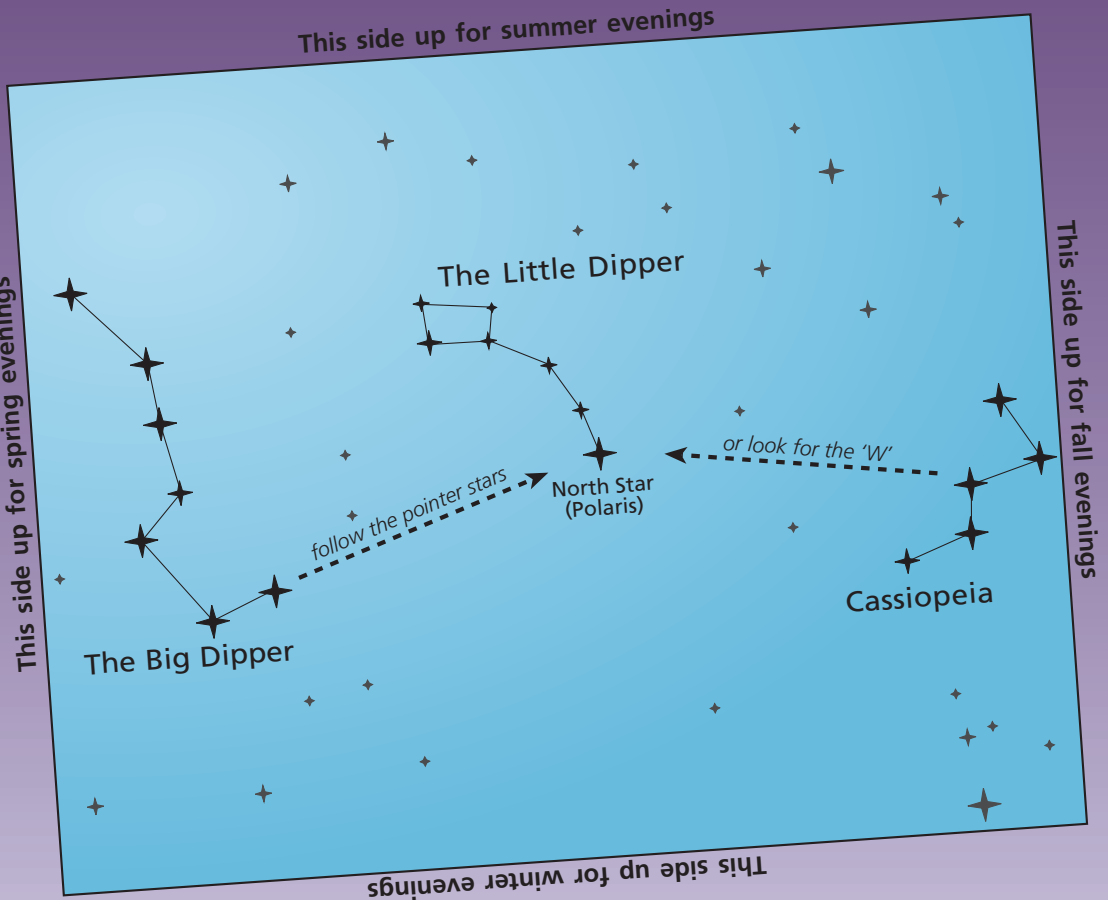


Navigating at night

Altitude is the height that an object appears above the horizon. An object on the horizon has an altitude of zero degrees, and an object directly overhead has an altitude of 90 degrees.

For over a thousand years, sailors have used the stars to find their way across the ocean on long voyages. As the Earth rotates, all of the stars appear to spin around a point called the Celestial Pole. Because the star Polaris (also called the North Star) is very close to the Celestial Pole, it is the only star that does not appear to move during the night. Its *altitude* is equal to the observer's *latitude* (these distances are measured in degrees). Sailors could find their latitude by measuring how far above the horizon the North Star appeared. To test your own skill at navigating by the stars, go outside at night, and use the chart below to find Polaris. Now hold your arm out straight and level to the ground. Make a fist with your thumb resting on top of your first finger. Starting with the base of your fist on the horizon, count how many fists you need to reach Polaris. Each "fist" is about 10 degrees.

Latitude is the distance from any point on the Earth to the equator. The equator has a latitude of zero degrees, and the North Pole has a latitude of 90 degrees.



★ Look for the North Star in the sky. Did you find it?

_____

★★ Estimate your latitude using the North Star. Remember that one fist is about 10 degrees.

_____

★★★ Look at a map or ask an adult to help you find your exact latitude. How close were you?

_____

Moon Observation Journal

Spend the next month getting to know the Moon. Set aside some time each day to look at the Moon. Record your observations in the log provided on the back of this page. **Once you have completed your observations for the whole month, answer the questions below.**

Questions:

1. Did the Moon look the same each day? If not, describe how it changed throughout the month.

2. Did you see the Moon at the same time each day throughout the month? Was there a pattern to the time when you were able – or not able – to observe it? If so, describe the pattern.

3. Did anything ever prevent you from being able to see the Moon? If so, what? Could you figure out what the Moon would have looked like if you could have seen it? If so, how?

4. What do you think will happen to the Moon's shape in the sky during the next week?

5. Look up information on the phases of the Moon. Indicate in your Moon Observation Journal (on the back of this page) where you think the Moon most closely matched each of the following phases: Waxing Crescent, First Quarter, Waxing Gibbous, Full Moon, Waning Gibbous, Third Quarter, Waning Crescent, and New Moon.

6. What questions do you have about the Moon? Look up information about the Moon that interests you, and share what you learn with your friends and family.

Some places you can find information about the Moon and the solar system are:

NASA's Moon Site: moon.nasa.gov
NASA's Solar System Exploration Site: solarsystem.nasa.gov
NASA's Scientific Visualization Studio: svs.gsfc.nasa.gov

Moon Observation Journal

NAME ______________________________

OBSERVE the MOON

DIRECTIONS: Observe the Moon each day for one month. Write down the date and time you make each observation, and illustrate how the Moon looks each day by shading in the circles to reflect the shape of the Moon. For example, if you can see the whole Moon, you do not need to shade in any part of the circle. If you can only see half of the Moon, shade the side of the Moon that you cannot see in the circle for that day. If you cannot see the Moon at all on a day, indicate this on your journal and also write down why you could not see the Moon.

Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______
Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______
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Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______	Date: ______ Time: ______

The National Optical Astronomy Observatory's Dark Skies and Energy Education Program

The Night You Hatched

Grades: K – 5

Overview: The Night You Hatched is a science simulation that builds understanding in young learners about the effects of light pollution on the sea turtles during hatching. The lesson demonstrates animal behavior and the predator/prey relationship.

Students will observe and record behaviors of sea turtles during a hatching simulation, collect then map data, and participate in a critical thinking exercise related to the human impact on animal survival. *This lesson/lesson may be executed as a nighttime lesson with parent volunteers as the light sources and predators or in a semi-dark classroom with students as lights and predators.*

Scientific inquiry promotes critical thinking and analysis of data. Group processing of the simulation encourages students to use data to explain the impact of light pollution on animals (sea turtles) and serves as an introduction to the dynamics of a system. Refer to the NSTA Science Inquiry Continuum (attached) to adapt this exercise for your learners.

Purpose: *"The fundamental goal of life sciences is to attempt to understand and explain the nature of life."* (NAEP 2000) Students will apply scientific inquiry skills, ability, & attitudes associated with science *and* expand their biological understanding of life and life cycles, and the interactions of living organisms with their environment.

Objectives:

- Ask a question about objects, organisms, & events in the environment
- Plan & conduct a simple investigation
- Employ simple equipment & tools to gather data & extend the senses
- Use data to construct a reasonable explanation
- Communicate investigations & explanations

Time – estimated:
Teacher set up - reserve area, gather volunteers, materials (30 minutes)
Lesson - depending on length of discussion (90 minutes)

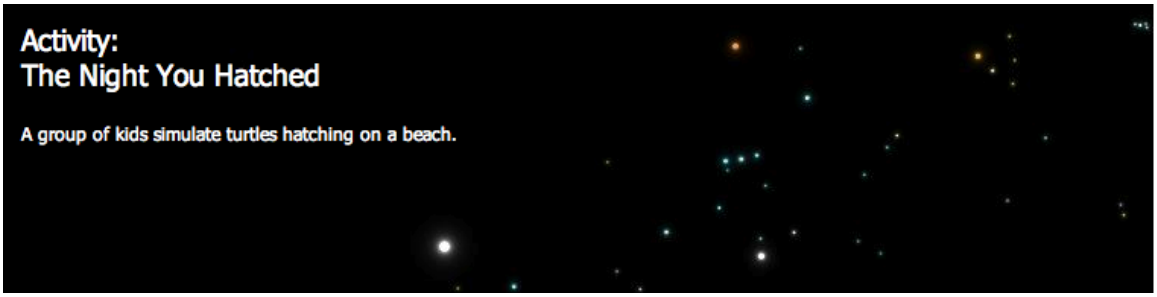
Materials: paper, paper plates, pencils, flashlights/stronger lights, Follow the Moon book, volunteers

Preparation/prerequisites: This lesson is best when integrated with a unit on light or animal adaptations. Other than reserving the space, knowing the lesson sequence and collecting materials, there is no preparation.

Background Information -- teacher/students (online/offline)
All materials for this lesson and other light pollution lessons: http://www.globeatnight.org
Contact your local International Dark-Sky Association for support/class visits on the impact of lighting on astronomical observations, and animal behaviors/circadium rhythms.
Contact your local Scuba diving club for support/class visits related to sea turtles.
http://www.darksky.org
http://www.youtube.com/watch?v=oNqKi2eUUi0
http://www.seaworld.org/infobooks/SeaTurtle/sthatch.html
http://en.wikipedia.org/wiki/Sea_turtle
http://www.nova.edu/ocean/seaturtles/sea_turtle_nesting_behavior.htm
http://photo2.si.edu/turtles/nesting.html
http://www.cccturtle.org/sea-turtle-information.php?page=whycareaboutseaturtles
http://www.nmfs.noaa.gov/pr/education/turtles.htm (great content reading)
http://www.seaworld.org/infobooks/SeaTurtle/home.html

The Night You Hatched

Lesson Sequence (use the step by step lesson below by Chuck Bueter)
Activator: read/discuss with the class Follow the Moon (book)
Formative Assessment: Brainstorm facts about sea turtle hatching behaviors
Instructional Strategies: see lesson plan sequence below
Summative Assessment: Students survey home lighting for animal impact



Author: Chuck Bueter from LetThereBeNight.com; color photos courtesy of Kurt Kruggel.

This lesson integrates well with animal behavior, light and astronomy units. Students will be actively engaged as "sea turtles" in the real world where increasing human populations invade their nesting/hatching habitats.

Opening Class Procedure: Before the simulation, read the picture book Follow the Moon by Sarah Weeks ; illustrated by Suzanne Duranceau. A young boy protects and encourages a newly hatched sea turtle, whose instinct is to "follow the moon" to find the ocean. The sea turtle is drawn instead by a glittering mirrored ball. The sea turtle is rescued by a young boy who helps him learn to listen to the voice inside his head. Follow the Moon has an upswing tropical beat and an upbeat message about friendship and a child's deep bond with nature. ,

After the story, gather students and have them hold their arms around their knees as you describe this night and begin the simulation.

The Night You Hatched

Setting the Stage with the Turtles (tell the students)
Six months ago their mother deposited them into a hole in the sand on the shore of the ocean. Tonight they hatch.

Sea turtles generally hatch only at night. What are the benefits of hatching at night? How does the turtle hatchling, in an egg while buried under the sand, know that it's nighttime?

When a sea turtle emerges, it looks around the horizon, moves away from the dark silhouette of the dunes and vegetation, and scurries toward light.

Instructions to parents and students: In this demonstration, several parents equidistant from the group encircle the kids from afar while holding lights. On the count of three, the students look around the horizon, and then crawl on their elbows and knees to a source of light.

One caveat: the teachers are predators. The kids will not become prey if they first reach someone holding a light. If a predatory teacher does get them, the victim has to lie on his/her back while kicking feet and arms in the air. Look around first.

Begin the Simulation: One, two, three, go! They're off, scattering in every direction toward the lights all around. Predators descend.

Teacher Note: Hear the kids as they rush to the lights. *http://uk.youtube.com/watch?v=-adYa8zrKCo*.)

Clusters of turtles are at the feet of people holding lights.

In the middle of the field are turtles that did not escape the clutches of the predators. While seemingly unfortunate, it reflects the natural order.

The Night You Hatched

Survey the scene with the kids. Collect data and map results.
When the giggling and screaming abates, take inventory of the turtles that reached the lights and of turtles in the middle of the field. Specifically count aloud how many turtles reached each light. On a paper plate, plot the positions of the turtles outward from the nest. Note what the respective lights might represent in the real world.

For example, this pair of lights held by two parents represents the stars and moon reflecting off the water. Under a pristine sky with no light pollution, sea turtle hatchlings naturally move away from a dark shore and toward the starlight and moonlight reflecting off the water.

In this trial 7/89 turtles reached the safety of the water, before they scrambled toward two lights randomly deemed the natural light.

Extend the data collection: What about the rest of the turtles? Those of you gathered by that light over there--that's a *streetlight*, so you might have gotten run over crossing the road while heading in the wrong direction. And, the turtles by the light over there? That's a *retail development*; so those half dozen turtles were overheated in the sun the next day. And what about the turtles by that other *beachside light*? They were disoriented by the unshielded *apartment lights*, and they won't have enough energy to finish life's jumpstart journey to sea. SO…. What is next for the sea turtle

Discuss the results and propose solutions.
Bring students into a large group and describe how sea turtles emerge and head for light. What can people do to improve the survival rate of these sea turtles? This group proposed turning shore side lights off. Note that we need outdoor lighting in our modern society. Yes, some lights can be turned off. What can we do about other necessary lighting? Guide the students to propose better lighting options. Shield the lights. Aim lights downward. Lessen the wattage of existing bulbs. Put lights on motion detectors or timers. Turn off unnecessary lights.

Rerun the turtle hatch.

After adjusting some of the lighting held by parents to reflect the suggestions above, rerun the turtle hatch. So that the kids are not preconditioned to run toward the same "seaward" direction, move the parents around. The "reflected moonlight and starlight" will then be in a new spot. The "shore side" lights are not all turned off, just altered per the kids' recommendations.

Remind the kids that they have to scan the horizon before they can take off, stay on their elbows and knees, and head for light. One, two, three, go!

When the giggling and piling on stops, re-survey the scene. There are still many who got nabbed by the predators. That's nature. However, now how many ended up at the shore side lights and how many made it to the safety of the water? Again have someone plot the positions of the turtles outward from the nest. Compare results and summarize.

The Night You Hatched

Teacher/Student Resources:

http://research.myfwc.com/features/view_article.asp?id=2156 - Artificial Lighting and Sea Turtle Hatchling Behavior ("Artificial lighting on marine turtle nesting beaches disrupts the ability of hatchlings to find the sea from their nest") from the Fish and Wildlife Research Institute.

http://www.urbanwildlands.org/Resources/LongcoreRich2004.pdf - Ecological Light Pollution Travis Longcore and Catherine Rich paper summarizes ecological consequences of night lighting. See also their book Ecological Consequences of Artificial Night Lighting.

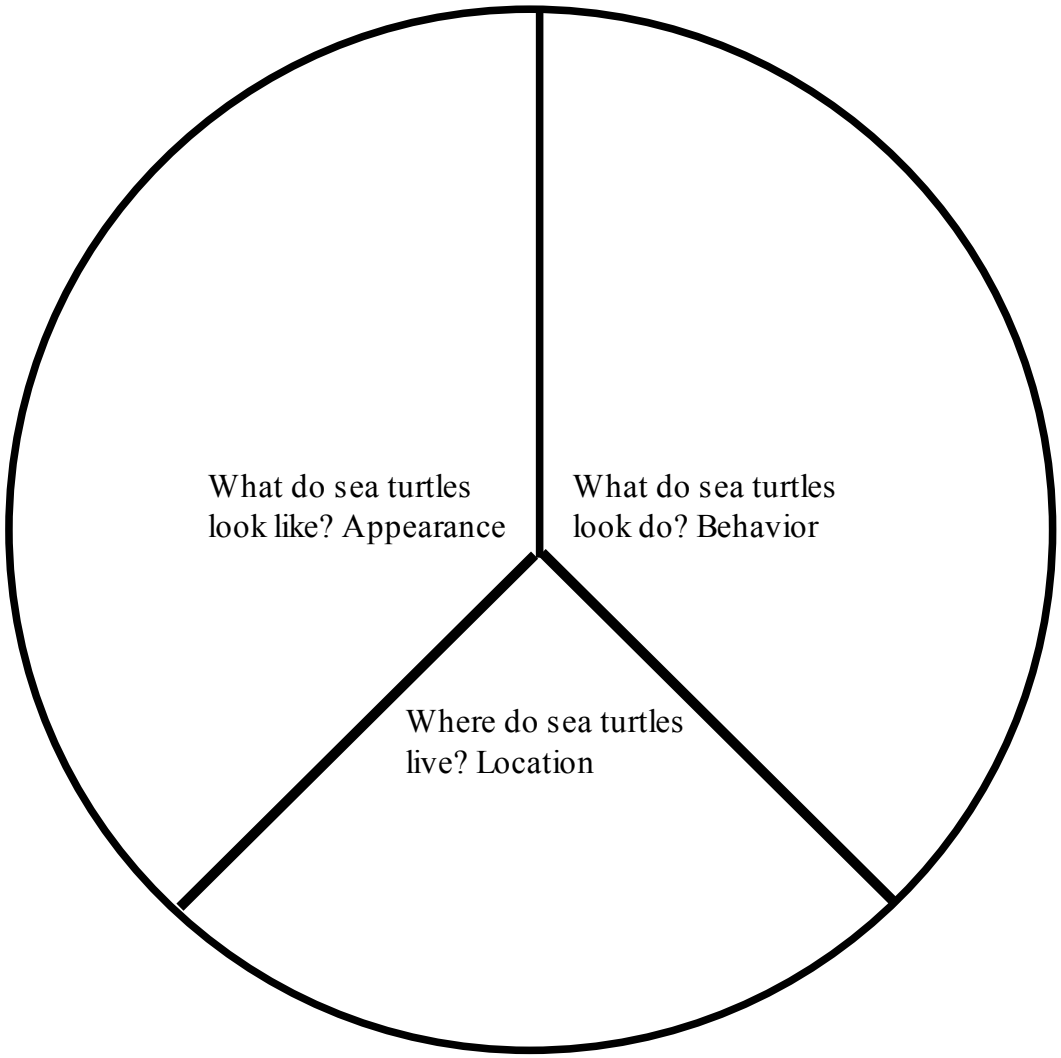
A Silent Cry for Dark Skies (http://www.astrosociety.org/education/publications/tnl/74/74.html) from the Universe in the Classroom series (No. 74-Winter 2008) presents examples of how the natural world is impacted by excessive outdoor lights.

http://uk.youtube.com/watch?v=Tl3yYd-4Rw*s* - A real turtle hatch on a beach.

Student Materials: see below for student materials (required and optional.

The Night You Hatched

Brainstorming Graphic Organizer: include prior knowledge and new knowledge from reading Follow the Moon or from content reading both online and offline.



Adapted from National Research Council *Inquiry and the National Science Education Standards*
Washington D.C.: National Academy Press, 2000

Essential Features of Classroom Inquiry and Their Variations				
Essential Feature	**Variations**			
1. Learner engages in scientifically oriented questions	Learner poses a question	Learner selects among questions, poses new questions	Learner sharpens or clarifies question provided by teacher, materials, or other source	Learner engages in question provided by teacher, materials, or other source
2. Learner gives priority to **evidence** in responding to questions	Learner determines what constitutes evidence and collects it	Learner directed to collect certain data	Learner given data and asked to analyze	Learner given data and told how to analyze
3. Learner formulates **explanations** from evidence	Learner formulates explanations after summarizing evidence	Learner guided in process of formulating explanations from evidence	Learner given possible ways to use evidence to formulate explanation	Learner provided with evidence and how to use evidence to formulate explanation
4. Learner connects explanations to scientific knowledge	Learner independently examines other resources and forms the links to explanations	Learner directed toward areas and sources of scientific knowledge	Learner given possible connections	
5. Learner communicates and justifies explanations	Learner forms reasonable and logical argument to communicate explanations	Learner coached in development of communication	Learner provided broad guidelines to use to sharpen communication	Learner given steps and procedures for communication

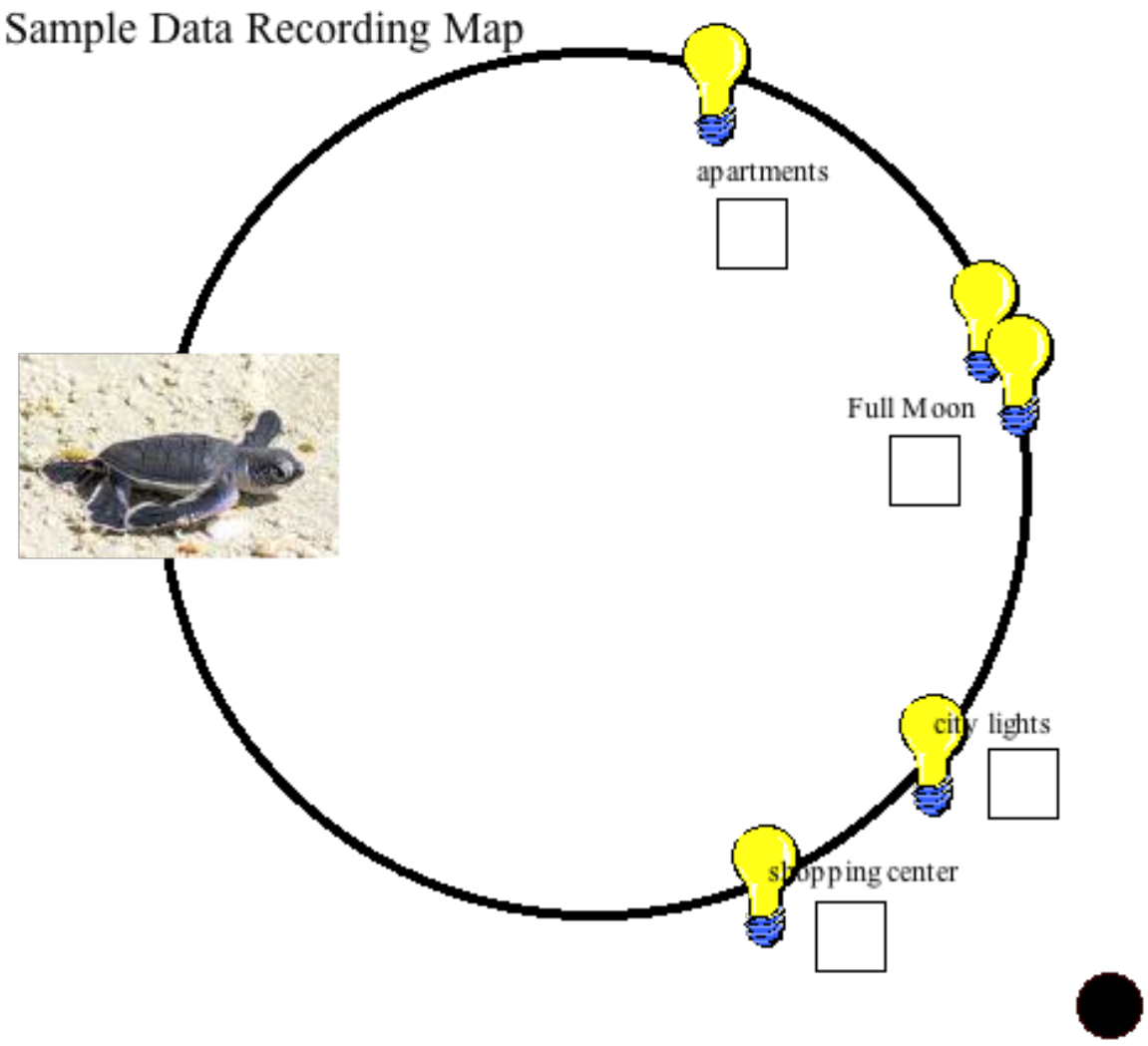
More ← Amount of Learner Self-Direction → Less

Less ← Amount of Direction from Teacher or Material → More

Sample BOTG (behavior overtime)

How has the sea turtle population changed overtime?
As the cities grow… The number of lights increase,
As the light pollution increases…. The turtle population decreases.
As the ……. What other changes overtime occur because of the LP?

The Night You Hatched



The Night You Hatched

Standards/benchmarks/measurement topics/Goals/Objective:
Record your district and grade level connections here: data collection and analysis

Other Content Area Connections
Record your notes and ideas here: content reading

Integration:
ADE Strand 3 of the Reading Standard (Informational Text) can be taught or reinforced with all areas of the Science Standard. Teachers are encouraged to explore the extensive opportunities to integrate writing, math, social studies, technology and the other academic standards with the Science Standard.

Other content reading skills (cause/effect, main idea/details, or vocabulary) may be reinforced using either online or offline reading materials to increase the effectiveness of this lesson. This is a perfect opportunity to integrate with research standards. The teacher can model sea turtle research before individuals/groups complete a similar project.

This lesson/lesson is adapted to integrate science inquiry, link to district standards and connect woth problem based learning for Dr. Connie Walker, NOAO and International Dark Skies classroom lessons by Caryl Jones, science educator.

Extensions: PROBLEM-BASED LEARNING (PBL) http://www.pbli.org/pbl/generic_pbl.html

PBL is a learner-centered educational method. In PBL learners are progressively given more and more responsibility for their own education and become increasingly independent of the teacher for their education. PBL produces independent learners who can continue to learn on their own in life and in their chosen careers. The responsibility of the teacher in PBL is to provide the educational materials and guidance that facilitate learning.

PBL is based on real world problems. PBL learning is based on the messy, complex problems encountered in the real world as a stimulus for learning and for integrating and organizing learned information in ways that will ensure its recall and application to future problems. The problems in PBL are also designed to challenge learners to develop effective problem-solving and critical thinking skills.

The Night You Hatched

THE MINIMAL ESSENTIALS FOR PROBLEM-BASED LEARNING IN EDUCATION In reviewing these essentials it is important to keep in mind the principle objectives of the method. The development of effective and efficient: Problem-solving and reasoning skills, Critical and Creative Thinking skills, Self-directed learning skills, Teamwork skills…. 21st Century Skills

• Students have the responsibility for their own learning.
• The problem simulations used in problem-based learning structured to allow free inquiry.
• Learning is integrated with the range of content areas and may include science inquiry.
• Collaboration is essential.
• What students learn during their self-directed learning must be applied back to the problem with analysis and resolution.
• A closing analysis of what has been learned from work with the problem and a discussion of what concepts and principles have been learned is essential.
• Self and peer assessment should be carried out at the completion of each problem and at the end of every curricular unit.
• The sequence of lessons carried out in problem-based learning, and problems employed in problem-based learning, reflect real-world problems.
• Student assessment measures student progress towards the goals of problem-based learning and district learninggoals/objectives/standards/benchmarks.

Problem-based learning (PBL) is a student-centered instructional strategy in which students collaboratively solve problems and reflect on their experiences. Characteristics of PBL are: http://en.wikipedia.org/wiki/Problem-based_learning
• Learning is driven by challenging, open-ended problems
• Students work in small collaborative groups.
• Teachers take on the role as "facilitators" of learning.
Accordingly, students are encouraged to take responsibility for their group and organize and direct the learning process with support from a teacher "facilitator." Advocates of PBL claim it can be used to enhance content knowledge and foster the development of communication, problem-solving, and self-directed learning skill.

The list of reasons includes the fact that problem-based learning (PBL) ends up orienting students toward meaning-making over fact-collecting. They learn via contextualized problem sets and situations. Because of that, and all that goes with that, namely the dynamics of group work and independent investigation, they achieve higher levels of comprehension, develop more learning and knowledge-forming skills and more social skills as well. This approach to teaching brings prior knowledge into play more rapidly and ends up fostering learning that adapts to new situations and related domains as quickly and with the same joyous magic as a stone skipped over a body of water. http://www.ntlf.com/html/pi/9812/pbl_1.htm

Senses Observation

Level 2, Lesson 2, Activity 2

It's important for us to know how important the dark is to our health. Not only does the dark help us sleep, but it also protects us from illnesses and other unhealthy habits. For this activity, you should go outside once it is dark with a responsible adult. You should turn off any artificial outdoor lighting that you have control of.

Once outdoors, you should focus on the senses, preparing to answer the following questions in writing when you come back in. When you first go outside, you should sit outside to let your eyes adjust to the dark. It usually takes around ten minutes. Once your eyes have adjusted to the dark, think through your senses: sight, hearing, touch, smell, taste. When you go back inside, answer the following questions:

- Seeing: Can you see the moon and the stars?

- Seeing: What is the brightest thing you see?

- Hearing: Close your eyes and listen. What do you hear?

- Smelling: What can you smell?

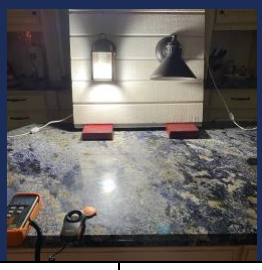
- Touching: What can you feel using your sense of touch? Is there any wind?

- Touching: Does the air feel different at night than during the day?

Shielded vs Unshielded
How to Save Money

Can using shielded light fixtures to direct light where you need it, as promoted by the second of the Five Principles for Responsible Outdoor Lighting, save you money? Let's compare two fixtures that are similar in size when one is shielded and the other is unshielded.

Our Setup:



Measurements were taken directly in front of fixtures at a constant distance.

Foot Candles with Unshielded Fixture	Foot Candles with Shielded Fixture	Type	Lumens	Kelvin	Wattage
8.5	14	LED	1100	6500	12.0
7.89	12.85	LED	800	5000	9.5
4	8	LED	450	5000	5.0
3.58	6.08	LED	450	2700	5.5
5.51	11.24	LED	800	3000	8.5
7.14	12.44	LED	800	2700	10.5
4.3	7.45	Incan	800	2700	60
0.79	1.35	LED Party Blue	400	3000	8.0
0.97	1.85	Incan Bug	550	2700	60
1.45 (3.5 to 5 above)	1.86 (1.5 to 2.5 above)	LED flat bottom	450	2400	7.0

When the same bulb is used in the SHIELDED fixture, you get from 1.62 to 2 times more light on the task surface than with the UNSHIELDED fixture. Therefore, a similar bulb with 1.62 to 2 times LESS wattage, would provide the same amount of light on the task surface using the SHIELDED fixture as the higher wattage bulb in the UNSHIELDED fixture.

CONCLUSION:
Use a SHIELDED fixture and a lower wattage bulb (of the same type) to get the light you want and SAVE MONEY!

Be sure to

Review Every Fixture Using the Five Principles of Responsible Lighting

Is this light acceptable?

Get out a piece of paper and a pencil!

1. Is this light acceptable?

2. Is this light acceptable?

3. Is this light acceptable?

4. Is this light acceptable?

5. Is this light acceptable?

6. Is this light acceptable?

7. Is this light acceptable?

8. Is this light acceptable?

9. Is this light acceptable?

10. Is this light acceptable?

Is this light acceptable?

Now for the answers...

1. Is this light acceptable?

No.

These lights are not targeted, controlled, or in a warm color temperature.

2. Is this light acceptable?

Yes.

These lights are shielded and serve a purpose. By reducing the number, we could save energy.

3. Is this light acceptable?

No.

These lights are not targeted. We need to investigate further to learn more about these lights.

4. Is this light acceptable?

No.

These lights are not targeted, are too bright, and are not in a warm color temperature. See that sky glow?

5. Is this light acceptable?

Yes.

This light is shielded and therefore targeted. We need to investigate further to learn more about this light.

6. Is this light acceptable?

No.

These lights are not targeted. We need to investigate further to learn more about these lights, but these lights are probably not a warm color temperature.

7. Is this light acceptable?

No.

These lights are not pointed down or in a warm color temperature. We need to investigate further to learn more about these lights.

8. Is this light acceptable?

Yes.

This lights is targeted and not too bright. We need to investigate further to learn more about this light.

9. Is this light acceptable?

No.

This light is not shielded, is too bright, and is not in a warm color temperature.

10. Is this light acceptable?

Yes.

This light is definitely shielded and pointed down and in a warm color temperature. We need to investigate further to learn more about this light.

Five Principles for Responsible Outdoor Lighting

The International Dark-Sky Association has worked to protect the night from light pollution since 1988. Our impact now reaches 51 countries, with members, advocates, and dark sky places in North America, East Asia, Europe, Latin America and the Caribbean, the Middle East, Africa, Oceania, and South Asia.

IDA works with lighting manufacturers and home retail stores so that you can easily source IDA approved Dark Sky Friendly lighting.

The newly announced International Dark-Sky Association (IDA) and Illumination Engineering Society (IES) joint "Five Principles to Protect the Night From Light Pollution" are explained in more detail in this document adapted from IDA's Dark Sky Friendly Home Lighting program. By applying these principles, properly designed electric lighting at night can be beautiful, healthy, and functional. Projects that incorporate these principles, whether a residential home, a development, community, or region, will save energy and money, reduce light pollution, and minimize wildlife disruption.

Dark Sky Friendly Lighting - At Home

1 – DOES THE LIGHT SERVE A CLEAR AND NECESSARY PURPOSE?

Light is useful for safe wayfinding and to help perform specific tasks. In the example below, the light illuminates only the entryway and stairs, where it is needed.

If you find that lights on your property are not necessary or useful, remove or disable them so that they are not accidentally turned on.

2 – DOES THE LIGHT FALL ONLY WHERE IT IS NEEDED?

Direct the light down, not up into the sky, and target your fixtures so that light does not spill beyond where it is needed. The light source should not be visible from beyond your property.

If the light spills beyond where it is needed, install proper shielding and/or re-orient the light so that it does not extend beyond where it is needed. Be especially mindful of light that spills up into the sky, or onto other people's property.

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3 – IS THE AMOUNT OF LIGHT APPROPRIATE FOR THE INTENDED TASK?

Use the lowest lighting level needed to perform the task. Light levels are measured in lumens, so check your light source and use the lowest lumens possible.

Excessive light can contribute to glare, actually making it harder to see things well. If you find that the lighting level around your home is too bright for the task it is intended for, consider changing the fixture's bulb or installing a new fixture with a lower lumens value.

4 – IS THE LIGHT CONNECTED TO ACTIVE CONTROLS?

All outdoor lighting should be connected to a light switch, timer, and/or motion sensor so that they are used only when they are needed.

Outdoor lights that cannot be easily controlled with an on/off switch should be connected to a timer or motion sensor. Motion sensors should be set to times of 5 minutes or less. Dusk-to-dawn sensors are strongly discouraged as they release light when it is not needed.

*Make sure sensor triggers are set appropriately so that they light the area only when people are present.

5 – IS THE LIGHT SOURCE WARM IN COLOR?

Most lightbulbs manufactured today have a Kelvin rating printed on the bulb. Low Kelvin ratings (3000 Kelvin or less) are considered warm and generally emit less harmful blue light than high Kelvin. For home lighting, there are good options at 2700 Kelvin or less.

DEFINITIONS

Fixture: An electrical device used to create artificial light through the use of an electric lamp. A fixture may house one or more lamps which can be either built-in or manually replaceable (i.e. bulbs).

Lamp: The bulb or other light-emitting portion of a fixture. This may include light-emitting elements built into a fixture (i.e. built-in LEDs) but is not inclusive of any reflective materials used to direct light.

Shielding: The portion of lighting fixture which covers the fixture's lamp(s). A fully-shielded fixture is a fixture constructed so that in its installed position, all of the light emitted is projected below the horizontal (90-degree) plane passing through the lowest light-emitting part of the fixture. Essentially, the shield is built so the fixture's lamp is not visible at all below the shield.

CCT: A measure of the color properties of light emitted by lamps, being equal to the temperature, expressed in kelvins (K), of a blackbody whose spectrum best approximates the spectrum of the light source in question. The higher the temperature in Kelvins, the "cooler" (bluer) the light is. CCT values are typically provided in lighting manufacturer data sheets or are printed onto LED light sources.

Lumens: The SI unit of luminous flux, equal to the amount of light emitted per second into a unit solid angle of one steradian from a uniform source of one candela. The higher the number of lumens emitted, the brighter a source will appear.

Active Controls: Any electronic or mechanical device that is attached to a fixture which is meant to dynamically control the duration, intensity, spectrum, or area illuminated by the lighting fixture. These can include timers, motion sensors, dimmers,

Evaluation Game

For each light, go through the Five Principles to determine if this light is acceptable. Then, come up with an idea to improve each problematic Principle. Principles 1 and 4 are unknown for all of these lights.

Evaluation Game Answer Sheet

Principles 1 and 4 are unknown for all of these lights.

Principle 2: Problematic. Extend the shields to cover the light source.
Principle 3: Appears acceptable.
Principle 5: Appears acceptable.

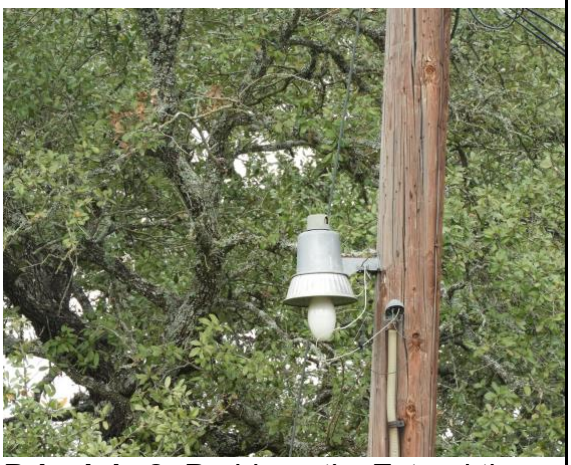
Principle 2: Problematic. The shield could be replaced by a non-clear shield. A flat bottomed bulb would be better but does not fully comply.
Principle 3: Appears acceptable.
Principle 5: Appears acceptable.

Principle 2: Appears acceptable.
Principle 3: Appears acceptable.
Principle 5: Unkown.

Principle 2: Appears acceptable.
Principle 3: Appears acceptable.
Principle 5: Appears acceptable.

Principle 2: Appears acceptable.
Principle 3: Appears acceptable.
Principle 5: Unknown.

Principle 2: Problematic. This fixture could be replaced with a shielded fixture.
Principle 3: Unknown.
Principle 5: Appears acceptable.



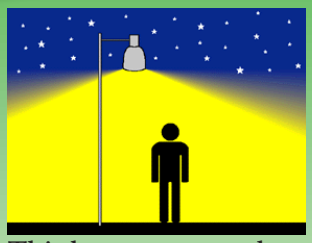
Principle 2: Problematic. Extend the shield to cover the light source.
Principle 3: Unknown.
Principle 5: Unknown.

Principle 2: Problematic. Either add a shield to cover the light source or replace with a shielded fixture.
Principle 3: Appears acceptable.
Principle 5: Unknown.

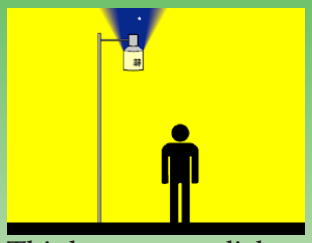
Principle 2: Problematic. Extend the shield to cover the light source.
Principle 3: Many wall packs are too bright, but we would need to look at this light when it is on.
Principle 5: Most wall packs do not have warm colored lights, but we would need to look at this light when it is on.

Principle 2: Appears acceptable.
Principle 3: Appears acceptable.
Principle 5: Unknown.

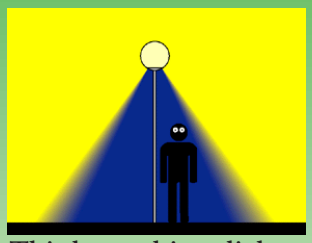
Where should the light go?



This lamp protects the night sky and animals by only shining light down to the ground.



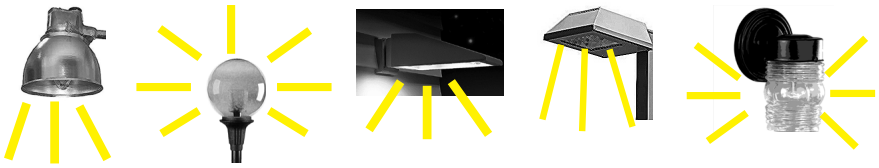
This lamp wastes light into the sky: it goes everywhere!



This lamp shines light everywhere **except** where it is needed: on the ground.

Humans are creatures who have adapted to do most of our activities during the day. When we do things at night, we need light, but light is a tool we must learn to use responsibly. Outdoor lamps are often too bright or point up into the sky. They add to *light pollution*, and when light pollution is really bad, we cannot see the stars and nocturnal animals may be harmed.

Light pollution is the brightening of the night sky by man-made lights.



★ Mark an "X" over the wasteful lamps (above) and circle better lamps.

★★ Draw an "X" over wasteful lamps and circle good ones. Draw a triangle around one that is like what you see at this park.

★★★ Identify the lights outside your home and talk to your parents about how your family can reduce light pollution.

Nocturnal animals

★★ Draw a line from each picture to its description.

★★★ What can you do to help the nocurnal animals where you live? _____

_____

Moths

I am unable to resist being drawn to a light, and may fly for over a mile to your porchlight.

Firefly

I used to find my favorite foods- moths and gnats- everywhere I flew. But now I must commute much further to the city for my dinner.

Warbler

Lights from tall buildings and houses confuse me during migration each fall. I must be careful, or I can crash into one of those shiny bright windows

Bat

My flickering tail will attract a mate, but only if she can see me among the many streetlights.

Level 2, Lesson 5 Pictures to Enhance Learning

This illustration shows the range of lighting temperatures. In general, the warmer the light, the less light in the blue wavelength it contains. A light's temperature is measured in Kelvins, seen at the top of this illustration.

Light Fixtures:

Two Examples of "Barn" Lights

Cobra Head lights - Drop Lens on the left; Flat Lens on the right.

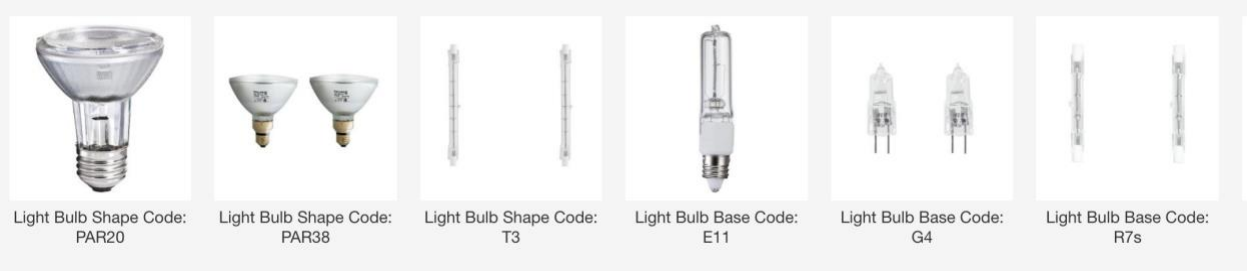
Shoebox Style Light Fixtures

Two Examples of Wall Packs

Two Examples of Spot or Flood Lights

Two examples of Sports Lighting

Light Sources (Lamps):



Halogen Bulbs with various bases

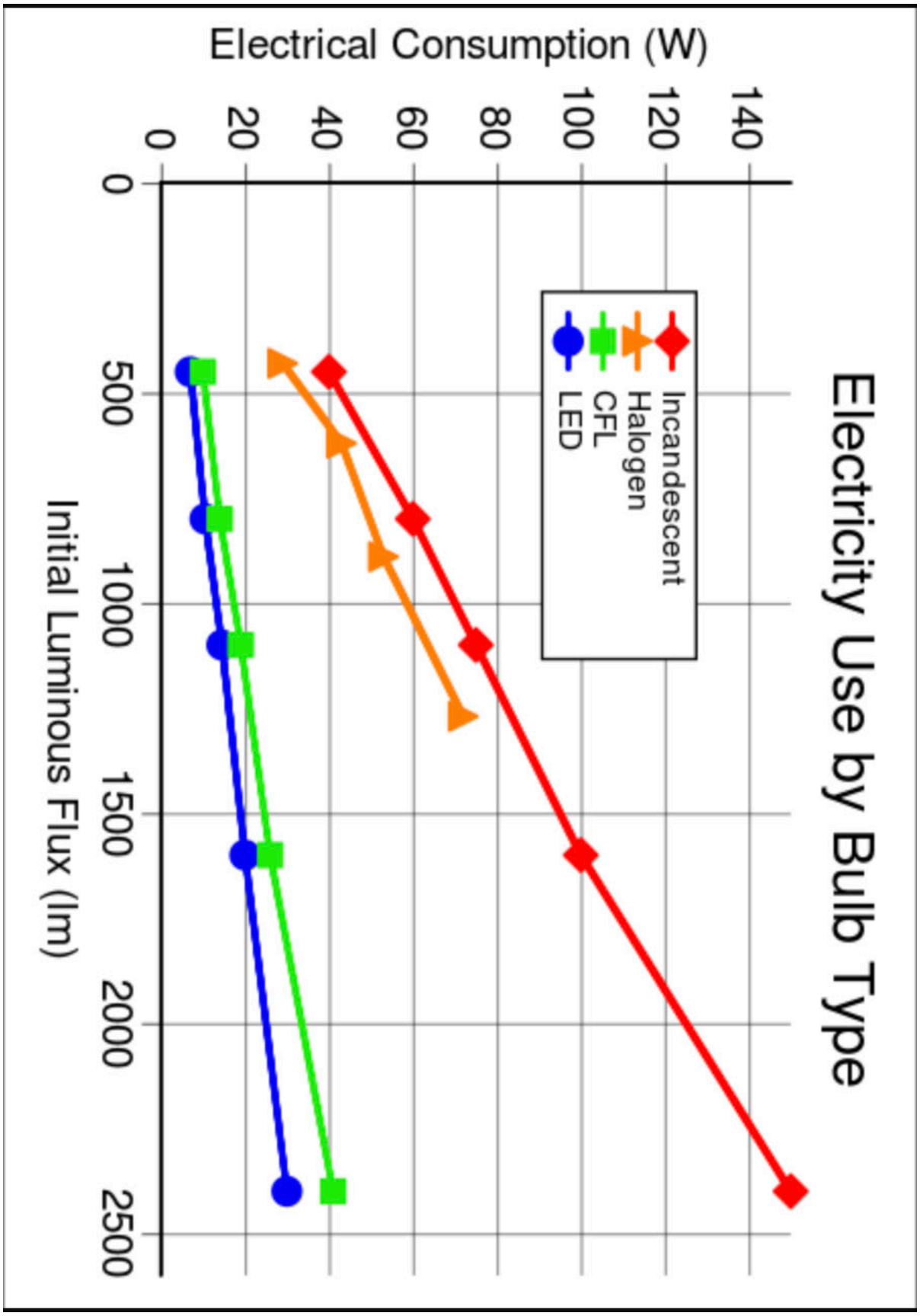
Metal Halide

Two Examples of High Pressure Sodium (HPS) Bulbs

Incandescent Bulb

Two Examples of Compact Fluorescent Light (CFL) bulbs

Two Examples of LED Light Bulbs


Electricity Use by Bulb Type
Electrical Consumption (W)
0
20
40
60
80
100
120
140
Initial Luminous Flux (lm)
0
500
1000
1500
2000
2500
Incandescent
Halogen
CFL
LED

Electrical power equivalents for differing lamps

Minimum light output (lumens)	Electrical power consumption (watts)		
	Incandescent	Compact fluorescent	LED
450	40	9–11	6–8
800	60	13–15	9–12
1100	75	18–20	13–16
1600	100	23–28	15–22
2400	150	30–52	24–28
3100	200	49–75	30
4000	300	75–100	38

Labels Game

Fight for the Stars Level 2, Lesson 5, Activity

Pair each fixture or lamp label with the picture that corresponds with each. There is one picture for each label.

Labels

1. Barn Light
2. Cobra Head Drop Lens
3. Cobra Head Flat Lens
4. Shoebox Style
5. Wall Pack
6. Spot or Flood Light
7. Halogen Bulb
8. Metal Halides
9. High Pressure Sodium (HPS) Bulb
10. Incandescent Bulb
11. Compact Fluorescent Light (CFL) Bulb
12. LED Light Bulb

Pictures:

A)

B)

C)

D)

E)

F)

G)

H)

I)

J) 

K) 

L) 

Labels Game Answer Sheet

Fight for the Stars Level 2, Lesson 5, Activity

1. Barn Light = **F**
2. Cobra Head Drop Lens = **A**
3. Cobra Head Flat Lens = **J**
4. Shoebox Style = **G**
5. Wall Pack = **I**
6. Spot or Flood Light = **D**
7. Halogen Bulb = **E**
8. Metal Halides = **B**
9. High Pressure Sodium (HPS) Bulb = **C**
10. Incandescent Bulb = **L**
11. Compact Fluorescent Light (CFL) Bulb = **H**
12. LED Light Bulb = **K**

Glossary of Lighting Terminology

Fight for the Stars Level 2, Lesson 6, Activity

Adapt: the process by which the human visual system adjusts to light levels. Complete adaptation takes lots of time, especially when changing from a light to a dark environment.

Annual operating cost: the cost per year of electricity and maintenance of a lighting system, including replacement parts.

Area lighting: lighting provided to illuminate open areas uniformly such as lighting in a parking lot.

Beam spread: the width, expressed in degrees, of a light beam from a reflector lamp. The edge of the beam is typically defined as the point at which the luminous intensity is 50% as great as at the center of the beam (e.g. if a light source emits 10 lumens, then the edge of the beam spread around that light is where there is 5 lumens of light).

Bollard: a low post-shaped fixture, typically 3 to 4 ft in height, used to light pathways, walkways, and perimeters.

Contrast: the luminance of an object related to its immediate background.

Control: a device or system that turns lamps on and off, or dims them. Controls include switches, dimmers, timing devices, motion detectors/sensors, photo sensors, and central control systems.

Efficacy (of a light source): the ratio of light output from a lamp to the electric power it consumes (lamp output divided by input power). Efficacy is expressed in lumens per watt (LPW).

Efficiency (of a fixture): the ratio of lumens of a fixture to the lumens of the lamp(s) alone. Luminous efficiency is a dimensionless measure, expressing the percentage of initial lamp lumens that exit the fixture.

Energy: the product of power (watts) and time (hours). Energy used for lighting can be saved by reducing the power required or the time lighting is used, or both.

Fixture: a complete lighting unit consisting of a lamps or lamps, together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to a power supply.

Glare: excessive brightness from a source of light in the line of sight. Fixtures with poor optical control can be sources of direct glare.

Illumination: the distribution of light on a horizontal surface.

Kilowatt-hour (kWh): measure of electrical energy use; the product of power, as measured in kilowatts, and time, as measured in hours. For example, one kilowatt of energy used for one hour equals one kilowatt-hour (kWh).

Lamp: a lighting industry term for an electric light bulb, tube or other lighting device. In other words, a lamp is any light source.

Light distribution: the spread of light that is produced by a lamp or a fixture; also the overall pattern of light on a surface.

Light output: luminous flux, measured in lumens. The lumen rating of a lamp is a measure of its total overall light output. See also lumen.

Light pollution: adverse effects, including glare, light trespass, and sky glow, of unwanted light in the atmosphere, typically produced by the upward components of outdoor lighting systems at night. Wasted light.

Light trespass: extraneous light on adjacent property, typically produced by stray light from outdoor lighting systems. Light trespass includes glare from direct viewing, as well as unwanted "spill light."

Lumen: the unit of luminous flux. The lumen is the rate of flow of light, and is used to express the overall light output of a lamp.

Luminance: the photometric quantity most closely associated with the perception of brightness. It is the intensity of light emitted or reflected in a particular direction.

Luminous flux: the rate of the flow of light, measured in lumens. The overall light output of a lamp.

Photo sensor: a device that converts light to electrical current. Photo sensors switch lights on or off, based on the amount of incident light.

Reflector lamps: a class of lamps that have reflecting material integrated into the lamp.

Sky glow: a result of scattered light in the atmosphere above urban areas. Sky glow is exasperated by the presence of water vapor, air pollution, clouds, or rain.

Uniformity: in outdoor lighting, a measure indicating how evenly light is distributed across a surface. Perfect uniformity would mean all the lights in an area are evenly distributed and the light is therefore evenly distributed.

Watt: unit of electric power; the rate at which electric energy is used.

Vocabulary Fill in the Blank

Fight for the Stars Level 2, Lesson 6, Activity

Using your Glossary of Lighting Terminology, fill in the blanks in these sentences. Each lighting terminology only completes one blank.

Overall light output is measured in _____.

The ratio of luminous flux (lumens) of a fixture to the luminous flux of the lamp(s) is called _____.

Cities and schools must budget for the _____, which are the sum total expenses for using and repairing the lighting system.

Any lighting device in the industry is referred to as a _____.

_____ is the lighting provided to illuminate open areas uniformly.

This low post-shaped fixture, called a _____, usually lights pathways, walkways, and perimeters.

Businesses can reduce energy costs by installing _____ devices that turn lamps on and off, or dims them.

It can take up to 20 minutes for you eyes to _____ to the dark after they have been in a brightly lit area at night.

The overall pattern or spread of light on a surface is referred to as _____.

Watts times hours of operation equals the _____ used by a fixture.

_____ is best described as the distribution of light on a horizontal surface.

Blinding light that usually shines from unshielded fixtures is known as _____.

_____ is a term used to express lumens per watt of a light source.

The luminous flux of a fixture, also called _____, is measured in lumens.

Too much wasted artificial light at night that produces glare, light trespass beyond its intended destination, and/or contribution to sky glow is called _____.

A neighbor's light spilling into your bedroom window is a good example of _____.

When all the light in an area is evenly distributed, perfect _____ has been achieved.

A lighting _____ consists of a lamp, the materials to distribute that light, and the materials to connect the lamp to a power source.

A type of control device, a _____, switches lights on or off, based on the amount of surrounding light.

This orange haze known as _____ is a result of scattered light in the atmosphere above urban areas.

The rate at which electricity is used is measured in units called _____.

When someone is talking about the perception of brightness of a source of light, they are talking about its _____.

The width of light emitted from a light source is called its _____.

The _____ of a flashlight compared to the night sky is very big because the flashlight is much brighter than the dark night sky.

If a light uses 10 kilowatts of energy for an hour, then that light uses 10 _____ of electrical energy.

_____ is the rate of the flow of light, measured in lumens.

Some lights are classified as _____ because they have reflecting material integrated into the light.

Vocabulary Fill in the Blank

Fight for the Stars Level 2, Lesson 6, Activity

Using your Glossary of Lighting Terminology, fill in the blanks in these sentences. Each lighting terminology only completes one blank.

Overall light output is measured in _lumens_.

The ratio of luminous flux (lumens) of a fixture to the luminous flux of the lamp(s) is called _efficiency_.

Cities and schools must budget for the __Annual Operating Costs_, which are the sum total expenses for using and repairing the lighting system.

Any lighting device in the industry is referred to as a _lamp_.

__Area lighting_ is the lighting provided to illuminate open areas uniformly.

This low post-shaped fixture, called a _bollard_, usually lights pathways, walkways, and perimeters.

Businesses can reduce energy costs by installing _control_ devices that turn lamps on and off, or dims them.

It can take up to 20 minutes for you eyes to _adapt__ to the dark after they have been in a brightly lit area at night.

The overall pattern or spread of light on a surface is referred to as __light distribution_.

Watts times hours of operation equals the _energy_ used by a fixture.

Illumination is best described as the distribution of light on a horizontal surface.

Blinding light that usually shines from unshielded fixtures is known as _glare_.

Efficacy is a term used to express lumens per watt of a light source.

The luminous flux of a fixture, also called __light output__, is measured in lumens.

Too much wasted artificial light at night that produces glare, light trespass beyond its intended destination, and/or contribution to sky glow is called __light pollution_.

A neighbor's light spilling into your bedroom window is a good example of __light trespass__.

When all the light in an area is evenly distributed, perfect _uniformity_ has been achieved.

A lighting _fixture_ consists of a lamp, the materials to distribute that light, and the materials to connect the lamp to a power source.

A type of control device, a _photo sensor__, switches lights on or off, based on the amount of surrounding light.

This orange haze known as _sky glow_ is a result of scattered light in the atmosphere above urban areas.

The rate at which electricity is used is measured in units called _watts_.

When someone is talking about the perception of brightness of a source of light, they are talking about its _luminance_.

The width of light emitted from a light source is called its __beam spread_.

The _contrast_ of a flashlight compared to the night sky is very big because the flashlight is much brighter than the dark night sky.

If a light uses 10 kilowatts of energy for an hour, then that light uses 10 _kilowatt-hours (kWh)_ of electrical energy.

Luminous flux is the rate of the flow of light, measured in lumens.

Some lights are classified as __reflector lamps__ because they have reflecting material integrated into the light.

Data Collection Sheet

Retrofit/Replacement Considerations: Is the light fixture & placement good or does it need a shield, motion detector, timer, reduction in lumens, replacement, or to be removed?

Location/Purpose ____
Photo order ______Type of fixture___________________Type of lamp_____________
at this location _______ Est Wattage __________ Est Color Temp _________
Need(s) attention? Y/N Retrofit / Replacement notes _________________________
____
____

Location/Purpose ____
Photo order ______Type of fixture___________________Type of lamp_____________
at this location _______ Est Wattage __________ Est Color Temp _________
Need(s) attention? Y/N Retrofit / Replacement notes _________________________
____
____

Location/Purpose ____
Photo order ______Type of fixture___________________Type of lamp_____________
at this location _______ Est Wattage __________ Est Color Temp _________
Need(s) attention? Y/N Retrofit / Replacement notes _________________________
____
____

Location/Purpose ____
Photo order ______Type of fixture___________________Type of lamp_____________
at this location _______ Est Wattage __________ Est Color Temp _________
Need(s) attention? Y/N Retrofit / Replacement notes _________________________
____
____

Location/Purpose ____
Photo order ______Type of fixture___________________Type of lamp_____________
at this location _______ Est Wattage __________ Est Color Temp _________
Need(s) attention? Y/N Retrofit / Replacement notes _________________________
____
____

Outdoor Light Fixture Replacement Options

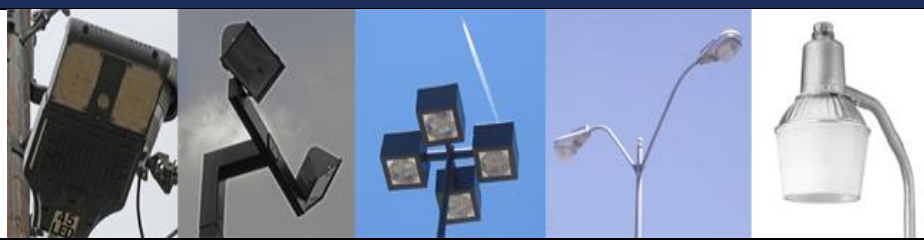
You may feel like you're in a maze when you go to select outdoor light fixtures to replace old light pollution producing fixtures. These options are certainly not a complete list. The hope is that this will get you started and the ones at https://www.darksky.org/our-work/lighting/lighting-for-industry/fsa/fsa-products/ will also guide your selections.

Fixtures are grouped by common names even though many fixtures could fit in more than one category. As an example, a so-called "Barn Light" could also be called more generically an "Area Light" or a "Security Light".

Select the lowest Kelvin rating offered and ask for one with the least amount of light in the blue spectrum. Due to demand more luminaires are being offered in amber o around 2000 Kelvin.

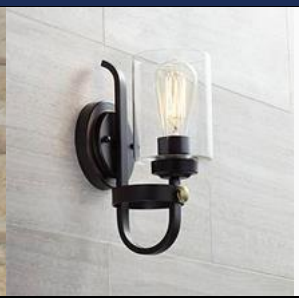
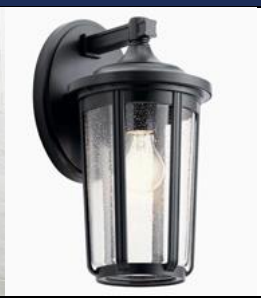
Your mission, should you choose to accept it, is to

Test Every Selection Using the Five Principles of Responsible Lighting

	REMEMBER: This is just a small sample list. Check the IDA list online and use the Five Principles of Responsible Lighting to select others.
Area, Security, Shoe Box, Cobra Head & Barn (NEMA Head) Type Fixtures	
Original Fixtures	
Option 1 	Acuity Brands DSX0 or DSX1 with 360 degree add on shielding (usually from 1 inch to 2.5 inches on each side). https://www.acuitybrands.com/products/detail/196671/lithonia-lighting/d-series-area-size-0/dsx0-led-area-luminaire
Option 2 	Crossroads LED Astrophile series and their dark sky compliant product line. Amber and LEDs rated at 2400 Kelvin and less are preferred. https://crossroadsled.com/lighting-products/phosphor-converted-amber-street-lights/
Option 3 	The CHU in amber with their optional one-inch shield. 2700K with lowest number of LEDs is acceptable. https://www.ela-lighting.com/pdf/update/CHU_Chute_LED.pdf  Note the very good optional shield in this drawing.

Option 4 	Sellux Saturn Cutoff with 2700K option (ask about amber). https://www.selux.us/usa/en/exterior/products/saturn#downloads
Option 5 	Cooper Lighting Streetworks; preferred is the 2200K option but the 2700K option is acceptable; https://www.cooperlighting.com/content/cooper-lighting/us/en/brands/streetworks/pmm-mesa.html
Option 6  	Lithonia RSX1 with the Exterior 360 Full Visor; https://www.acuitybrands.com/products/detail/885168/lithonia-lighting/rsx1-led-area-luminaire/up-to-17000-lumens
Wall Packs (Usually Commercial)	
Original	  
Option 1 	Pick the 2700 Kelvin option unless they have a lower Kelvin option when you are selecting it. https://www.acuitybrands.com/products/detail/1008034/lithonia-lighting/wdge1-led-wall-mount/architectural-wall-luminaire-size-1---up-to-2000-lumens
Option 2	So many manufacturers make this style. Make sure the top is closed (i.e. downlight only) and that you can either use your own bulb or the Kelvin rating / CCT is Amber or absolutely no higher than 2700 K. If you can use your own

	bulb, you can pick a comfortable 2200K or 2400K. As always, ensure the bulb does NOT protrude below the metal of the fixture.
Option 3 	Turtle Friendly Costal Wildlife amber LED with baffle
Option 4 	Envirolux Sphere Wallpack available in Amber and 2700K
Option 5 	EcoLights; 500 lumens and less http://www.csbg.ca/ECOLIGHT.HTM
Option 6 	Ligman Lighting UQU Quarter 1 Surface IF you select the Amber option and the Frosted Lens. The 2700 K option with the Frosted Lens should be okay when mounted low enough to mitigate the >1 Glare Rating.
Alternate Option 	Cover the old wall pack with a RAB Shade. This won't reduce your electric bill like replacing it with a new more efficient fixture would if the fixture is a bit old.

Wall Sconces (Usually Residential)	
Original	  
Option 1 	If the bulb is pointing down, you can shield the bulb and keep the fixture. Progress Lighting lamp shield from Loews Home Improvement. Here's an example & another style:  
Option 2 	Designers Fountain Bayport at Loews Home Improvement. Be sure to get the size that is large enough to cover the bulb you want to use in it.
Option 3 	Ripley Collection dark sky outdoor wall light
Option 4 	Pine Slope fixture with your (2400K) bulb.

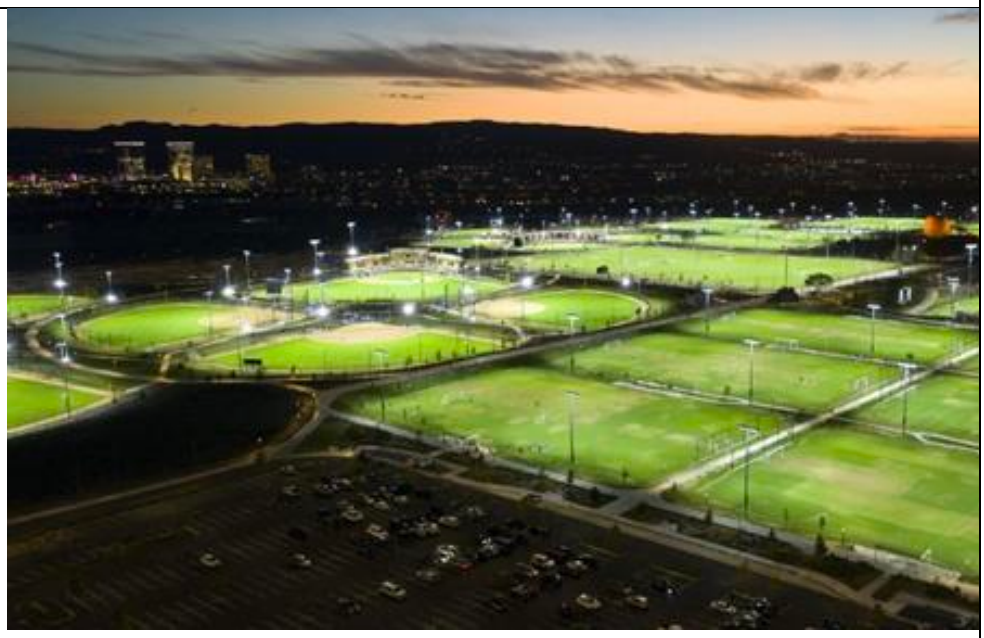
Option 5 	Rickey Outdoor Barn Light – use your own (2400K) bulb.
Option 6 	Pine Slope fixture with your (2400K) bulb.
Option 7 	Sage Ridge fixture with your (2400K) very short bulb.
Option 8 	Possini Euro Ratner 3000K LED wall light (I would prefer it with 2400K but this is acceptable.)
Option 9 	Under a completely closed canopy, this type of specialty fixture works beautifully. It emits light upwards to illuminate the underneath of the canopy and downward to illuminate the walkway. The fixture hides the light sources and prevents glare.

Spot or Flood Lights	
Original	 
Option 1 	Bullet style fixture with long shroud.
Option 2 	Commercial Electric's Ultra Slim Color Selectable (select 2700K) recessed integrated LED.
Option 3 	Generation Lighting Flood Light Sea Gull Collection (your bulb)
Option 4 	Access Lighting 1 light 2800 Kelvin LED Fin Collection
Option 5 	MIK Solutions LED Spot Light with 2700 Kelvin bulb sold separately.

Post Top Fixtures	
Original	
Option 1 	Designers Fountain Bayport post top at Loews
Option 2 	Ripley Collection 16 inch high post light
Option 3 	Capital Lighting Dark Sky Outdoor Lantern; Model: **9445OB**
Sign Lighting	
Original	 

Option 1 	Many manufactures make RLM style fixtures which is perfect for illumination of signs. Be careful to ensure that the bulb does NOT extend below the metal of the fixture.
Option 2 	A good example of reverse lighting of the letters in a sign.
Option 3 	The photo on the left was taken of the sign during the day. The one on the right was taken of the sign during the night. Note the way the sign maker restricted the internal illumination from most of the sign at night. It didn't take much to make the sign show up without causing excessive glare.
Path Lighting	
Original	
Option 1 	Selux Inula Bollard with Amber CCT selection. https://www.selux.us/usa/en/exterior/products/inula#downloads

Option 2 	Numerous manufactures offer similar fully shielded path lighting. Be sure the color temperature is 2700 Kelvin or less and that the amount of light is not too bright. The ambient light around the area will determine how much light you need to see the path. The darker the area the less light it will take for you to see well. A bright light in a very dark area will just cause the space beyond the path to be even darker and keep you from seeing it too.
Option 3 	EcoLights; 500 lumens and less http://www.csbg.ca/ECOLIGHT.HTM
Flag Lighting	
Original	 Yes, all of those were for supposedly for two flags.
Option 1 	Eagle Mountain Stargazer Flag Light if you select the Amber or 3000 Kelvin model
Option 2 	Use a shielded light from above and close to the flag.

Sports Field Lighting	
Original	 
Notes:	No matter what manufacturer: **Sports lighting should NOT be installed on top of a hill.** Have the lighting plan reviewed and evaluated by the International Dark-Sky Sports Field Community Friendly Lighting Criteria. https://www.darksky.org/our-work/lighting/lighting-for-industry/apply-osl/
Example of **Best Option** where only the fields are illuminated, very little light trespass, and the sports lighting is NOT used for the surrounding areas (like parking).	

Light Bulbs	
Option 1 	 If you have fixtures that are “eye candy” that you don’t want to replace, try putting flicker flame bulbs in them and use another light source to illuminate the area. The porch with this light has fixtures recessed in the ceiling for illumination.
Option 2 	This is a great bulb to use in any fixture but especially when the socket is pointed down. It can ‘save’ a fixture that otherwise would need to be replaced. TCP Dimmable 7W 2400K Par20 LED bulb
Option 3 	Bulbrite Dimmable 5W 2200K vintage G25 filament LED bulb
Option 4 	Maxlite Dimmable 6.5 W 2000K vintage filament LED bulb
Option 5 	QLS 4W 2200K decorative vintage filament LED bulb

Option 6 	GE Dimmable 10W 2700K A19 LED bulb works well when you absolutely must have some white light. Try one with a rating of 2000 Kelvin to 2400 Kelvin first.
Option 7 	Sunlite 12W Sea Turtle and Wildlife certified orange LED lamp.
Option 8 	Sunlite 3W Sea Turtle and Wildlife certified LED lamp
Option 9 	Emery Allen dimmable 5W 2700K LED bulb; Here is that short bulb you may need to reduce glare and hide the light source in a fixture.
Last Option	There are lots more great bulbs out there. Look for bug lights when appropriate and otherwise, look for light bulbs rated around 2000K to 2400K. If you can't find one, then use one that's 2700K. Those are abundant.

Cost Analysis Calculations!!

Money matters a lot when it comes to maintaining a property and paying for electricity. This analysis will determine the cost of the energy your outdoor lights are using and what they will use once improved or replaced. Remember to only fill out this analysis for the lights you are planning to change. The cost will not change if you are not changing the light.

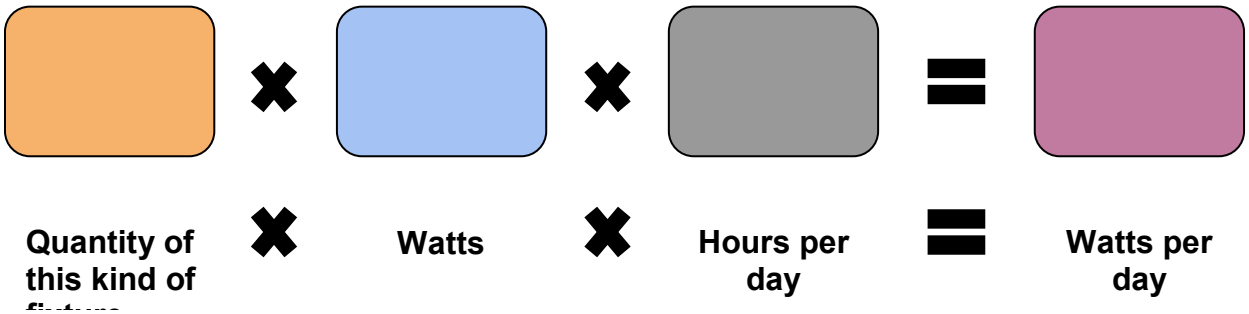
Be sure to download the Fight for the Stars Cost Analysis spreadsheet. The next pages will explain how to calculate the numbers to fill out the cost analysis spreadsheet.

First, you need to talk to the property manager or maintenance staff you have been in contact with to determine how many hours each day the lights are currently on. Remember, you only need to do these steps and calculations for the lights you plan to change.

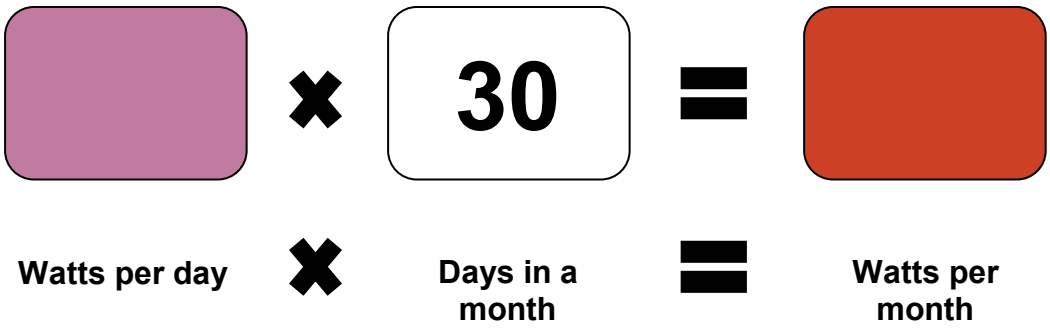
Current Fixture Calculations

For each of the current fixture calculations, you should do it for however many *different* kinds of lights you have on your property that you plan to change. For example, if there is a type of light that has five duplicates on your property, you only need to do these calculations once. If you plan to improve, replace, or remove ten different types of lights, you will need to do these calculations ten times, once for each kind of light.

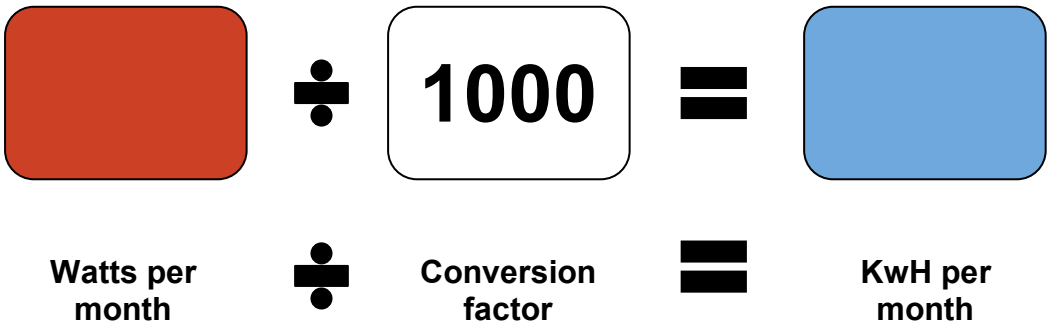
Now, we can figure out the watts used each day.



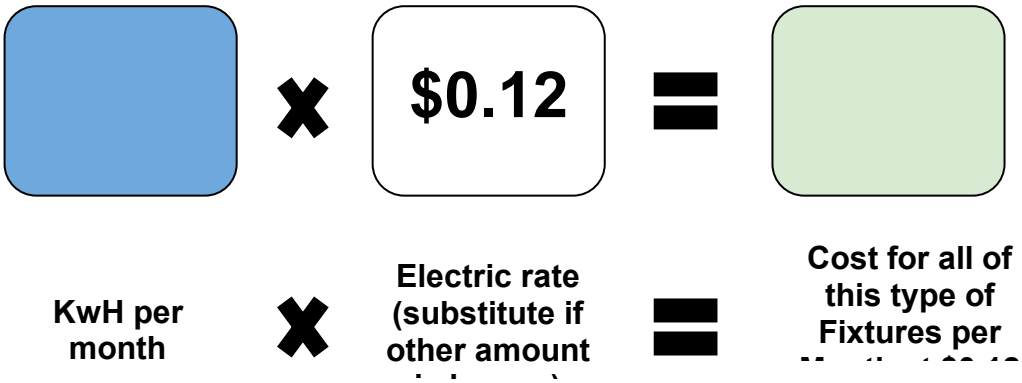
Although the amount of days in each month differs, the average is 30 days in each month. This is a general approximation of the watts used per month for this kind of light.



Electrical usage in watts are billed in KilloWatt Hours (KwH), so we convert watts used in a month to KwH per Month by dividing by 1000.



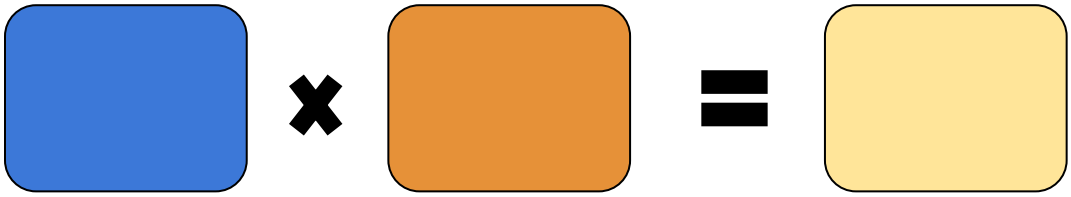
Now that we know how much energy in KwH each kind of light takes each month, we can figure out how much money each light costs to operate each month! We need to multiply the KwH per month by the current electric rate. You may want to substitute the local rate here. If you are not sure of the local rate, you can use $0.12 per KwH.



Replacement Fixture Calculations

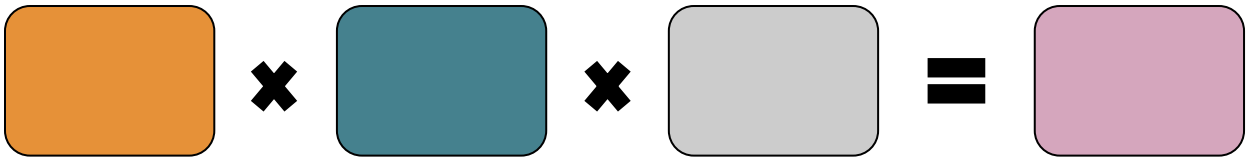
For these calculations, you will need to know the cost of each proposed replacement fixture, the number of those proposed replacement fixtures, how many watts each fixture used, and the hours per day the replacement fixtures will be illuminated.

This calculation is to figure out how much it will cost to buy the new fixtures. You should do this calculation for each type of fixture, but only once for duplicates.



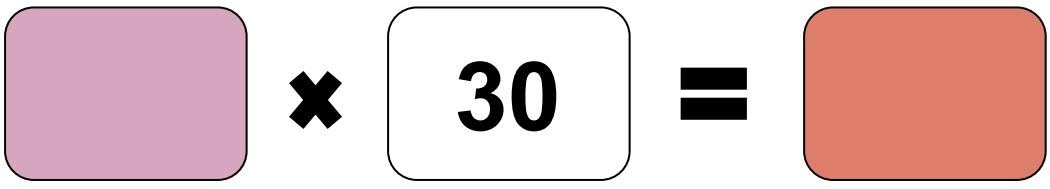
Cost per replacement fixture ✖ **Replacement fixture quantity** = **Cost to buy this type of replacement**

Now we are going to figure out the extended cost of the replacement fixtures. We can calculate the watts per day of each kind of replacement fixture using this formula.



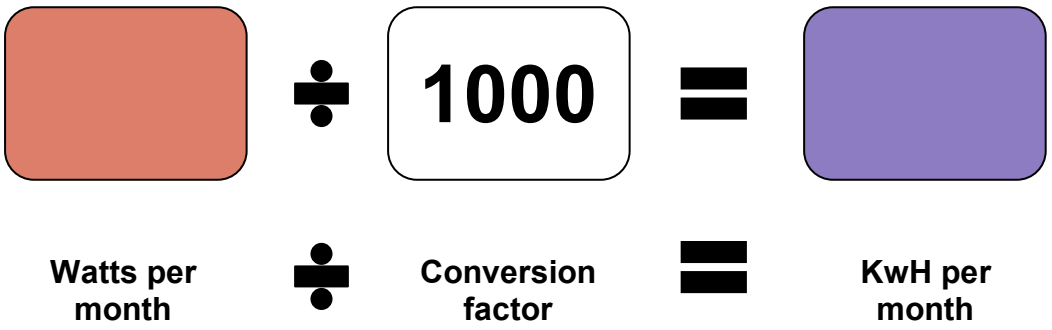
Quantity of this kind of ✖ **Watts** ✖ **Hours per day** = **Watts per day**

Although the amount of days in each month differs, the average is 30 days in each month. This is a general approximation of the watts used per month for this kind of light.

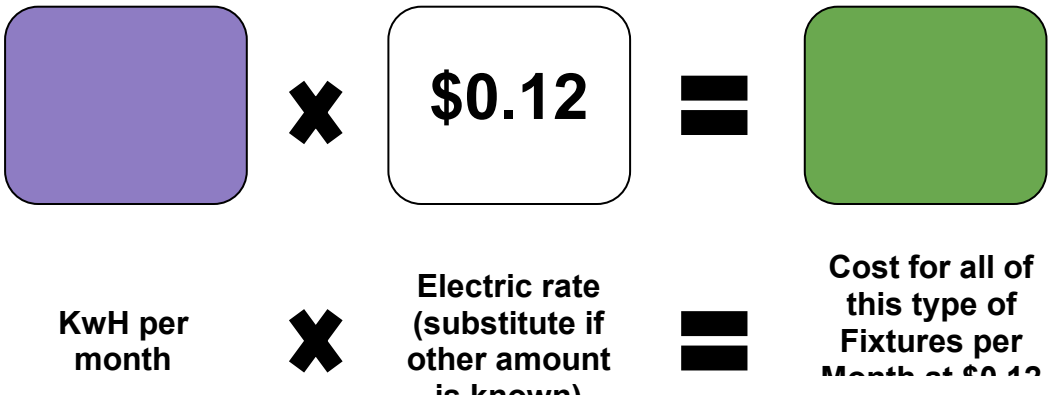


Watts per day ✖ **Days in a month** = **Watts per month**

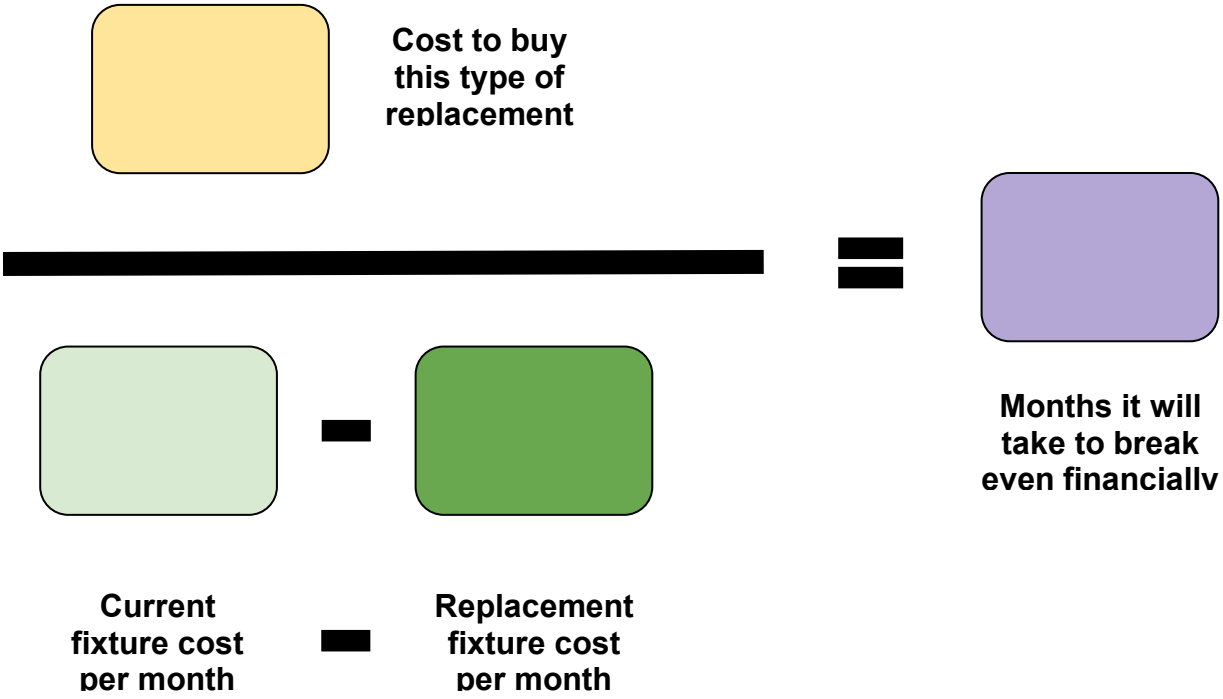
Electrical usage in watts are billed in KilloWatt Hours (KwH), so we convert watts used in a month to KwH per Month by dividing by 1000.



Now that we know how much energy in KwH each kind of light takes each month, we can figure out how much money each light costs each month! We need to multiply the KwH per month by the current electric rate. You may want to substitute the local rate here. If you are not sure of the local rate, you can use $0.12 per KwH.



Now we want to figure out how many months it will take to break even financially. We will only be able to break even if the extended cost of the replacement fixture each month is less than the amount the current fixture costs each month. If the extended cost of the replacement fixture is more than the current cost per month, then you won't be saving money with the new fixture. Do not let this dissuade the purchase. The value of eliminating glare, excessive lighting, and light trespass is not part of the numeric calculation yet it should be a priority too.



Once you have finished your calculations for each kind of fixture, both current and replacement, be sure to input your values into your electronic cost analysis spreadsheet!

Sample Assessment Letter to Accompany Inventory and Cost Analysis

Dr Janis Jones, Superintendent, Tree Top School District
Lighting Assessment & Cost Analysis Project
Date *insert today's date*

Dear *Dr Jones*,

Thank you for allowing us to assess the outdoor lighting at *Tree Top School*. This assessment was undertaken as the culminating project in our class study called "Fight for the Stars: Be a Knight for the Night©." The aims of the project recommendations are to reduce glare and operating expenses as well as to protect the night skies. The proposed modifications to the outdoor lighting will allow *Tree Top School* to be an example of good lighting practices that improve visibility where lighting is needed by humans while reducing operating costs, reducing health issues related to artificial lights at night, and reducing the intrusion of artificial light in the habitat of wildlife. At the same time, the project intends to identify locations that could receive recognition for implementing best practices in outdoor lighting.

Following those best practices of night-time lighting, as reflected in the Five Principles for Responsible Outdoor Lighting jointly published by the Illuminating Engineering Society and the International Dark-Sky Association, will provide comfortable outdoor lighting in the areas that humans need the light and allow *Tree Top School* be an example for the public of lighting practices that control the spread of light pollution. We have found that *Tree Top School* is a good candidate to apply to be recognized by the International Dark-Sky Association for its outdoor lighting practices.

Attached is the Outdoor Lighting Inventory. The majority of the current light fixtures follow the Five Principles for Responsible Outdoor Lighting. The recommendation is to replace the three types of fixtures that do not follow those Five Principles. The second attachment is the Cost Analysis we did on those three types of fixtures. The recommended replacements more than pay for themselves in less than ten months in terms of the costs of the fixtures and the electricity. We recognize that the installation costs will lengthen that pay-back time somewhat. The cost savings are due to significant gains in lighting efficiency as well as a reduction in light output as a result of directing light only where it is needed.

Our class is excited about this project and would love to provide a detailed presentation about the findings for you or others on your staff. It has been a fun learning experience for us.

With Best Regards,
Your name(s)