

In This Guide

In this guide, you will find language arts and science lessons for the stories in the March issue of EXTREME EXPLORER.

Explorer Magazine

EXTREME EXPLORER magazine is a classroom magazine specifically written for middle school students. The magazine contains a grade-appropriate reading experience, develops literacy skills, and teaches standards-based science content. Great storytelling and stunning photographs teach your students about our planet and the people, plants, and animals that live on it. Use EXTREME EXPLORER in your classroom to encourage students to explore our world and make it a better place.

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Objective

- Students will use context clues to infer the meaning of unfamiliar words.
- Students will analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text (e.g., through examples or anecdotes)
- Students will summarize a text.

Resources

- Vocabulary Activity Master (page 6)
- Language Arts Activity Master (page 7)

Summary

The article explores how chameleons communicate with color change and other unique adaptations that enable them to thrive in some of Earth's most threatened habitats.

BUILD VOCABULARY AND CONCEPTS

- **behavioral adaptation**
- **melanin**
- **nanocrystal**
- **pigment**
- **prehensile**

As a class, discuss the difference between familiarity and knowledge. Guide students to recognize that the more familiar you are with something, the more knowledge you have. Challenge students to explain how this concept applies to words when they read.

Display the vocabulary words. Remind students how to use a Frayer graphic organizer to understand new words. It can lead to a deeper knowledge of words and their relationship to their own lives. Divide the class into four groups and have them each use the **Vocabulary Activity Master** to explore their word. A Frayer diagram can also be made by folding a piece of paper four times and folding over middle of the page. Once unfolded, students can use the sections marked by the center crease line to hold the vocabulary word. Students could then label the other sections marked by the crease lines.

Have each group share their efforts before displaying the Wordwise feature on page 9 of the **Projectable Magazine**. Have students compare its definitions with the definitions they wrote. The two sets of definitions may be very different. Encourage students to scan the article to find out why. Guide the class to recognize that words can have different figurative, connotative, and technical meanings based on how they are used. Students can discuss how this applies to the vocabulary in Chameleons.

READ

Remind students that the purpose of this article is to explore evidence that explains how new research changes what scientists know about adaptations. Point out to students that scientific articles can sometimes be difficult to comprehend. Analyzing in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text can lead to increased comprehension of a scientific text passage. Examples or anecdotes given in the text are often critical components of building comprehension.

Use the text on page 4 to model analyzing how a key event is introduced in the text. Read the five paragraphs aloud and then **say**: *These paragraphs introduce me to an event that depicts how and why chameleons change color. As a reader who has never seen a chameleon, I'm pretty amazed at the color changes during this short interaction and the complexity of their behaviors. The behaviors displayed during the event make me more interested in chameleons, as does the very colorful photograph that supports the text.... In just a few seconds, his normally green skin morphs to orange and then red.... I notice that the chameleons' colors seem to be located in patches that are often connected to other patches but sometimes appear as isolated spots. This simple color changing interaction or event has allowed me to make a scientific observation and fired up my curiosity.*

Chameleons

LANGUAGE ARTS



Give each student a copy of the **Language Arts Activity Master**. Explain to students that analyzing how a key individual, event, or idea is introduced, illustrated, and elaborated on through examples and anecdotes can lead to increased comprehension of a passage.

TURN AND TALK

Have students turn and talk to discuss how key individuals, events, or ideas are introduced, illustrated, and elaborated in the text. You might also ask them to discuss how analyzing these aspects increased their understanding of the science concepts presented. Encourage the comparison of results as a class or in small groups. Then have students share their efforts on the **Language Arts Activity Master**. If another student mentions something they overlooked, instruct students to make revisions.

Summarize

Say: *One way to determine if you understand information is to summarize the main idea of what you have read. If you can't state a summary based on the main idea and details, you might need to read the article again.* Have students turn and talk to summarize the different ways chameleons use their ability to change color to survive. Prompt discussion with questions such as: What has to happen to a chameleon to cause its color to change? Why is it useful to understand how chameleons change color? What adaptations help chameleons to catch a meal? Is color change a chameleon's most useful adaptation?

WRITE AND ASSESS

You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about chameleons with prompts such as:

- Which adaptation serves chameleons better: bulging eyes, an incredibly long tongue, or powerful feet? Explain why you think so.
- What makes chameleons "Old World Wonders"?
- What information surprised you?

Objectives

- Students will analyze how the structure of chameleon skin supports the function of color change.
- Students will identify behaviors and physical adaptations that aid survival.
- Students will explain how new evidence changes science understanding.

Resources

- Content Activity Master (page 8)
- Science Quiz Master (page 9)
- "How Chameleons Change Color" poster (Teacher's Edition)

Science Background

Chameleons are often seen as prey by tree dwelling animals such as mammals, snakes, and birds. Yet, chameleons are predators themselves. They successfully hunt crickets, stick insects, cockroaches, spiders and other insects. Chameleons have also been known to eat leaves and fruits. Larger chameleons have been known to eat birds.

Chameleons are specially equipped to deal with their prey. Their eyes rotate to give them a full 360-degree field of view. They readily notice motion and can use their eyes like camera lenses to zoom in at what they are looking at.

Female chameleons lay their eggs in holes that they dig on the forest floor. Depending on the species, female chameleons lay a clutch of eggs consisting of one to one hundred eggs. The typical chameleon lays around twenty eggs.

Biologist Christopher V. Anderson, Ph.D., conducts extensive research on chameleons. You can find his videos of chameleons feeding and other information at his website: <http://www.chamaeleonidae.com>.

For more information about chameleons and how they communicate, see [The Colorful Language of Chameleons](#) in the September 2015 issue of *National Geographic Magazine*.

ENGAGE

Tap Prior Knowledge

Encourage students to discuss what they've observed, first hand or in the media, about chameleons. They might include characteristics of chameleons specifically, or larger related groups such as reptiles or vertebrates. Record the responses and have students differentiate between biological characteristics and those based on opinion. Then, as a class, develop an operational definition of what a chameleon is.

EXPLORE

Preview the Lesson

Invite students to read the headline and examine the photos on pages 2–3 and the brown heads, pictures, and graphics on the remaining pages. Ensure students have a general understanding of the words *behavioral adaptation*, *melanin*, *nanocrystal*, *pigment*, and *prehensile*.

Challenge students to predict what the article is specifically about. Discuss with students whether or not they find the fact that chameleons do NOT change color to match their surroundings surprising or even true. Encourage students to elaborate on their answers with some explanation. Prompt students to think about whether their explanation is based on fact or opinion. Then have students read the article to learn what science says.

Set a Purpose and Read

Have students read the article in order to analyze how the structure of chameleon skin supports the function of color change.

EXPLAIN

Chameleon Skin and Color Change

Display the "How Chameleons Change Color" poster. Have volunteers read each of the sections in order, starting in the upper left hand corner below the "Under Its Skin" head. After each section is read, call on other volunteers to restate what they heard in their own words. Allow discussion of each action. Conclude the activity by having each student summarize, in writing, how the different aspects of chameleon skin contribute to color change.

New Evidence Changes Understanding

The article presents a wide range of chameleon behaviors and adaptations. Challenge students to identify evidence that is new to them and how it has changed their understanding of chameleons. This might be done as a discussion or graphically. If you select the latter, students might draw two-panel cartoons that depict what they thought before and after becoming aware of the new evidence.

Characteristics Aid Survival

Give each student a copy of the **Science Activity Master**. Allow students to work in pairs or small groups to identify behaviors and physical adaptations that aid chameleon survival. Students should identify each adaptation and how it aids chameleon survival. After the adaptations have been identified, have students rank them according to their value to aiding survival, with 1 being most important. Then facilitate a discussion in which students back up their claims with evidence.

ELABORATE

Find Out More

It is pointed out in the article that chameleons are Old World Wonders—most live in Africa and on the nearby island of Madagascar. Have students conduct research and draw on a world map to show the extent to which chameleons now range because of exportation from the Old World.

Extend Your Thinking About Chameleons

Have students extend their thinking about the adaptation of color change by researching other animals that have this adaptation. Students might focus on how these other species benefit from the ability to change their coloration and compare and contrast that adaptation with that of chameleons.

EVALUATE

Assess comprehension of science concepts mentioned in the article using the **Science Quiz** alone or in combination with the following questions. Have students record their answers in their science notebooks or on the back of the Science Quiz.

- **What role do nanocrystals play as chameleons change their color?** *(The colorless nanocrystals reflect different colors of light depending on their thickness and spacing.)*
- **Why is it a misconception that chameleons change their color to camouflage themselves against their surroundings?** *(Their coloration expresses their mood or reflects factors in their environment such as temperature, humidity, and presence of other chameleons.)*
- **How are behavioral adaptations and physical adaptations similar and different?** *(Both kinds of adaptations are controlled by genes. Behavioral adaptations are unlearned actions that help individuals to survive, such as the motions that mimic leaves moving in the breeze. Physical adaptations are physical structures, such as their tongues, eyes, and feet.)*

Name _____

Date _____

VOCABULARY ACTIVITY: Chameleons

Place a vocabulary word in the center oval and then complete the diagram.

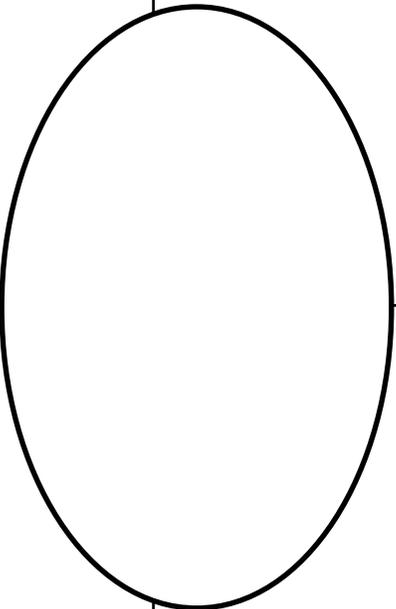
Frayer Diagram

Definition in your own words

Facts and characteristics

Examples

Nonexamples



Name _____

Date _____

LANGUAGE ARTS ACTIVITY: Chameleons

Analyze examples or anecdotes of individuals, events, or ideas and explain how they build comprehension.

Page	Example/Anecdote	Relevance to Text	How It Aids Comprehension

Name _____

Date _____

SCIENCE ACTIVITY: Chameleons

Identify behavioral and physical adaptations that aid in chameleon survival. Numerically rank each adaptation by its importance with 1 being the most important.

Rank	Adaptation	How It Benefits Survival

SCIENCE QUIZ: Chameleons

Circle the correct answer for questions 1–5. Then write your response to Your Ideas.

- Which is NOT a behavior that causes chameleons to change color?
 - excited
 - hungry
 - relaxed
 - submissive
- What are the chemicals that absorb some colors of light while reflecting others called?
 - melanins
 - nanocrystals
 - pigments
 - skin cells
- Which is a common misconception about chameleons?
 - Chameleons are carnivores.
 - Chameleons change color to match their surroundings.
 - Chameleons are omnivores.
 - Chameleons change color to match their emotions.
- What other factor, along with pigments, determines a chameleon's color?
 - sunlight
 - nanocrystals
 - skin transparency
 - skin opacity
- Which is NOT an adaptation that aides in chameleon survival?
 - cone-shaped eyelids
 - thick muscular tail
 - long gripping toes
 - odd gate that mimics a fluttering leaf

Your Ideas: How does sunlight and skin interact to make chameleon skin look green.

Objective

- Students will determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.
- Students will produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- Students will cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

Resources

- Vocabulary Activity Master (page 14)
- Language Arts Activity Master (page 15)

Summary

The article “A Tight Fit” depicts how scientists solve a series of physical problems to retrieve and catalog over 1,500 fragile fossils of a previously unknown primate species.

BUILD VOCABULARY AND CONCEPTS

- **chute**
- **excavate**
- **paleoanthropologist**
- **scientific name**

Display the vocabulary words. Remind students that increasing the frequency of use is a good way to become familiar with new vocabulary.

Increase the frequency with which the vocabulary words are used with the **Vocabulary Activity Master**. Instruct students to review them and answer any questions they may have. Advise them of time period during which the activity will take place and tally points at the end.

Then, have students increase their depth of knowledge by joining in think-pair-shares of the instances shown on their tracking sheets and how they used the vocabulary at school and at home.

READ

Remind students that this article examines how discoveries made by scientists in the course of their work often raises new questions to explore. Throughout the article, the writer gives examples that explain what is needed to solve specific and anticipated problems and catalog the efforts of the scientists working underground. On each page of the article the author makes explicit statements but also allows the reader to make inferences based on their previous knowledge and experiences.

Display pages 12–13 of the **Projectable Magazine**.

If needed, model how to identify explicit information and make inferences using the Fearless and Focused passage. Say: *When I read the headline “Fearless and Focused,” I think about how courage is required to stay focused on difficult tasks and it makes me think a difficult task is going to take place. The cell phone image grabs my attention and its short message tells the tale. I close my eyes for a second and try to picture who might respond to Berger’s Facebook request. I actually form a mental image of what his team might eventually look like. The first paragraph lets me check the validity of my inference.* Remind students that reading constantly involves making sense of what is being read. Making inferences is one way to do that. Also explain to students that identifying explicit information can help to validate their inferences.

Give each student a copy of the **Language Arts Activity Master**. Have students read the article on their own. As they do, instruct them to text code to identify explicit information (E) in the article or inferences (I) as they are encountered.

TURN AND TALK

Evidence of Explicit Text

Have students turn and talk to compare their **Language Arts Activity Master** with a partner. Did students find the same examples of explicit language? Did they form inferences from the same material or information? Have students explain their reasoning to their partners. If partners used the same information to come to different understandings, encourage them to reread the text and review the information together. Students should discuss and examine the support they cited to come to a better understanding of how the author used explicit language to make points.

Inferences

With a different partner, have students turn and talk to compare their **Language Arts Activity Master**. Students can cite an inference and explain the reasoning behind it to their partners. If partners used the same information to validate a different inference, encourage them to discuss what they already knew or their thinking process that led them to different inferences.

Produce Clear and Coherent Writing

Say: *One way to determine if you can produce clear and coherent writing is to construct a graphic organizer to help with the task.* Have students turn and talk to about the strategies involved in producing such writing. Challenge groups of students to produce a graphic organizer that will be shared with the class. Prompt discussion with questions such as: *How will you organize concepts into coherent content? What can you do to make your sentences and paragraphs clear and concise? What role will examples and anecdotes play? How important is editing and revision? How will you determine if a writing passage is clear and coherent?*

WRITE AND ASSESS

You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about the manner in which solutions to problems were found in *A Tight Fit*. Prompts might include:

- How might Berger's outcome have been different if he had used the men who discovered the cave to retrieve the fossils instead of his team underground and on the surface?
- Should social media play a role in solving scientific problems? Why or why not?
- What might have been a technological solution to Berger's problem?

Objectives

- Students will make generalizations about the work of scientists as they uncover new information.
- Students will analyze the difficulty in establishing how old the fossils are found in the Rising Star Cave.
- Students will consider how problems and solutions play a part in scientific investigations.

Resources

- Content Activity Master (page 14)
- Science Quiz Master (page 15)

Science Background

Rising Star cave is described as a crack in the ground. It has three larger room-like structures that are joined by treacherously narrow passages. Because of these passages, Lee Berger himself was anatomically unable to fit through the passages to observe the fossils where they were located.

This article shows the convergence of science, research, and social media. Berger wanted to get the word out quickly and used Facebook as his tool. The message was passed along through professional groups to attract the attention of more applicants than one would find through traditional channels. Berger knew that he needed people of a certain physical size, and it just happened that among the applicants, the most qualified based on their science expertise and climbing/caving experience were women. Few others could fit. One was photographer Garrreth Bird. Some of his photographs appear in this article and more can be found at <http://proof.nationalgeographic.com/2015/09/10/one-videographers-journey-to-find-a-lost-human-ancestor/>.

For more about the story of the find and Lee Berger's work retrieving it, analyzing it, and drawing conclusions from it, see [Almost Human](#) in the October 2015 issues of *National Geographic Magazine*.

ENGAGE

Tap Prior Knowledge

Display the diagram of the Rising Star cave system found on page 12 of the **Projectable Magazine**. Have students talk about what they know about caves, how they think cavers move through systems like this, how they feel about enclosed spaces themselves, and anything else they would like to share about working in an environment like Rising Star.

EXPLORE

Preview the Lesson

Invite students to read the headline and examine the photo on pages 10–11 and the green heads, pictures, and graphics on the remaining pages. Ensure students have a general understanding of the words *chute*, *excavate*, *paleoanthropologist*, and *scientific name*.

Challenge students to predict what the article is about specifically. Discuss with students whether or not they find the fact that a new species can be found today is surprising or even true. Encourage students to elaborate on their answers with some explanation. Prompt students to think about whether their explanation is based on fact or opinion.

Set a Purpose and Read

Have students read the article to explore how scientists conduct their efforts and how their discoveries frequently raise new questions.

EXPLAIN

How Scientists Uncover New Information

Berger and his team of underground astronauts put in a backbreaking month digging and moving fossils from the Dinaledi Chamber. Months more were required to sort and assemble the bones into skeletons. All of these efforts led to recognition that a new species of primate had been discovered. Students might make a time line that delineates the efforts made by Berger's team and the new information that resulted. Discuss with them how Berger's tack of bringing in many scientists from all over at the beginning of the work differs greatly from many scientists who work with small teams to limit who knows about the work until the final conclusions are drawn.

Problems and Solutions in Scientific Research

In September of 2013 cavers discovered a chute that opened to a deep chamber where dozens of bones jutted out of the dirt floor. The cavers that made the discovery turned their find over to Lee Berger who put together a team to solve numerous problems presented by the fossils in the Rising Star cave. Many of the problems and their solutions are given in the article. Pass out the **Science Activity Master** and have students identify problems and their related solutions.

ELABORATE

Find Out More

One of the biggest mysteries about *Homo naledi* is the age of the fossils themselves. African fossils are often dated based on dating the volcanic ash or stone layers found above or below them. This method is foiled by the fact that these fossils were found deep within Rising Star cave where layers of sediment did not pile up on one another. Have students conduct research relative and absolute dating methods for fossils or other materials and share their findings with the class.

Extend Your Thinking About Puzzling Out the Find

Direct interested students extend their thinking about the underground astronauts themselves or the fossil find and the questions scientists were grappling with. Students can conduct Internet searches using a key word string such as *rising star cave national geographic 2015*. They will find many photos of the work as well as interviews with the scientists themselves.

EVALUATE

Assess comprehension of science concepts mentioned in the article using the **Science Quiz** alone or in combination with the following questions. Have students record their answers in their science notebooks or on the back of the Science Quiz.

- **Underground astronaut Becca Peixotto practiced squeezing through the narrow gap between her bed and the floor before she left for South Africa. What activity would you use to get ready for Superman's Crawl?** *(Answers will vary. Students should describe an activity in which they have to crawl through an area with limited space and light.)*
- **What were the major problems that had to be solved by the underground astronauts?** *(Answers may vary but should include: two very narrow constricted crawl spaces must be traversed; Dragon's Back ridge has to be climbed; the fossil chamber was damp, small, cramped and stuffy; the air in the fossil chamber could easily become poisonous requiring safety precautions; a lot of coordination and communication were required to figure out how the astronauts could work efficiently in such a small space; special precautions had to be taken to avoid damaging the fossils; removing each fossil from the chamber was a painstaking process.)*
- **One of the most puzzling aspects of the fossils found in the Rising Star cave was how the bones came to be so deep within the cave. How would you explain how the bones came to be there?** *(Answers will vary. Some ideas include: it is possible that the individuals were placed in their collective tomb as part of a funerary rite; they may have all crawled into the cave for safety or to escape severe weather and been overcome by the collection of poisonous gases; a small remnant of surviving Homo naledi people may have been killed off and their bodies secreted away by others; a later group of people found the collection of Homo naledi bones and placed them in the cavern out of respect as a more secure final resting place.)*

VOCABULARY ACTIVITY: A Tight Fit

Vocabulary Tracking Sheet

Total Points _____

Tracking Vocabulary Words found in speech, print or media – 5 points

When	Instance	Points

Tracking Vocabulary Words I used in class – 10 points

When	Instance	Points

Tracking Vocabulary Words I used in writing assignments – 15 points

When	Instance	Points

Documenting Vocabulary Words I used at home – 20 points

When	Instance	Initials	Points

Name _____

Date _____

LANGUAGE ARTS ACTIVITY: A Tight Fit

Analyze the text, photos, captions, and labels to identify explicit statements or combine with what you already know to make inferences about the article. Tell what supports your inferences.

E/I	Explicit Statement or Inference	Support

Name _____

Date _____

SCIENCE ACTIVITY: A Tight Fit

Identify the problems presented by the fossils in the Rising Star cave and how they were solved.

Problem	Solution

SCIENCE QUIZ: Tight Fit

Circle the correct answer for questions 1–5. Then write your response to Your Ideas.

1. What was Lee Berger’s problem?
 - A. The fossils in the Rising Star Cavern were too fragile to move.
 - B. He was too large to pass through Superman’s Crawl passage.
 - C. Berger was unable to identify needed topnotch scientific explorers using social media.
 - D. Rising Star Cavern had not been fully explored.
2. Which was not an attribute listed in Berger’s Facebook ad?
 - A. candidates should be skinny and small
 - B. candidates should not be claustrophobic
 - C. candidates should have some climbing experience
 - D. candidates should not be adverse to working alone.
3. What trick did scientific explorer Peixotto learn while crawling under her bed?
 - A. crawling while on her back
 - B. inflating her lungs
 - C. deflating her lungs
 - D. pretzeling her arms in odd positions
4. What word is used to identify a person who studies ancient human ancestors?
 - A. paleoanthropologist
 - B. anthropologist
 - C. archeologist
 - D. paleontologist
5. Which is NOT one of the remaining mysteries about *Homo naledi*?
 - A. the age of the fossils
 - B. why the 15 individuals were living in Rising Star cave
 - C. why the bones of 15 individuals were found in the cavern
 - D. why the fossils were so deep in Rising Star cave

Your Ideas: The bones could have been collected in large bags. Why do you think it was important *scientifically* to do such careful digging, bagging, and labeling of the fossils?

Objective

- Students will use context clues to infer the meaning of unfamiliar words.
- Students will identify and synthesize the main ideas of a text.
- Students will delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient.

Resources

- Vocabulary Activity Master (page 22)
- Language Arts Activity Master (page 23)

Summary

The article “Space Rocks” identifies what asteroids are, their relationship to Earth in the past and the future, and the potential role they can play in future space exploration.

BUILD VOCABULARY AND CONCEPTS

- **asteroid**
- **asteroid belt**
- **crater**
- **NEA**
- **orbit**

After you have previewed the article using the **Projectable Magazine**, display the vocabulary words. Remind students that using context clues such as the sentences before and after an unknown word and photographs on the page can help them figure out what the unfamiliar word means.

Use the **Vocabulary Activity Master** to create sets of Name that Word vocabulary cards. Distribute one set to each pair of students. Instruct students to add another term of their own choosing to the blank card. One student should then choose a card and give phrases from the word’s definition or clues that do not include the word itself, using the article as needed.

The other student has 30 seconds or less to reason out the vocabulary word. Instruct students to take turns as they explore the vocabulary words and shuffle through the cards multiple times.

Have students increase their depth of knowledge by joining in think-pair-shares to discuss how their understanding of the vocabulary terms increased during the activity. They might also discuss future rule changes that would promote success in identifying the vocabulary words.

READ

Subhead

Remind students that the purpose of this article is to explore how scientists can see asteroids as both a problem and a solution. In much of the article, the writer uses language to persuade readers of her point of view. Arguments revolve around claims that can be supported with evidence. Help students develop strategies to evaluate an author’s arguments by distinguishing between claims that are supported by evidence and those that are not.

Display pages 20–21 of the **Projectable Magazine**. If needed, model how to evaluate an author’s argument using the first paragraph on page 20. **Say:** *When I read in the passage that scientists are also worried about ‘smaller asteroids’ that can wreak havoc to Earth’s surface, I recognize that the author is making a claim. This claim sets up my expectations for the next paragraph. I want to learn all of the dangers of smaller asteroids. I want to read on to learn about the evidence for her claim.*

Remind students that when finding an author’s position they can ask themselves some questions:

- What main idea is the author trying to convince me of?
- Does the author provide support and examples to back up this point of view?
- Do the stated reasons and support persuade you to accept the author’s claims or point of view?
- What additional support might the author have included that would have convinced me to agree with the author’s point of view?

Give each student a copy of the **Language Arts Activity Master**. Have students read pages 20–21 on their own. As they do, instruct them use text coding to identify passages in which the author makes a claim with a C and information that supports a claim with an S. Students should then use what they’ve learned to complete the Language Arts Activity Master.

TURN AND TALK

Have students compare their **Language Arts Activity Master** with a partner to observe differences and similarities. If partners used the same information to come to different understandings, encourage them to reread the text and review the information together.

Supporting Claims

Remind students that individual reading passages should support the claims made in the article. Have students review their **Language Arts Activity Master** together. Did students find the same examples of claims that were strongly supported? Did they disagree on the level of support that a claim was given? Have students explain their reasoning to their partners. Most students will come to a consensus on how well the author supported the claims that were made in the article. Have students turn and talk to discuss how the author's claims influences their perception the overall article.

Identifying Main Ideas

Have students turn and talk with these or other prompts:

- What is the theme or central message the author tries to get across?
- How does the main idea of each blue-headed section support the theme? Discuss an example.
- How do the main ideas of the individual paragraphs help build toward the theme?

Say: *One way to determine the theme or central idea of a text passage is to outline the passage. In the outline you would identify each main idea and the details that support it. After your outline is finished you would examine each of the parts to see how they support and lead to the theme or central idea of the article as a whole.* Have teams of students outline the various sections of *Space Rocks*. Display the group-derived main idea of each section and use it to discuss the author's development of the article's theme. Prompt discussion with questions such as the following.

- What strategy did the author follow to build support for the theme or central idea?
- How effective was this effort?
- In which areas could the support have been stronger?
- How could the author have strengthened those areas?

WRITE AND ASSESS

You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about the topic.

- Which argument for spending time and effort on asteroid exploration do you think is the most compelling? Why?
- How confident are you that a PHA on course to impact on Earth could be stopped? Why?
- What surprised you about what you read?

Objectives

- Students will make generalizations about how asteroids are alike and different from other objects in the solar system.
- Students will evaluate how asteroids can threaten Earth but also provide solutions for space travel.
- Students will consider how problems and solutions play a part in scientific investigations.

Resources

- Asteroid: Mission Extreme (page 22)
- Content Activity Master (page 23)
- Science Quiz Master (page 24)
- "The Solar System" poster (Teacher's Edition)
- Space Rocks Interactive Whiteboard Lesson (website; optional)

Science Background

Near Earth Objects (NEOs) are usually either asteroids or comets. Comets were formed in the cold outer planetary system of materials left over from the formation of the gas giants. Comets consist mostly of water ice and dust particles.

Asteroids are a different story. The mostly rocky asteroids were formed in the much warmer inner solar system between the orbits of Jupiter and Mars. Scientists speculate that had it not been for the close proximity to Jupiter's orbit the asteroids that orbit in the asteroid belt would have possibly formed a planet. Scientists think that there are millions of asteroids. They think that 750,000 of these are larger than a kilometer. Of those, about 200 are over 100 kilometers in diameter. Ceres, the largest asteroid, is over 900 kilometers across. The rest are very small.

There are three types of asteroids. The most common type are chondrites (61%), also known as stony meteorites. Iron meteorites (35%) are formed of iron-nickel alloys. Only 4% of meteorites are classified as pallasites. These meteorites are comprised of both stone and iron. Review other facts about asteroids at <http://solarsystem.nasa.gov/planets/asteroids>.

ENGAGE

Tap Prior Knowledge

Before discussion, conduct an Internet search for headlines associated with the February 2016 asteroid impact over the south Atlantic Ocean, but do not show students. Elicit from students a description of asteroids. Have them include their size, makeup, and activity in space. Then encourage more science talk about whether or not asteroids might strike Earth or not. Reveal your Internet search on the headlines and point out the analogy of it exploding with the strength of an atom bomb. Use that as a springboard into pages 18–19.

EXPLORE

Preview the Lesson

Invite students to read the headline and examine the photo on pages 18–19 and the purple heads, pictures and graphics on the remaining pages. Ensure students have a general understanding of the words *asteroid*, *asteroid belt*, *crater*, *NEA* and *orbit*.

Challenge students to predict what the article is about. Discuss with students whether or not they find the fact that the impact of a space rock ten kilometers long fueled climate change and killed more than 70% of all species on the planet surprising or even true. Encourage students to elaborate on their answers with some explanation. Prompt students to think about whether their explanation is based on fact or opinion.

Set a Purpose and Read

Have students read the article in order to find out how scientists see asteroids as both a problem and the solution to other problems.

EXPLAIN

Alike but Different

Display the "The Solar System" poster. Use it to help students brainstorm and share what they know about the solar system. Encourage students to use the poster to compare and contrast the properties of objects in the solar system. Use prompts such as these or others to guide their discussion:

- What generalizations can be made about the gravitational force of the different objects?
- Do all solar system objects travel at similar speeds?
- How do the orbits of objects in the solar system vary?
- Some objects found in the solar system have atmospheres. Others do not. Why?
- Temperatures vary greatly in the solar system. How would you arrange solar system objects in the spectrum from hot to cold?

Threat or Asset?

Combined, all of the asteroids in the asteroid belt have less mass than Earth's moon. Give each student a copy of the **Science Activity Master**. Allow students to work in pairs or small groups to identify both the threats and benefits presented by asteroids. It is possible that students may see some threats as potentially valuable. Some may point out that the enormous space rock that killed off more than 70% of Earth's species made things advantageous for the adaptable mammals then present. Students could compare their efforts through a class discussion where groups take turns sharing. See <http://www.nasa.gov/content/exploring-comets-and-asteroids-time-capsules-of-the-solar-system> for some NASA ideas about what to do with asteroids.

Retrieving Asteroids

NASA and the Japan Aerospace Exploration Agency are currently planning missions to acquire samples of asteroids and return them to Earth. Encourage students to research these and other efforts to learn more about asteroids that will take place in their future.

ELABORATE

Find Out More

Have students use the **Space Rocks Interactive Whiteboard Lesson** to extend their thinking about asteroids. It allows them to interact with pertinent vocabulary, view image resources to extend their thinking, make comparisons of asteroid impacts on several solar system objects, and learn about Earth might avoid future asteroid impacts. If you don't have a whiteboard, your students can use all of its functionality using a computer workstation that is connected to a classroom projector.

Extend Your Thinking About Asteroids

National Geographic and Sky-Scan have partnered to produce **ASTEROID: MISSION EXTREME**. The movie explores what it would take for astronauts to reach an asteroid and then tame it for our use. Find out more about the movie and additional teaching resources at <http://movies.nationalgeographic.com/movies/asteroid/>. Consider using **Asteroid: Mission Extreme** as a tool for generating excitement about a school field trip or family event.

EVALUATE

Assess comprehension of science concepts mentioned in the article using the **Science Quiz** alone or in combination with the following questions. Have students record their answers in their science notebooks or on the back of the Science Quiz.

- **What causes an asteroid's orbit to move into an intercept course with Earth?** *(Students should describe the interaction of asteroids with the gravity of Jupiter or Mars and how that changes the asteroid's orbit.)*
- **What might comprise a checklist that could be followed to stop an incoming asteroid from impacting Earth?** *(Answers will vary but might include various aspects of tracking and analyzing asteroids and tools to change their orbit.)*
- **What are some possible benefits that asteroid offer?** *(Students may cite benefits such as adding to our understanding of the solar system, developing new sources of valuable fuel, metals, and other resources, and having locations for future space stations.)*



ASTEROID: MISSION EXTREME takes audiences on an epic journey to discover the possibilities that asteroids present for space travel. Using stunning visuals and state of the art computer graphics, the film presents the fascinating idea, based on real science, that asteroids could be used as stepping stones to other worlds, veritable “way stations” in space enabling us to cross the entire Solar System.

Detecting, tracking and possibly capturing asteroids could be the next giant step in space exploration. It’s also a mission that is crucial to protecting ourselves on Earth before a large one strikes.

Tracking millions of asteroids is underway—now begins the giant step toward astronauts visiting these silent, swift-moving objects.

A dramatic and captivating 3D film, *Asteroids*, immerses audiences in the incredible history of these near earth objects, and also examines their potential danger in the future. Asteroids represent the oldest objects in our solar system and from them we are learning how the solar system formed and even how life could have arrived on Earth. Yet, as the recent explosion in Russia reminds us, asteroids are also hazardous.

NASA’s mission to identify and study these objects is more urgent than ever. With a team of scientists, the film embarks on a remarkable journey of space exploration. Through scientific discoveries and technological capabilities, the film explores how we might change the course of asteroids heading toward us and protect ourselves on Earth.

The film explores what it would take for astronauts to reach an asteroid and then tame it for our use, as well as how such an extraordinary adventure could benefit humankind in.

ASTEROID: MISSION EXTREME can be seen now in digital full dome theaters in museums and science centers worldwide. Visit asteroidfilm.com to see where it is playing.

To support the learning around the film, a Giant Traveling Map of the Solar System will be available to rent beginning fall 2016. The map is a similar design to the pullout map featured in this issue. Imagine your students walking across the solar system! Visit GiantTravelingMaps.org to learn more.

VOCABULARY ACTIVITY: Space Rocks

Photocopy two-sided so that a vocabulary word appears on the back of each Name that Word card. Cut apart the cards and create sets of six that include each word plus a blank.

<i>Name that Word</i>	<i>Name that Word</i>	<i>asteroid</i>	<i>asteroid belt</i>
<i>Name that Word</i>	<i>Name that Word</i>	<i>crater</i>	<i>NEA</i>
<i>Name that Word</i>	<i>Name that Word</i>	<i>orbit</i>	
<i>Name that Word</i>	<i>Name that Word</i>	<i>asteroid</i>	<i>asteroid belt</i>
<i>Name that Word</i>	<i>Name that Word</i>	<i>crater</i>	<i>NEA</i>
<i>Name that Word</i>	<i>Name that Word</i>	<i>orbit</i>	

LANGUAGE ARTS ACTIVITY: Space Rocks

Use the your observations from pages 20–21 to complete the chart.

1. Briefly summarize a claim that the author made that you thought was very strong.						
2. What information or reasons were given to support this claim?						
3. Briefly summarize a claim that the author made that you thought was weak.						
4. Explain what it was about the support, reasons or examples given that did not persuade you to accept the author's claim?						
5. What additional support might the author have provided that would cause you to see the claim more favorably?						
6. Rate how well this author provides support/reasons/examples for the claims that are made:						
Weak	1	2	3	4	5	Strong

Name _____

Date _____

LANGUAGE ARTS ACTIVITY: Chameleons

Use the article or other resources to identify examples of how asteroids threaten Earth or are of value to humans.

Feature of Asteroid	Threat	Value	Nature of Threat or Value to Humans

SCIENCE QUIZ: Space Rocks

Circle the correct answer for questions 1–5. Then write your response to Your Ideas.

- Why are NEAs dangerous?
 - They are huge piles of space rock as big as mountains that could destroy Earth.
 - They are worse than PHAs.
 - They are impossible to track because they have such irregular orbits.
 - They are asteroids that orbit in paths that cross over Earth's orbit.
- Most asteroids are made of _____.
 - rock
 - metal
 - ice and dirt
 - rock and metal
- Asteroids may be pulled out of their circular orbits by _____.
 - passing comets
 - Jupiter
 - Mars
 - Both B and C
- Which is NOT a reason why asteroids are valuable?
 - contain oldest unchanged debris in our solar system
 - might serve as stepping stones for further exploration
 - could contain natural resources to sustain a spacecraft's atmosphere
 - may serve as a source for important metals
- Why is there not more evidence of asteroid impact on Earth's surface?
 - impacts only occurred early in Earth's history.
 - wind and water wear them away
 - Earth's atmosphere burns up all asteroids
 - most asteroid impacts occur in the oceans

Your Ideas: How do you think is the best way to retrieve or move an asteroid?
Explain your reasoning.

Explorer - Extreme

ANSWER KEY



Chameleons

Vocabulary Activity, page 6

Students should expand on one of the four boldface words—behavioral adaptation, melanin, nanocrystal, pigment—using the Frayer diagram. Responses will vary for students targeting the same term, but their responses should be logical.

Language Arts Activity, page 7

Students will have their own ideas about the relative importance of any given adaptation to survival. Evaluate students' responses based on whether they reflect fact or opinion and the logic behind them.

Science Activity, page 8

Students responses will vary, but should show logical relationships for the adaptations and their relative benefit to survival.

Science Quiz, page 9

1. B 2. C 3. B 4. B 5. C

Your Ideas: Students answers should describe how yellow light combines with blue light to look green to the human eye.

A Tight Fit

Vocabulary Activity, page 14

Students should record usage of the terms from the WordWise feature—chute, excavate, paleoanthropologist, and scientific name.

Language Arts Activity, page 15

Students' answers will vary. Discuss with students the rationale for their explicit statements or inferences and the thinking process they used to reach them.

Science Activity, page 16

Students responses will vary, but should show logical relationships for the problems and solutions chosen.

Science Quiz, page 17

Answers: 1. B 2. D 3. C 4. A 5. D

Your Ideas: Students answers will vary, but should reflect an understanding that careful observations must be made to draw valid conclusions.

Space Rocks

Vocabulary Activity, page 23

Students should use the following terms from the article—asteroid, asteroid belt, crater, NEA, and orbit—and add another of their own choosing. The clues and phrases that students use will vary. Evaluate them for accuracy.

Language Arts Activity, page 24

The claims and support students cite will vary, however they should be logically connected.

Science Activity, page 25

Students' responses will vary as some students might cite a specific action as a threat where others see potential value in it. Evaluate responses on their logic and sense.

Science Quiz, page 26

Answers: 1. D 2. A 3. B 4. C 5. D

Your Solution: Answers will vary. Look for logical support in the students' rationales.