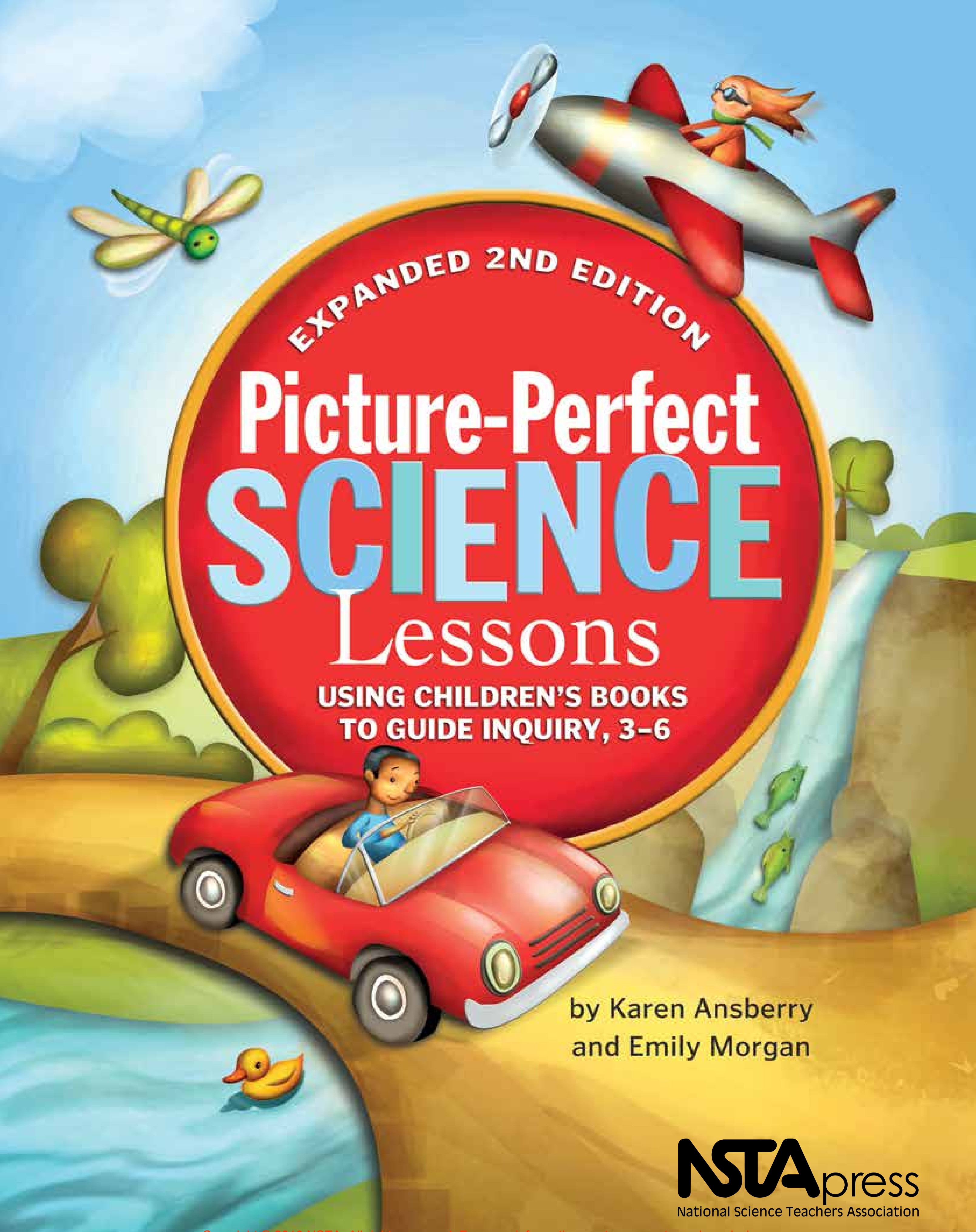

EXPANDED 2ND EDITION

Picture-Perfect SCIENCE Lessons

USING CHILDREN'S BOOKS TO GUIDE INQUIRY, 3–6

by Karen Ansberry
and Emily Morgan

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Foreword

I had the good fortune to meet the authors of *Picture-Perfect Science Lessons,* Karen Ansberry and Emily Morgan, in the fall of 2003 at a workshop I facilitated on inquiry-based science. At that event, we had a lively discussion about the nature of science and how the teachers in attendance might impart their love of science to elementary-age children. The authors then took me aside and told me of their plans to write a book for teachers (and parents, too) using children's literature to engage children in scientific inquiry. I have always believed that children in the elementary grades would experience more science if elementary teachers were provided with better ways to integrate literacy and science. So, of course, I was intrigued.

As I reviewed this manuscript, I was reminded of one of my favorite "picture books" as an adult—*The Sense of Wonder,* by Rachel Carson. In that book, Ms. Carson expresses her love of learning and how she helped her young nephew discover the wonders of nature. As she expressed,

> *I sincerely believe that for the child, and for the parent seeking to guide him, it is not half so important to know as to feel. If facts are the seeds that later produce knowledge and wisdom, then the emotions and the impressions of the senses are the fertile soil in which the seeds must grow. The years of early childhood are the time to prepare the soil. Once the emotions have been aroused—a sense of the beautiful, the excitement of the new and the unknown, a feeling of sympathy, pity, admiration or love—then we wish for knowledge about the object of our emotional response. Once found, it has lasting meaning. It is more important to pave the way for the child to want to know than to put him on a diet of facts he is not ready to assimilate.* (Carson 1956)

Rachel Carson used the natural environment to instill in her nephew the wonders of nature and scientific inquiry, but I believe, along with the authors, that picture books can have a similar emotional effect on children and inspire their wonder and their curiosity. Then, when teachers and parents couple scientific inquiry experiences with the content of the picture books, science really comes to life for children. *Picture-Perfect Science Lessons* provides an ideal framework that encourages children to read first; explore objects, organisms, and events related to what they've read; discern relationships, patterns, and explanations in the world around them; and then read more to gather more information, which will lead to new questions worth investigating.

In addition, *Picture-Perfect Science Lessons* is the perfect antidote to leaving science behind in the elementary classroom. As elementary teachers struggle to increase the basic literacy of all students, they often cannot find the time to include science in the curriculum, or they are discouraged from teaching science when literacy scores decline. Teachers need resources such as *Picture-Perfect Science Lessons* to genuinely integrate science and literacy. There is no doubt that inquiry-based science experiences motivate children to learn. Through this book, teachers have the best of both worlds—they will have the resources to motivate children to read and to "do science." What could be better?

As one of the developers of the BSCS 5E Instructional Model, I was gratified to learn that the authors intended to use the "5Es" to structure their learning experiences for children and teachers. These authors, as with many teachers across the country, had become acquainted with the 5Es and used the model extensively to promote learning in their own classrooms; however, they did not know the origin of the model until we had a conversation about BSCS and the 5Es. This book helps set the record straight—the 5E Instructional Model was indeed developed at BSCS in the late 1980s in conjunction with an elementary curriculum project and thus is appropriately titled "The BSCS 5E Instructional Model" in this book. The authors' iterative use of the BSCS 5Es is appropriate because the model is meant to be fluid, where one exploration leads to a partial explanation that invites further exploration before a child has a grasp of a complete scientific explanation for a phenomenon. As the authors mention, the final E—evaluate—is applied more formally at the end of a unit of study, but the BSCS 5E model by no means implies that teachers and students do not evaluate, or assess, student learning as the students progress through the model. Ongoing assessment is an integral part of the philosophy of the BSCS 5Es and the authors appropriately weave formative assessment into each lesson.

Once you place your toe into the waters of this book, I guarantee that you will dive right in! Whether you are a teacher, a parent, or both, you will enjoy this inviting approach to inquiry-based science. If you follow the methods outlined in *Picture-Perfect Science Lessons*, you and the children with whom you interact will have no choice but to learn science concepts through reading and scientific inquiry.

I don't know about you, but I'm rather curious about those sheep in a jeep. Enjoy!

Nancy M. Landes
Senior Science Educator
Center for Professional Development
Biological Sciences Curriculum Study

Reference

Carson, R. 1956. *The sense of wonder.* Berkeley, CA: The Nature Company. (Copyright renewed 1984 by Roger Christie. Text copyright 1956 by Rachel Carson.)

Preface

A class of fifth-grade students laughs as their teacher reads Jeanne Willis's *Dr. Xargle's Book of Earth Hounds.* Students are listening to the alien professor, Dr. Xargle, teach his pupils about Earth Hounds (puppies): "Earth Hounds have fangs at the front and a waggler at the back. To find out which is which, hold a sausage at both ends." The fifth-grade class giggles at this outrageous lesson as Dr. Xargle continues to lecture. Students then begin sorting cards containing some of the alien professor's "observations" of Earth Hounds. The teacher asks her students, "Which of Dr. Xargle's comments are truly observations?" Students review their cards and realize that many of his comments are not observations but rather hilariously incorrect inferences. They re-sort their cards into two groups: observations and inferences. This amusing picture book and word sorting activity guide students into hands-on inquiry where they make observations about sealed mystery samples Dr. Xargle collected from Earth. Eventually students develop inferences about what the mystery samples might be. Through this exciting lesson, students construct their own understanding of the difference between an observation and an inference, how scientists use observations and inferences, and how to make good observations and inferences.

What Is Picture-Perfect Science?

This scenario describes how a children's picture book can help guide students through an engaging, hands-on inquiry lesson. *Picture-Perfect Science Lessons* contains 20 science lessons for students in grades 3 through 6, with embedded reading comprehension strategies to help them learn to read and read to learn while engaged in inquiry-based science. To help you teach according to *A Framework for K–12 Science Education*, the lessons are written in an easy-to-follow format for teaching inquiry-based science: the Biological Sciences Curriculum Study 5E Instructional Model (Bybee 1997, used with permission from BSCS). This learning cycle model allows students to construct their own understanding of scientific concepts as they cycle through the following phases: Engage, Explore, Explain, Elaborate, and Evaluate. Although *Picture-Perfect Science Lessons* is primarily a book for teaching science, reading comprehension strategies are embedded in each lesson. These essential strategies can be modeled throughout while keeping the focus of the lessons on science.

Use This Book Within Your Science Curriculum

We wrote *Picture-Perfect Science Lessons* to supplement, not replace, an existing science program. Although each lesson stands alone as a carefully planned learning cycle based on clearly defined science objectives, the lessons are intended to be integrated into a more complete unit of instruction in which concepts can be more fully developed. The lessons are not designed to be taught sequentially. We want you to use *Picture-Perfect Science Lessons* where appropriate within your school's current science curriculum to support, enrich, and extend it. And we want you to adapt the lessons to fit your school's curriculum, your students' needs, and your own teaching style.

Special Features

1. Ready-to-Use Lessons With Assessments

Each lesson contains engagement activities, hands-on explorations, student pages, suggestions for student and teacher explanations, opportunities for elaboration, assessment suggestions, and annotated bibliographies of more books to read on the topic. Assessments range from poster sessions with rubrics to teacher checkpoint labs to formal multiple choice and extended response quizzes.

2. Reading Comprehension Strategies

Reading comprehension strategies based on the book *Strategies That Work* (Harvey and Goudvis 2000) and specific activities to enhance comprehension are embedded throughout the lessons and clearly marked with an icon. Chapter 2 describes how to model these strategies while reading aloud to students.

3. Standards-Based Objectives

All lesson objectives are from *A Framework for K–12 Science Education* (NRC 2012) and are clearly identified at the beginning of each lesson. Chapter 5 outlines the *Framework* for those grade ranges, and Appendix 1 (p. 393) shows the correlation between the lessons and the *Framework*. In addition, Appendix 2 (p. 395) shows the correlation to the *Common Core State Standards, English Language Arts* (NGAC and CCSSO 2010).

4. Science as Inquiry

As we said, the lessons in *Picture-Perfect Science Lessons* are structured as guided inquiries following the 5E Model. Guiding questions are embedded throughout each lesson and marked with an icon ?. The questioning process is the cornerstone of good teaching. A teacher who asks thoughtful questions arouses students' curiosity, promotes critical-thinking skills, creates links between ideas, provides challenges, gets immediate feedback on student learning, and helps guide students through the inquiry process. Each lesson includes an "Inquiry Place," a section at the end of the lesson that suggests ideas for developing open inquiries. Chapters 3 and 4 explore science as inquiry and the BSCS 5E Instructional Model.

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Bybee, R. W. 1997. *Achieving scientific literacy: From purposes to practices*. Portsmouth, NH: Heinemann.

Harvey, S., and A. Goudvis. 2000. *Strategies that work: Teaching comprehension to enhance understanding.* York, ME: Stenhouse Publishers.

National Governors Association Center for Best Practices and Council of Chief State School Officers (NGAC and CCSSO). 2010. *Common core state standards.* Washington, DC: NGAC and CCSSO.

National Research Council (NRC). 2012. *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

Children's Book Cited

Willis, J. 2011. *Dr. Xargle's book of Earth hounds.* London, UK: Anderson Press Ltd.

Editors' Note: *Picture-Perfect Science Lessons* builds on the texts of 38 children's picture books to teach science. Some of these books feature animals that have been anthropomorphized—sheep crash a jeep, a hermit crab builds his house. While we recognize that many scientists and educators believe that personification, teleology, animism, and anthropomorphism promote misconceptions among young children, others believe that removing these elements would leave children's literature severely underpopulated. Furthermore, backers of these techniques not only see little harm in their use but also argue that they facilitate learning.

Because *Picture-Perfect Science Lessons* specifically and carefully supports scientific inquiry—"The Changing Moon" lesson, for instance, teaches students how to weed out misconceptions by asking them to point out inaccurate depictions of the Moon—we, like our authors, feel the question remains open.

Acknowledgments

We would like to give special thanks to science consultant Carol Collins for sharing her expertise in teaching inquiry-based science, for giving us many wonderful opportunities to share *Picture-Perfect Science Lessons* with teachers, and for continuing to support and encourage our efforts.

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- To our husbands, families, and friends for their moral support (and for keeping an eye on our kids!).
- And to our parents, who were our very first teachers.

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About the Authors

Karen Ansberry is an elementary science curriculum leader and a former fifth- and sixth-grade science teacher at Mason City Schools, in Mason, Ohio. She has a bachelor of science in biology from Xavier University and a master of arts in teaching from Miami University. Karen lives in historic Lebanon, Ohio, with her husband, daughter, twin boys, two dogs, and two cats.

Emily Morgan is the science leader for the High AIMS Consortium in Cincinnati, Ohio. She is a former elementary science lab teacher at Mason City Schools in Mason, Ohio, and a seventh-grade science teacher at Northridge Local Schools in Dayton, Ohio. She has a bachelor of science in elementary education from Wright State University and a master of science in education from the University of Dayton. Emily lives in West Chester, Ohio, with her husband, son, dog, and two cats.

Karen and Emily, along with language arts consultant Susan Livingston, received a Toyota Tapestry grant for their Picture-Perfect Science grant proposal in 2002. Since then, they have enjoyed facilitating teacher workshops at elementary schools, universities, and professional conferences across the country. They are also the authors of *More Picture-Perfect Science Lessons: Using Children's Books to Guide Inquiry, K–4.*

Karen Ansberry, right, and Emily Morgan developed *Picture-Perfect Science Lessons* based on their workshops supported by a Toyota Tapestry grant.

About the Picture-Perfect Science Program

The Picture-Perfect Science program originated from Emily Morgan's and Karen Ansberry's shared interest in using children's literature to make science more engaging. In Emily's 2001 master's thesis study involving 350 of her third-grade science lab students at Western Row Elementary, she found that students who used science trade books instead of the textbook scored significantly higher on district science performance assessments than students who used the textbook only. Convinced of the benefits of using picture books to engage students in science inquiry and to increase science understanding, Karen and Emily began collaborating with Susan Livingston, the elementary language arts curriculum leader for the Mason City Schools in Ohio, in an effort to integrate literacy strategies into inquiry-based science lessons. They received grants from the Ohio Department of Education (2001) and Toyota Tapestry (2002) to train all third-grade through sixth-grade science teachers, and in 2003 they also trained seventh- and eighth-grade science teachers with district support. The program has been presented both locally and nationally, including at the National Science Teachers Association national conferences.

For more information on Picture-Perfect Science teacher workshops, go to *www.pictureperfectscience.com.*

Lessons by Grade

Chapter		Grade	Picture Books
6	Earth Hounds	3–6	*Dr. Xargle's Book of Earth Hounds* *Seven Blind Mice*
7	Name That Shell!	3–5	*Next Time You See a Seashell* *A House for Hermit Crab*
8	Rice Is Life	3–6	*Rice Is Life* *Rice*
9	What's Poppin'?	5–6	*Popcorn!*
10	Mystery Pellets	3–6	*White Owl, Barn Owl* *Butternut Hollow Pond*
11	Close Encounters of the Symbiotic Kind	3–6	*What's Eating You? Parasites—The Inside Story* *Weird Friends: Unlikely Allies in the Animal Kingdom*
12	Turtle Hurdles	3–5	*Turtle Watch* *Turtle, Turtle, Watch Out!*
13	Oil Spill!	3–5	*Prince William* *Oil Spill!*
14	Sheep in a Jeep	3–5	*Sheep in a Jeep*
15	Sounds of Science	3–6	*Sound* *The Remarkable Farkle McBride*
16	Chemical Change Café	3–5	*Pancakes, Pancakes!*
17	The Changing Moon	3–5	*Next Time You See the Moon* *Papa, Please Get the Moon for Me*
18	Day and Night	3–5	*Somewhere in the World Right Now*
19	Grand Canyon	3–6	*Erosion* *Grand Canyon: A Trail Through Time*
20	Brainstorms: From Idea to Invention	5–6	*Imaginative Inventions* *Girls Think of Everything: Stories of Ingenious Inventions by Women*

Chapter		Grade	Picture Books
21	Bugs!	3–5	*The Perfect Pet* *Bugs Are Insects* *Ant, Ant, Ant! (An Insect Chant)*
22	Batteries Included	3–5	*Electrical Circuits* *Too Many Toys*
23	The Secrets of Flight	3–6	*How People Learned to Fly* *Kids' Paper Airplane Book*
24	Down the Drain	3–6	*Down the Drain: Conserving Water* *A Cool Drink of Water*
25	If I Built a Car	3–6	*If I Built a Car* *Inventing the Automobile*

Activity-specific safety guidelines are highlighted throughout the lessons. For a more thorough discussion of safety procedures, see *The NSTA Ready-Reference Guide to Safer Science* or *Exploring Safely*. The National Science Teachers Association has also created a convenient *Safety in the Elementary Science Classroom* flipchart. This colorful and student-friendly safety resource can be hung on the wall for easy reference or a quick refresher.

Resources

Kwan, T., and J. Texley. 2002. *Exploring safely: A guide for elementary teachers.* Arlington, VA: NSTA Press.

National Science Teachers Association (NSTA). 2003. *Safety in the elementary science classroom* flipchart. Arlington, VA: NSTA Press.

Roy, K. R. 2007. *The NSTA ready-reference guide to safer science.* Arlington, VA: NSTA Press.

Earth Hounds

Description

Learners develop understandings of the differences between observations and inferences by analyzing Dr. Xargle's comical, yet misguided, attempts to teach his extraterrestrial students about dogs. Learners then make observations and inferences of "mystery samples" collected from Earth by Dr. Xargle.

Suggested Grade Levels: 3–6

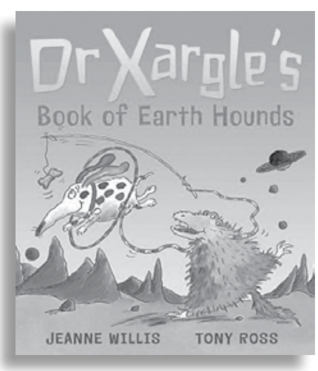
Lesson Objectives Connecting to the ***Framework***

Science and Engineering Practices

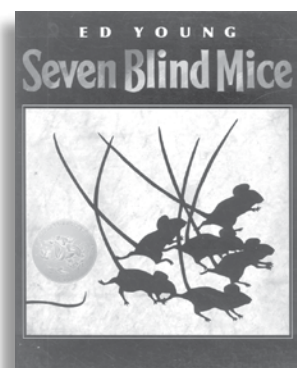
- Obtaining, evaluating, and communicating information

Crosscutting Concepts

- Scale, Proportion, and Quantity



Featured Picture Books



Title	***Dr. Xargle's Book of Earth Hounds***
Author	**Jeanne Willis**
Illustrator	**Tony Ross**
Publisher	**Andersen Press**
Year	**2011**
Genre	**Story**
Summary	**Dr. Xargle, a green, five-eyed alien, teaches a lesson about strange creatures called Earth Hounds.**

Title	***Seven Blind Mice***
Author	**Ed Young**
Illustrator	**Ed Young**
Publisher	**Puffin Books**
Year	**2002**
Genre	**Story**
Summary	**Retells the fable of the blind men discovering the different parts of an elephant and arguing about its appearance**

Time Needed

This lesson will take several class periods. Suggested scheduling is as follows:

Day 1: **Engage** with read aloud of *Dr. Xargle's Book of Earth Hounds*, **Explore** with word sorts, and **Explain** with observation versus inference and Inference Frayer Model

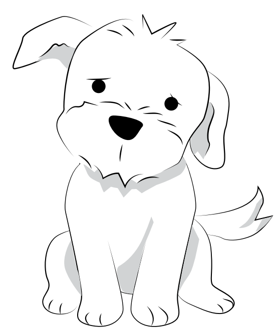
Day 2: **Explore** and **Explain** with mystery samples from Planet Earth

Day 3: **Elaborate** with *Seven Blind Mice*, **Evaluate** with Observation and Inference Practice and Quiz

Day 4: **Evaluate** with review and Observation and Inference Quiz

Materials

- Black film canisters or small opaque containers with lids (1 per student) to make mystery samples: Make the mystery samples in sets of 2 so you can randomly distribute 2 identical samples of each kind. Be sure to put in equal amounts, such as 1 tbs. popcorn kernels in each, 1 of the same size marble in each, and so on. Put in familiar, everyday household items that make sound when shaken, such as
  - 5 small paper clips
  - 1 tbs. popcorn kernels
  - 1 marble
  - 1 screw
  - 1 small disc magnet or magnetic marble
  - 3 pennies
  - 2 plastic centimeter cubes
  - 1 key chain
  - 1 salt packet
  - 1 pencil eraser
  - 1 tbs. water
  - 1 button
  - 5 rubber bands
  - 1 tbs. sand or small gravel
  - 1 crayon, broken in half
  - 1 piece of chalk, broken in half
- Magnets for testing magnetic properties
- Balances or electronic kitchen scales for measuring mass



Student Pages

- Earth Hounds Word Sort Cards
- Inference Frayer Model
- Mystery Sample From Planet Earth Data Sheet
- Observation and Inference Practice
- Observation and Inference Quiz

Background

When learning to work and think scientifically, students need to use both observation and inference to construct explanations for phenomena. Making an *observation* involves using one or more of the senses to gather evidence about objects or events. Making an *inference* involves logical reasoning—drawing a conclusion using prior knowledge to interpret our observations. Students can observe many things directly, for example, a weather vane on top of a building. However, they cannot see moving air, so they must make inferences about wind by noting the direction the weather vane is pointing, feeling the breeze against their skin, and observing tree branches moving in the wind. They can see the lightbulbs in a circuit, but they must make inferences about the electric current going through them by observing the bulbs′ brightness. They can see tracks in the snow, but they must infer what type of animal made them by studying their shape and size and comparing that information to what is already known about animal footprints. Children quite naturally make inferences from their observations, but it is important for science teachers to help them understand the difference between the two to fine-tune these skills.

It is also important for students to understand how scientists make observations and inferences in their work. Sometimes scientists gather information using their senses; other times, direct observation is not possible. For example, the inside of an atom is much too small to be seen, even with the most powerful microscope. Scientists have had to make inferences about atomic structure based on their observations of how atoms behave. For many years, the ″plum pudding″ model was the widely accepted model of atomic structure. In this model, negatively charged particles were thought to be scattered throughout an atom. However, in 1909 a scientist by the name of Ernest Rutherford conducted a famous experiment in which he observed how particles of matter behaved as they passed through a thin layer of gold foil. From his observations, he inferred that atoms had a small nucleus, with a positive charge, surrounded by electrons. By combining his experimental results with what was already known about subatomic particles, Rutherford was able to propose a new model of atomic structure without ever seeing an atom.

In this lesson, students make observations and inferences about the unseen properties of mystery objects and, in doing so, learn the difference between observations and inferences and how scientists generate knowledge using both.

Engage

Inferring

Show students the cover of the book, and ask the following questions:

- ? Who do you think Dr. Xargle is?
- ? What do you think Earth Hounds are?

Earth Hounds Read Aloud

Introduce the author and illustrator of *Dr. Xargle's Book of Earth Hounds*. Then read *Dr. Xargle's Book of Earth Hounds* to the class.

Explore

Ask students the following questions after reading the book:

- ? Who is Dr. Xargle? (a teacher or professor from another planet)
- ? What are Earth Hounds? (dogs)
- ? What observations did Dr. Xargle make about dogs? (Responses will vary.)
- ? What is an observation? (information taken in directly through the senses)

Word Sorts

Word sorts help learners understand the relationships among key concepts and help teach classification.

Open Sort: Pass out the Earth Hounds Word Sort Cards student page to each pair of students. Have them cut out the cards containing several statements made by Dr. Xargle about Earth Hounds. Then ask them to sort the cards any way they wish. At this point, it should be an open sort, in which students group the cards into categories of their choice and then create their own labels for each category. As you move from pair to pair, ask students to explain how they categorized the cards. Then ask

- ? Do you notice any differences among the kinds of statements Dr. Xargle makes on the cards?
- ? Which statements are truly observations, or information Dr. Xargle got directly through his eyes or ears?

Closed Sort: Tell students that now you want them to classify the cards into only two groups: statements that are *observations* and those that aren't. Give them time to sort the cards.

Next make a T-chart on the board. Don't label it yet. Discuss the statements the students have identified as observations. As students give answers, write them (or attach the cards) on the left side of the T-chart if they are truly observations with the corresponding (incorrect) inferences on the right. Then ask

- ? Does anyone know what the statements on the right-hand side of the T-chart are called? (inferences)

Next label the T-chart with "Observations" on the left and "Inferences" on the right.

Sample T-Chart

Observations	Inferences
Earth Hounds have eyes and tongues.	The eyes of the Earth Hounds are made of buttons, and their tongues are made of flannel.
Earth Hounds are taken for walks.	Earth Hounds are attached to strings so they can be pulled along in the sitting position.
Earth Hounds roll in compost.	Earth Hounds roll in compost to dry themselves after a bath.
The Earthlings place newspapers on the floor.	The Earthlings place newspapers on the floor for the Houndlets to read.

Explain

Observation Versus Inference

Discuss the differences between observations and inferences using the following explanation: "Making an *observation* involves using one or more of the senses to find out about objects or events. Making an *inference* involves logical reasoning—drawing a conclusion using prior knowledge to explain our observations. A problem Dr. Xargle has is that he makes incorrect inferences to explain his observations. Dr. Xargle observes people putting newspapers on the floor. Dr. Xargle infers that people do that so that puppies can read them.

- ? Why do people really put newspapers down for puppies? How do you know? (People put newspapers down so puppies can "potty" on them. We know this from our past experiences with puppies.)

Use the following example to further illustrate the concept of inference: "Inferences are always based on observations. When you make an inference, you use your observations combined with your past experiences to draw a conclusion. Think about this example: You are walking on the grass barefoot. It is a warm, sunny day. You reach the end of the grass and have a choice between walking barefoot on blacktop or on a sidewalk. You notice heat waves rising from the blacktop. You choose to walk on the sidewalk because you *infer* from the heat waves and your prior knowledge about dark surfaces that the blacktop is too hot. This is an inference because you did not directly observe the temperature of the blacktop by stepping on it, but your observations, combined with past experience, led you to the conclusion that the blacktop is hotter than the sidewalk.

"Dr. Xargle, being from another planet, doesn't have any past experiences with dogs. So, he makes inferences that are incorrect. For example, Dr. Xargle makes an incorrect inference about why people put newspapers down for puppies. He does not base his inference on past experience with puppies (perhaps dogs on his planet can read!). Sometimes scientists have to reject their first inferences when observations later disprove them. If Dr. Xargle went back to Earth to make more observations, he would be able to revise his incorrect inferences."

Lead students to more examples of inferences by asking the following questions:

- ? Your dog comes in from outside and you observe its fur is wet. What inferences could you make from your observation? Turn and talk. (It is raining outside; your dog jumped in a creek; someone gave it a bath.)
- ? You walk into your backyard and you observe feathers all over the ground. What inferences could you make from your observation? Turn and talk. (An animal caught a bird; someone had a pillow fight; birds were fighting.)
- ? A paleontologist observes a fossil of a fish in the desert. What inferences could she make from her observation? Turn and talk. (The desert was covered with water at one time; someone dropped the fossil there.)

Explain

Inference Frayer Model

The Inference Frayer Model is a tool used to help students develop their vocabularies. Students write a particular word in the middle of a box and proceed to list characteristics, examples, nonexamples, and a definition in other quadrants of the box.

Give each student an Inference Frayer Model student page. Explain that the Frayer Model is a way to help them understand the meaning of concepts such as *inference*. Have students formulate a definition for inference in their own words in the top left box of the Inference Frayer Model

Sample Frayer Model for "Inference"

Definition	Characteristics
Conclusion you draw to explain your observations	• Uses your past experiences • Always based on observations
Inference	
Examples	**Nonexamples**
• I inferred that it was raining outside because people came in carrying wet umbrellas	• I saw an umbrella

student page. Then have students write some characteristics of inferences in the top right box. Have students work in pairs to come up with examples and nonexamples from their own lives. Encourage them to use their previous experiences as a basis for their inference examples. Refer back to the blacktop example and encourage them to think of similar experiences from their lives. For nonexamples, encourage students to think of direct observations they have made using their senses. Students can then present and explain their models to other groups. As they present to each other, informally assess their understanding of the concept and clarify as necessary.

Explore

Mystery Samples From Planet Earth

Tell students that they are scientists from Dr. Xargle's planet and that he has asked for their help in identifying certain samples that have been collected from Earth. The problem is that students cannot look directly at the samples to make observations. The samples must be kept sealed in small black containers because Dr. Xargle believes they could contain radiation or harmful microorganisms. Tell students that under no circumstances can they open the containers. Discuss the properties of the objects that they might be able to observe without looking at them (sound, mass, and magnetic properties). Then pass out the Mystery Sample From Planet Earth Data Sheet and the sealed mystery samples.

Procedure for Mystery Samples From Planet Earth Activity

1. Before the lesson, prepare one film canister for each student. Put in items that make sounds, such as water, a paper clip, popcorn kernels, a marble, or a penny. Make pairs of canisters so that you can randomly distribute two of each kind: two canisters with popcorn in them, two with marbles in them, and so forth. Make sure you put equal amounts of materials in each pair of canisters, such as 1 tablespoon popcorn in each, and one of the same-size marble in each.
2. Students can calculate the mass of the samples in their canisters by subtracting the mass of an empty canister from the mass of their full canisters.
3. Ask students to make observations of the sounds the samples make. Walk around and check their descriptions. Are they making observations or inferences? They may find it difficult to make an observation of sound without inferring based on past experience. Accept observations such as "swishy," but do not accept inferences such as "It is water" at this point. Students should be using their sense of sound to describe what they hear without making inferences as to the identities of the samples.

4 Students can slide a magnet against the side of the film canister to observe whether the contents move with the magnet.

5 Have students make an inference about the contents of their canisters. "I think the mystery sample is ____________ because ________________________."

6 Ask some of the students to share their inferences with the class.

FINDING THE MASS OF A "MYSTERY SAMPLE"

explain

After all students have finished the Mystery Sample From Planet Earth Data Sheet, have them stand, holding their containers. They will want to open their samples to see if their inferences are correct, but don't let them yet! Instead have them form two groups—the students holding magnetic mystery samples should go to one side of the room and those holding nonmagnetic mystery samples should go to the other side of the room. Tell them to listen to the sounds that the samples make as they are gently shaken, and then try to find the person with an identical sample. When they find a "match," have them sit down with the person holding that sample and discuss their observations and inferences. Remind them not to open their containers, as they may contain radiation or harmful microorganisms.

When all students have found their match, discuss the following:

"There are many things in the world that cannot be directly observed by scientists because they no longer exist, they are too small or too far away, or (like our mystery samples) it is too dangerous to observe them. For example, has anyone ever seen a live dinosaur? (No.) Why not? (They have been extinct for millions of years.) So how do we know so much about dinosaurs? (Paleontologists observe fossils to make inferences about dinosaurs.) What kind of inferences can paleontologists make by looking at fossil evidence? (They can measure the bones to infer the size, look at the teeth to infer what they ate, look at the footprints to infer how they moved, and so on.) *But paleontologists will never see a live dinosaur, just as you may never see what is inside your container!*

Has anyone ever seen the inside of an atom? (No.) Why not? (Atoms are too small to be seen, even with the most powerful microscopes.) So how do we know so much about atoms? (Physicists observe how matter behaves in all kinds of chemical reactions. They have to make inferences about atoms and build models of atoms based on this indirect evidence rather than by directly observing them.) *But physicists may never see the inside of an atom, just as you may never see what is inside your container!*

Has anyone ever directly observed the center of the Earth? (No.) Why not? (It is too dangerous or difficult to go there.) So how do we know that the Earth's core is made of iron? (Geologists are able to use a variety of observations, including measurements of earthquake waves, to come up with inferences about the composition of Earth's core.) *But geologists may never see the center of the Earth, just as you may never see what is inside your container!"*

Next ask students to think about their mystery sample inferences. Ask

- How many of you are absolutely certain that your inference is correct?
- How many of you are fairly certain that your inference is correct?
- How many of you have no idea whether or not your inference is correct?

Explain that in science, there's often not absolute certainty. But making careful repeated observations, performing controlled experiments that can be replicated by others, and analyzing research thoroughly can reduce uncertainty and decrease the chances of making incorrect inferences.

Let students open their containers now, or make them wait until the next class period. If you really want to make your point (and you aren't afraid of a mob of angry kids), never let your students open them!

Elaborate

Seven Blind Mice

Questioning

Introduce the author and illustrator of the book *Seven Blind Mice*. Show students the cover of the book.

- What do you think this book might be about?

As you read the book aloud, do not show the illustrations of the elephant so that students can infer what the "something" is. Only show the pages of the pillar, spear, etc. After reading, ask

- What was the "something" the blind mice observed?

After student share their inferences, show the illustrations of the elephant's parts. Then ask the following questions:

- What did the first mouse observe? (He felt the elephant's foot.)
- What did he infer from his observation? (He thought it was a pillar.)
- What did the seventh mouse do before making an inference? (She ran from one end of the elephant to the other and made observations of each part.)
- Why is it a good idea to make multiple observations before making an inference? (When you base your inference on more observations, you are less likely to make an incorrect inference.)
- The mouse moral is, "Knowing in part may make a fine tale, but wisdom comes from seeing the whole." How does this apply to making good observations and inferences? (Making only one observation may allow you to make an inference, but it is not likely to give you the big picture. Making multiple observations is more likely to give you the wisdom to draw an accurate conclusion about something.)

Making Connections: Text-to-Text

- What advice could White Mouse give Dr. Xargle about his study of Earth Hounds? (Dr. Xargle should go back to Earth to make more observations, reject his original ideas about dogs, and make new inferences.)

Evaluate

Observation and Inference Practice

Have students practice making observations and inferences using the Observation and Inference Practice. Check for understanding by having students explain their thinking.

Evaluate

Review and Observation and Inference Quiz

After reviewing the differences between observations and inferences, have students complete the Observation and Inference Quiz. Answers are below:

1. Answers will vary but should be based on what can be directly observed in the picture. Responses may include the following: Water or another liquid is dripping from the fish bowl; water or another liquid is on the floor; there is no fish in the bowl; the cat is "smiling."
2. Answers will vary but should be based on the observation in question number 1. Responses may include the following: The cat put its head in the fishbowl; the cat ate the fish; the cat is happy.
3. b.
4. b.

5–6 Answers may include any two of the following: Mealworms prefer dark places or enclosed places; mealworms are attracted to cardboard; mealworms do not like water; mealworms do not like light; mealworms can't climb; and so on.

7. c.
8. Answers will vary, but they should suggest that Dr. Xargle make more observations on which to base his inferences.

Inquiry Place

Have students investigate animal tracks in a natural area. A good time to do this is when the ground is wet or snow covered. Students can place food in the area to attract animals. A cast of a track can be made by encircling it with a dam made of a strip of poster paper taped together at the ends, and then pouring plaster of paris into the track.

If a natural area is not available, you can construct a simulation by placing two or more different kinds of animal footprints made of paper on the floor of the classroom. Arrange them in a pattern that suggests how the animals interacted. For example, place rabbit and fox footprints in a pattern that implies there was a chase. When students enter the room, they can try to figure out what happened. As they work to solve the mystery, assess their ability to distinguish observations from inferences.

? What observations can you make about the footprints?

? What inferences can you make from your observations?

Students can present their findings in a poster session.

More Books to Read

Banyai, I. 1995. *Zoom*. New York: Puffin Books. Summary: This wordless picture book presents a series of scenes, each one from farther away, showing, for example, a girl playing with toys, which is actually a picture on a magazine cover, which is then revealed to be part of a sign on a bus, and so on. Students will enjoy making observations about each page and then inferring what might really be happening in each scene.

Banyai, I. 1998. *Re-Zoom*. New York: Puffin Books. Summary: This book reprises the wordless format of *Zoom*, beginning with a cave painting

and ending with the lights of a subway train disappearing into a tunnel.

George, L. B. 1995. *In the snow: Who's been here?* New York: Greenwillow Books.
Summary: Two children, on their way to go sledding, see evidence of animal life. Readers must infer what animals had been in each location. Each time, the answer is revealed on the next page.

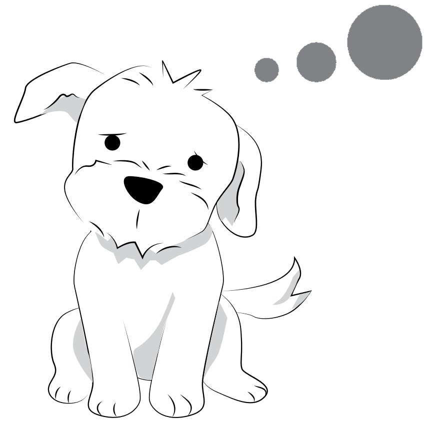
Kramer, S. 2001. *Hidden worlds: Looking through a scientist's microscope.* Boston: Houghton Mifflin Co.
Summary: This book for upper elementary students provides a wealth of information about how scientists study the world using powerful electron microscopes. The book features the work of microscopist Dennis Kunkel, who has examined and photographed objects ranging from a mosquito's foot to a crystal of sugar to the delicate hairs on a blade of grass. It describes how he became interested in microscopes as a boy, how he prepares specimens for study, and how different kinds of microscopes work.

Pallotta, J. 2002. *The skull alphabet book.* Watertown, MA: Charlesbridge Publishing.
Summary: A detailed painting of an animal's skull represents each letter of the alphabet. The name of the animal isn't revealed, but visual tips to its identity are given in the background and through clues in the text. Readers will enjoy using their observational skills and prior knowledge to make inferences about the identity of the animals.

Selsam, M. E. 1998. *Big tracks, little tracks: Following animal prints*. New York: HarperCollins Children's Books.
Summary: This picture book for lower elementary students leads readers through the process of identifying animals and animal activities by their tracks. Explaining that scientists use clues to investigate the natural world, the book tells readers to make observations of a set of tracks, collect information about the animals that left those tracks, and finally infer what happened based on information revealed by the tracks.

Earth Hounds

Word Sort Cards



Earth Hounds have eyes and tongues.	Earthlings place newspapers on the floor for the Houndlets to read.
Earth Hounds are attached to strings so they can be pulled along in the sitting position.	Earth Hounds roll in compost.
Earthlings place newspapers on the floor.	The eyes of Earth Hounds are made of buttons, and their tongues are made of flannel.
Earth Hounds roll in compost to dry themselves after a bath.	Earth Hounds are taken for walks.

Name: ______________________________

Inference Frayer Model

Definition	Characteristics
Examples	**Nonexamples**

Inference

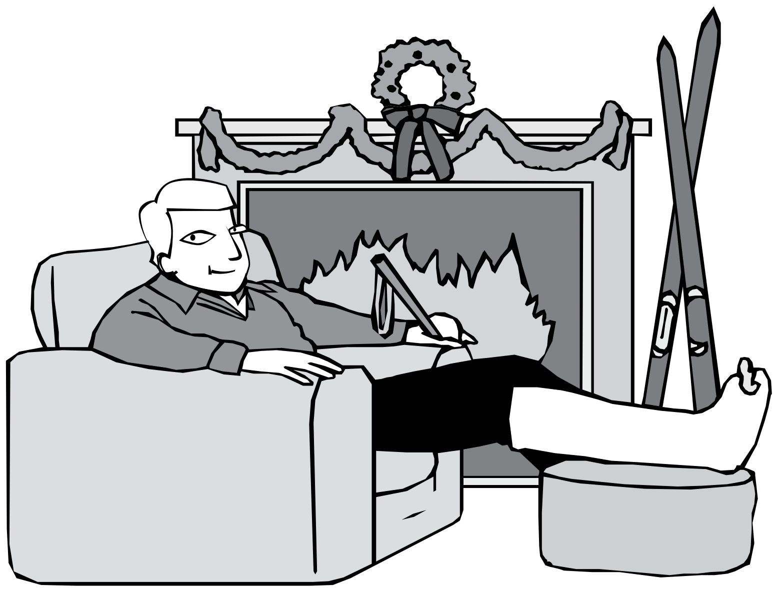
Name: ______________________________

Mystery Sample From
Planet Earth
Data Sheet

Mass	Sample + Container = _____ g Empty Container = _____ g Sample = _____ g
Sound	Make an observation of the sound your sample makes when you shake the container: ______________________________ ______________________________
Magnetic Property	Use a magnet against the side of the container to determine if the sample is attracted to a magnet. _____ YES _____ NO
Inference	I think the mystery sample is ______________________________ because ______________________ ______________________________

Name: ______________________________

Observation and Inference Practice

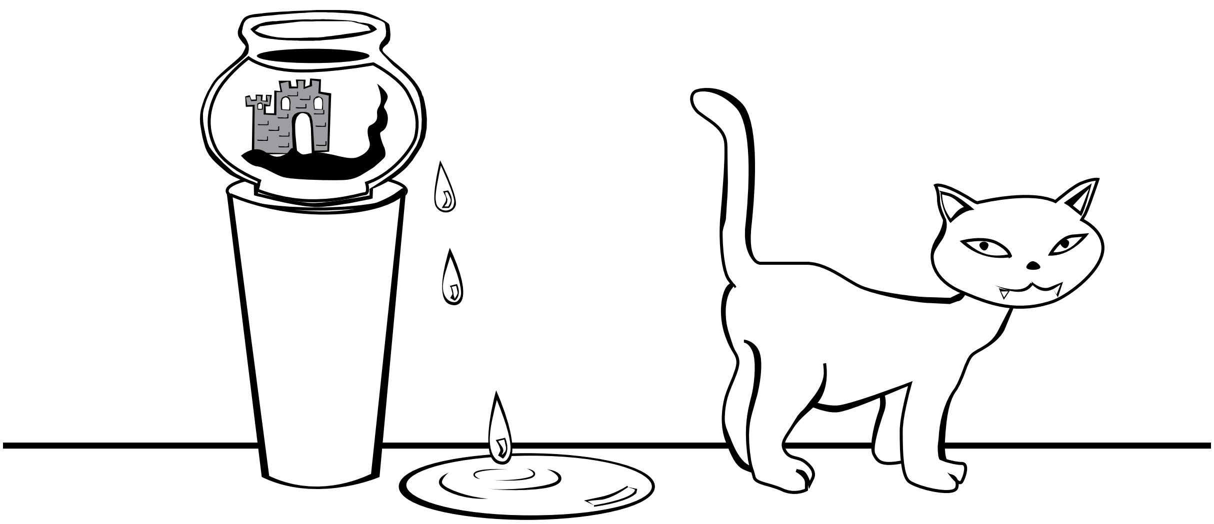


Look at the picture. List in the chart below three observations and three inferences that can be made from those observations. An example of each is given for you.

Observation	Inference
The man is sitting by a fireplace.	The man is warm.

Name: ________________________________

Observation and Inference Quiz



Look at the picture above. Write one observation about the picture. Then write one inference based on that observation.

1 Observation: ____

2 Inference: ____

3 Scientists must be able to tell the difference between observations and inferences. Which of the following is an **inference?**

a The bird has blue feathers and a yellow beak that measures 3 cm long.

b The rodent might be nocturnal because it has large eyes and long whiskers.

c The snake is wrapping its body around its prey.

d The leaf measures 12.4 cm long.

Name: ______________________________

Observation and Inference Quiz cont.

Rainforest Journal 2/16/15 Today I found the body of an unusual frog. The frog might be poisonous because it is very brightly colored.	It has a mass of 22.4 grams. The frog is probably a tree climber because it has large, round toe pads. I think the frog is a species of poison dart frog because of its size and color.

4 A scientist discovers the body of an unknown species of frog in the rain forest of Brazil. She writes several statements in her journal about the animal shown above. Which of the following is an **observation** about the frog?

a The frog might be poisonous because it is very brightly colored.

b It has a mass of 22.4 grams.

c The frog is probably a tree climber because it has large, round toe pads.

d I think the frog is a species of poison dart frog because of its size and color.

Name: ______________________________

Observation and Inference Quiz cont.

Trial	Number of mealworms under light	Number of mealworms in cardboard tube	Number of mealworms in water dish
1	12	37	1
2	6	44	0
3	7	43	0

A student placed 50 mealworms in the middle of an aquarium containing a light, a cardboard tube, and a water dish. He waited 5 min. and then recorded the data for the first trial in the table above. The student repeated this procedure two more times, and recorded the results. Read the results of all three trials. Then write two inferences you could make about mealworms based on the results.

5 Inference: ______________________________

6 Inference: ______________________________

Name: ______________________________

Observation and Inference Quiz cont.

7 A scientist finds the skeleton of an animal that lived long ago. He observes that the animal had broad, flat teeth and feet with hooves. What is the best **inference** he could make from his observations?

a The animal lived in an area with few trees.

b The animal was a good swimmer.

c The animal was probably a plant eater.

d The animal was probably a meat eater.

8 When Dr. Xargle visits Earth and observes Earthlings placing newspapers on the floor, he infers that the newspapers are for the Houndlets to read. What is incorrect about his inference, and what advice would you give Dr. Xargle about making inferences?

____

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