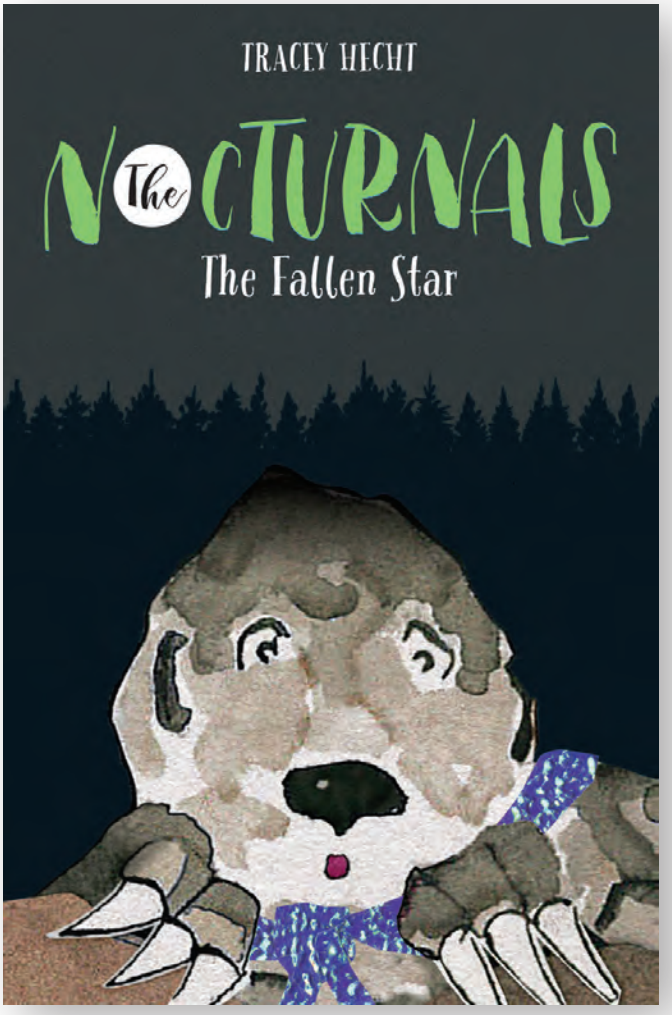
EDUCATOR'S SCIENCE GUIDE

The Nocturnals: *The Fallen Star*



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By
TRACEY HECHT
with illustrations by
KATE LIEBMAN

Series Overview

The Nocturnals series features three unlikely friends: Dawn, a serious fox; Tobin, a sweet pangolin; and Bismark, the loud mouthed, pint-sized sugar glider. The stories all play out in their nighttime world with teamwork, friendship, and humor in every adventure.

For More Information:
www.nocturnalsworld.com

About the Book

In *The Fallen Star*, Dawn, Tobin and Bismark awaken one evening to disaster: all the forest's pomelos have been mysteriously poisoned and animals are falling ill. They set out to investigate and encounter a mysterious aye-aye who blames monsters from the moon. The Nocturnal Brigade suspects a more earthly explanation and must race to find answers, before it's too late.

Next Generation Science Standards Alignments and Activities

The activities in this guide have been correlated with the Next Generation Science Standards (NGSS), which were developed by the National Research Council (NCR) of the National Academy of Sciences. The NCR's Framework for K–12 Science Education combines practices, crosscutting concepts, and disciplinary core ideas to address relevant science, technology, engineering and math (STEM) concepts that students should learn.

This guide was written by Erica Colon, the President and curriculum designer of Nitty Gritty Science, which she started as a way to share her passion for teaching. She received her Ph.D, M.Ed from University of Hawaii at Manoa, and her BS from SUNY at Oswego. She is a National Board Certified Teacher.

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Activity 1

Make a Model of a Crater and Learn the Impact of a Meteorite

Background

When you look up at the night sky and see a shooting star, it's not actually a star; rather, it's a streak of light called a meteor. Meteors are caused by meteoroids—chunks of rock or dust in space—that are a result of asteroids colliding or a comet breaking apart. When a meteoroid enters Earth's atmosphere, the friction created by its contact with the air generates heat, which burns the meteoroid and causes a streak of light. Most meteors burn up in space; however, some meteors are large enough that they reach a planet's or moon's surface before they completely burn up. When this happens, they are called meteorites. When meteorites make contact with a surface, they create a large, bowl-shaped depression—an impact crater—and cause massive amounts of dust and debris to be thrown into the air, which blocks the sunlight. This is the mystery that the Nocturnal Brigade has to uncover in the beginning of *The Fallen Star*.

Instructions

1. Place students into groups and give each group the "Crater Comparison" laboratory investigation. Discuss any lab safety rules and behavior expectations.

2. Students can collect materials, or you can already have materials at stations. For younger students, you may want to have the flour poured into each tub ahead of time. Another helpful tip is to have cocoa powder in salt shakers so students are able to lightly sprinkle the surface of flour with cocoa powder. The cocoa powder allows for easier observations of the "debris splatter" of the impact crater.

3. Allow students to conduct the investigation and collect data and observations. Afterward, take time to discuss how scientists believe that impacts of meteorites in the past were the cause of major extinctions that led the way for new geological eras.

References and Helpful Links

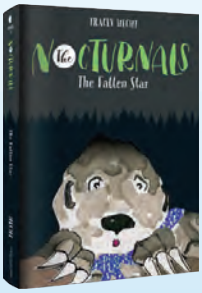
- **https://solarsystem.nasa.gov/planets/meteors**
- **https://solarsystem.nasa.gov/planets/meteors/indepth**
- **https://www.nasa.gov/audience/foreducators/topnav/materials/listbysubject/Asteroids_Comets_Meteorites_landingpage.html**
- **http://mineralsciences.si.edu/collections/meteorites.htm**
- **http://solarviews.com/eng/meteor.htm**

NEXT GENERATION SCIENCE STANDARDS USED IN THIS ACTIVITY

3-5-ETS1-1: Engineering Design
- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

4-ESS1-1: Earth's Place in the Universe
- Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

5-PS2-1: Forces and Interactions
- Support an argument that the gravitational force exerted by Earth on objects is directed down.



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Student Activity 1

Make a Model of a Crater and Learn the Impact of a Meteorite

Problem

How does a meteorite's size and distance from the surface of Earth affect the formation of a crater?

Inquiry-Based Skills

Data collection, measurement, observations, controlling variables, analyzing data, drawing conclusions.

Materials (per group)

- 12- to 15-quart dish tub
- Newspaper
- 2-pound bag of flour
- Cocoa powder
- Meter stick
- Metric ruler
- 3 meteorites (rocks or marbles: one small, one medium, and one large)

Procedure

1. Make a prediction of how the size of a meteorite will affect a crater's formation.

   _____

   _____

2. Make a prediction of how a meteorite's distance from Earth's surface will affect a crater's formation.

   _____

   _____

3. Lay out some newspaper to protect your work surface. Set the tub in the middle of the newspaper and carefully pour flour into the tub until the flour is about 4 cm deep. Lightly shake the tub to make sure the flour's surface is flat.

4. Sprinkle just enough cocoa powder to lightly cover the surface of the flour.

5. Have one group member hold the meter stick next to the tub and identify the 25-cm mark.

6. Have another group member drop the small "meteorite" from a height of 25 cm.

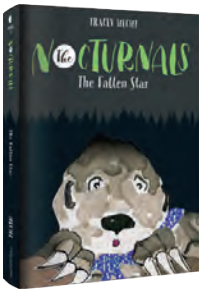
7. Without removing the "meteorite," use the ruler to measure the diameter of the crater. The *diameter* is the length from one side of the crater to the other. Record the measurement in the data table.

8. Repeat steps 6–7 with the medium and large meteorites, making sure to drop them in different areas of the tub so you have three different craters.

9. Compare the three different craters and record any observations in the data table.

10. Remove the three meteorites and gently shake the tub to smooth out the flour and flatten the surface. Sprinkle the surface again with cocoa powder.

11. Repeat steps 5–10 for each height: 50 cm, 75 cm, and 100 cm. Be sure to measure and record the data for each drop and crater, along with other careful observations.



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Data Table

Drop Height (cm)	Crater Diameter (cm)			Observations
	Small Meteorite	Medium Meteorite	Large Meteorite	
25				
50				
75				
100				

Analyze and Conclude

1. Compare your data results to your predictions. Were your predictions correct? Explain.

2. Describe the differences between the crater made by the large meteorite dropped from 25 cm and the one dropped from 100 cm.

3. Using your observations of the impact crater, describe how the area and living things around it would be immediately affected.

4. Earth has been struck several times in the past by meteorites, some larger than 50 meters in diameter. Explain why many of these craters cannot be seen today.

Activity 2

Investigation of Sound Waves

Background

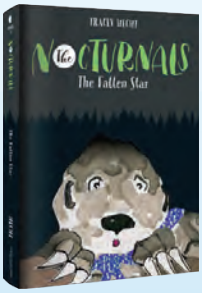
In *The Nocturnals: The Fallen Star*, the woylies try to avoid predators by sensing movement in the earth. They are able to do this because sound is produced when it vibrates in matter, and they can pick up on these vibrations. The state of matter could be a solid, like the earth in the woylies' case; a liquid, such as water; or a gas, like air.

Sound waves travel at different speeds depending on the state of matter they are traveling through. Sound travels fastest in solids because the molecules are packed closer together than in liquids or gases. These tightly packed molecules can pass on vibrations from one molecule to the next much more quickly, resulting in sound traveling faster in the string (solid) of this activity than through the air (gas).

Sound waves transfer energy, making each molecule bump into the next molecule. However, these molecules do not travel with the wave; each molecule is only temporarily moved away from its point of rest and then, eventually, returns to it.

Introduction

1. Before the activity, ask the students to hum with their hand on their throat. Ask for observations. Students should be able to share that they feel a vibration. This vibration is coming from their vocal chords. Ask them if they know how the sound of your voice reaches their ears.



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2. To explain how sound waves travel through the air when speaking, use a coiled spring toy. Stretch the spring between yourself and a volunteer. Explain that each coil represents the air molecules between your mouth and a student's ear. Give the spring a quick forward push (not a side-to-side movement) and explain that this represents a word spoken by you. The vibrations of the vocal chords start to move air molecules toward the other end in a compression wave. Students should be able to see how a sound wave is transmitted and how each molecule moves away momentarily but eventually returns to its rest point.

3. After the demonstrations, allow students to conduct the investigation and collect data and observations.

References and Helpful Links

- **http://www.ducksters.com/science/sound101.php**
- **https://online.kidsdiscover.com/unit/sound-and-vibration**
- **https://www.dkfindout.com/us/science/sound/**

NEXT GENERATION SCIENCE STANDARDS USED IN THIS ACTIVITY

4-PS3-2: Energy
- Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS3-3: Energy
- Ask questions and predict outcomes about the changes in energy that occur when objects collide.
- **PS3.B: Conservation of Energy and Energy Transfer:** Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2; 4-PS3-3)

3-5-ETS1-1: Engineering Design
- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Student Activity 2

Investigation of Sound Waves

Problem

Does sound travel differently between a gas and a solid?

Inquiry-Based Skills

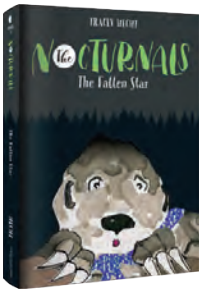
Communication, observation, controlling variables, analyzing data, drawing conclusions

Materials (per group)

- 2 metal spoons
- 80-cm string

Procedure

1. In pairs, one student should tie the center of the string around one of the spoons.
2. Wrap each end of the string around each of your partner's index fingers. The string should hang in a V-shape with the spoon at the bottom of the V.
3. The partner should stand with their hands in front of them, ensuring that the spoon is not resting on anything and is hanging freely.
4. Use the second spoon to gently strike the spoon attached to the string.
5. Switch places with your partner, repeat steps 2–4, and record your observations in the data table.
6. Wrap each end of the string around each of your partner's index fingers again. This time, however, your partner should press their index fingers to their ears (but should not put them in their ears).
7. The partner should bend slightly forward to ensure that the spoon is hanging freely in front of them.
8. Again, gently strike the second spoon against the spoon attached to the string.
9. Switch places with your partner, repeat steps 6–8, and record your observations in the data table.



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Data Table

Test	Observations
Spoon tapped—sound traveling through air (gas)	
Spoon tapped—sound traveling through string (solid)	

Analyze and Conclude

1. Draw a sketch of how sound traveled from the spoon when your fingers were on your ears. Use descriptive labels to explain how sound moves from the spoon to your ears.

2. Compare and contrast the sounds you heard when your fingers were on your ears versus when your fingers were in front of you.

3. Do sounds travel better through a gas or a solid? Explain your answer.

4. What are examples of how some animals use sound waves to learn about their surroundings?

Activity 3

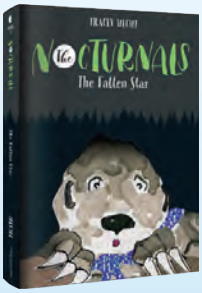
Prosimian Dichotomous Key

Background

When biologists come across an animal, plant, or rock that they need to identify, they use classification systems. Classifying organisms is important, especially when working in a field such as botany—a botanist may need to identify one of over 600 species of conifers—or in entomology, a field in which an entomologist may need to identify one of over 3,000 species of cockroaches. To recognize each individual species, these scientists may use a *dichotomous key*.

The word dichotomous comes from the word *dichotomy*, meaning a contrast between two things that are being opposed or are entirely different. A dichotomous key consists of pairs of statements or descriptions. By eliminating one statement of each pair, scientists can narrow down the possibilities until they have identified one organism.

The following activity is based on characters found in *The Nocturnals: The Fallen Star*. Aye-Aye Iris and the mob of lemurs she controls are part of a small group of primates called prosimians. Prosimians are nocturnal primates that are typically small and have a well-developed sense of smell, red-green color blindness, and a toilet claw for grooming.



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Along with aye-ayes and lemurs, the prosimians also include lorises, tarsiers, and galagos, also known as bush babies.

Instructions

1. Hand out the illustrations of prosimians that the students will need to identify.

2. Make sure students understand how to use a dichotomous key. Remind students that they should start with descriptive pair #1 each time they are attempting to identify a new species.

3. Allow students time to work through each prosimian—some will be easier than others to identify.

4. Once students have finished, challenge them to construct their own dichotomous keys to identify objects, such as candy, musical instruments, or balls used in sports.

Answer Key for Student Activity

A. ring-tailed lemur; B. indri; C. aye-aye; D. potto; E. slow loris; F. bush baby

Analyze and Conclude

1. The dichotomous key allows you to focus on specific characteristics in order to make quick comparisons. The internet would probably give long descriptions of each animal, and using it would take much longer.

2. Yes, if nonliving things, such as rocks, have characteristics that can be classified, then a dichotomous key can be useful.

References and Helpful Links

- **http://www.newworldencyclopedia.org/entry/Prosimian**
- **http://www.pbs.org/edens/madagascar/creature2.htm**
- **http://www.arkive.org/potto/perodicticus-potto/**
- **http://www.arkive.org/ring-tailed-lemur/lemur-catta/**
- **https://www.nationalgeographic.com/animals/mammals/a/aye-aye/**
- **https://a-z-animals.com/animals/indri/**
- **http://www.awf.org/wildlife-conservation/bush-baby**

NEXT GENERATION SCIENCE STANDARDS USED IN THIS ACTIVITY

3-LS3-1 Heredity: Inheritance and Variation of Traits

- Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

3-LS4-2 Biological Evolution: Unity and Diversity

- Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

Crosscutting Concepts: Patterns

- Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3-1)

Student Activity 3

Prosimian Dichotomous Key

Problem

How can a dichotomous key be used to identify organisms?

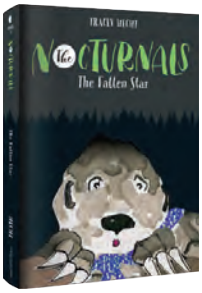
Inquiry-Based Skills

Observation, deductive reasoning

Procedure

1. The key shown on page 4 is a dichotomous key that will help identify the prosimians pictured on the same page. Begin with the paired statements 1a and 1b. One of these statements will describe prosimian A; the other statement does not. The number at the end of the description leads to the next pair of descriptions. If there is a name at the end of the description, the prosimian has been identified, and you will write that name in the observation box below.

2. Repeat step 1 with prosimian B and continue until all prosimians have been correctly identified.



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Observations

1. Once the correct prosimian has been identified, write the name on the line that corresponds to its letter.

A _____

B _____

C _____

D _____

E _____

F _____

Analyze and Conclude

1. Why do you think a dichotomous key is more helpful in identifying the prosimians than researching each one on the internet?

_____

_____

_____

_____

_____

2. Do you think a dichotomous key could be used to identify nonliving things, such as rocks? Why or why not?

_____

_____

_____

_____

Prosimian Dichotomous Key

1	a. Average length greater than 18 cm ————>	Go to 2
	b. Average length less than 18 cm ————>	Bush baby
2	a. Large eyes surrounded by dark patches encircling eyes ———>	Go to 3
	b. Large eyes with no dark patches ————>	Potto
3	a. Elongated fingers, all of similar length ————>	Go to 4
	b. Elongated fingers, with an extremely long third digit ————>	Aye-aye
4	a. Black-and-white fur ————>	Go to 5
	b. Golden-brown fur ————>	Slow loris
5	a. Long, slender tail with thirteen alternating rings ————>	Ring-tailed lemur
	b. Short, stubby tail ————>	Indri