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Earth Science

Geology, the Environment, and the Universe

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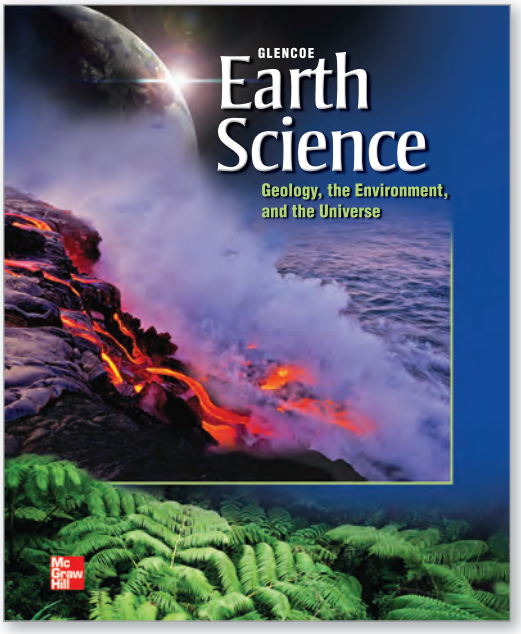

About the Photo

The lava photo on the cover was taken in Hawaii Volcanoes National Park on the Big Island of Hawaii. The lava in the photo is flowing from active vents on the flank of the Kilauea Volcano. When lava flows into the sea, sulfuric acid in the lava mixes with chlorides in the saltwater to form a mist of water vapor and hydrochloric acid.

Cover (earth) Chad Baker/The Image Bank/Getty Images, (lava) Adastra/Taxi/Getty Images, (ferns) Paul Chesley/Photographer's Choice/Getty Images

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STEM

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***A*ccuracy *A*ssurance** is central to McGraw-Hill's commitment to high-quality, learner-oriented, real-world, and error-free products. Also at the heart of our A² Development Process is a commitment to make the text ***A*ccessible** and ***A*pproachable** for both students and teachers. A collaboration among authors, content editors, academic advisors, and classroom teachers, the A² Development Process provides opportunities for continual improvement through customer feedback and thorough content review.

The A² Development Process begins with a review of the previous edition and a look forward to state and national standards. The authors for *Earth Science: Geology, the Environment, and the Universe* combine expertise in teacher training and education with a mastery of science content knowledge. As manuscript is created and edited, consultants review the accuracy of the content while our Teacher Advisory Board members examine the program from the points of view of both teacher and student. Student labs and teacher demonstrations are reviewed for both accuracy of content and safety. As design elements are applied, chapter content is again reviewed, as are photos and diagrams.

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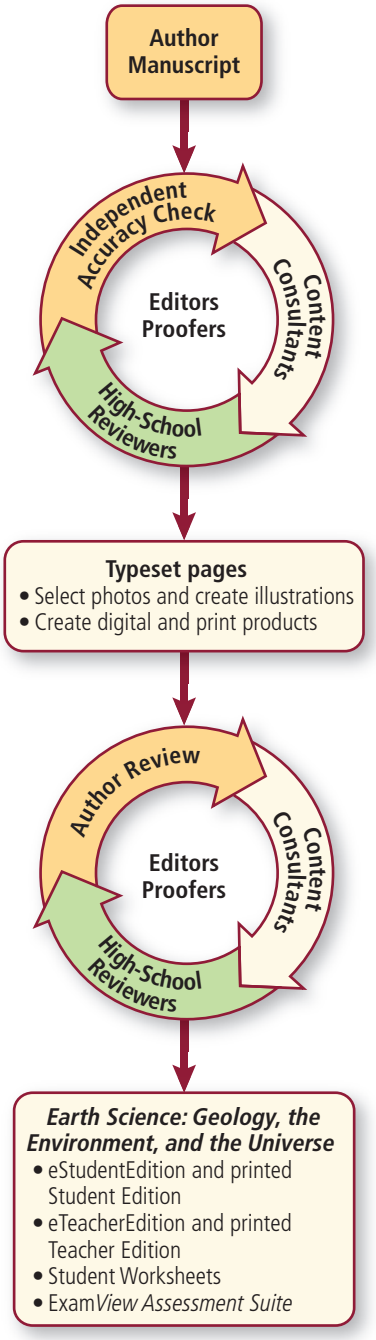

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The authors of *Earth Science: Geology, the Environment, and the Universe* used their content knowledge and teaching expertise to craft manuscript that is accessible and accurate, geared toward student achievement.

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The Teacher Advisory Board gave the editorial staff and design team feedback on the content and design of both the Student Edition and Teacher Edition. We thank these teachers for their hard work and creative suggestions.

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EARTH SCIENCE ONLINE

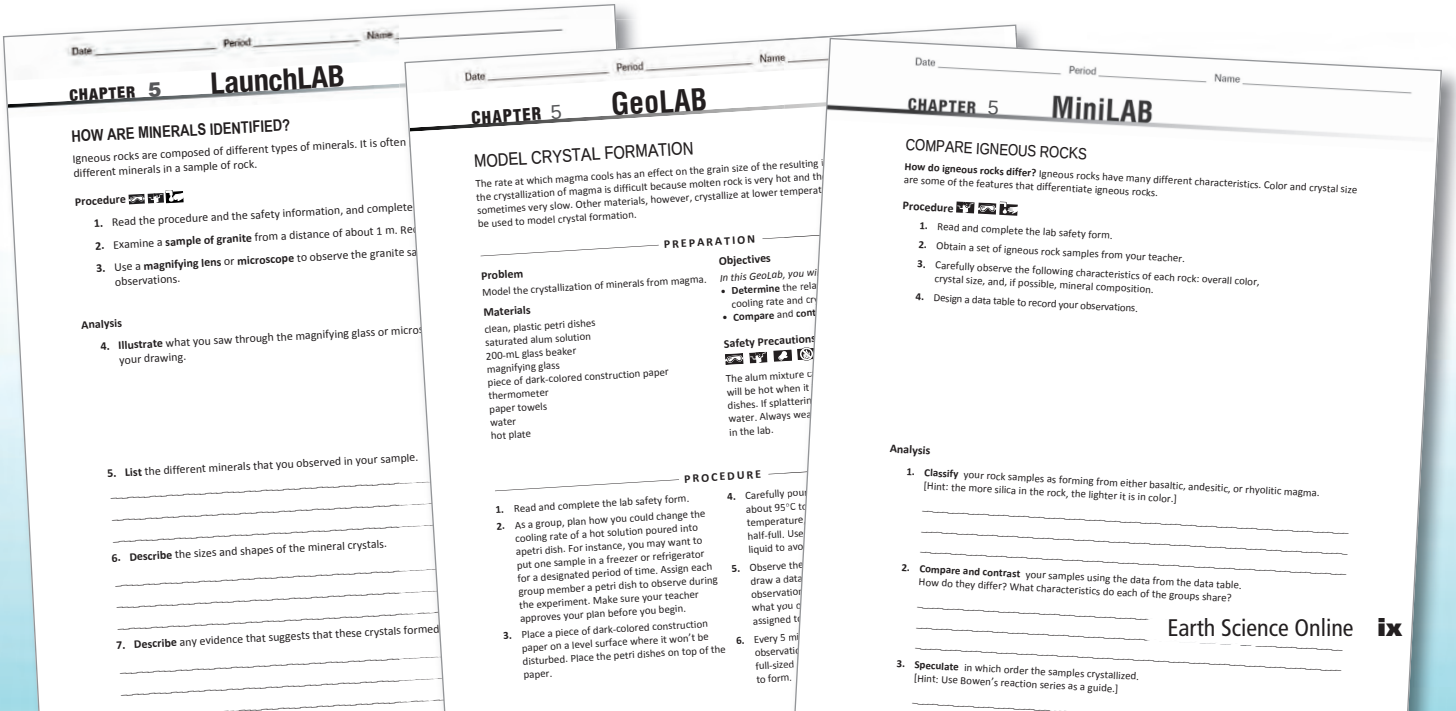
Introducing

iLab Station

At connectED.mcgraw-hill.com, you will find this one-stop online resource for laboratory investigations, procedures, and worksheets. Look for the iLab Station button throughout your eStudentEdition for links to these laboratory experiences:

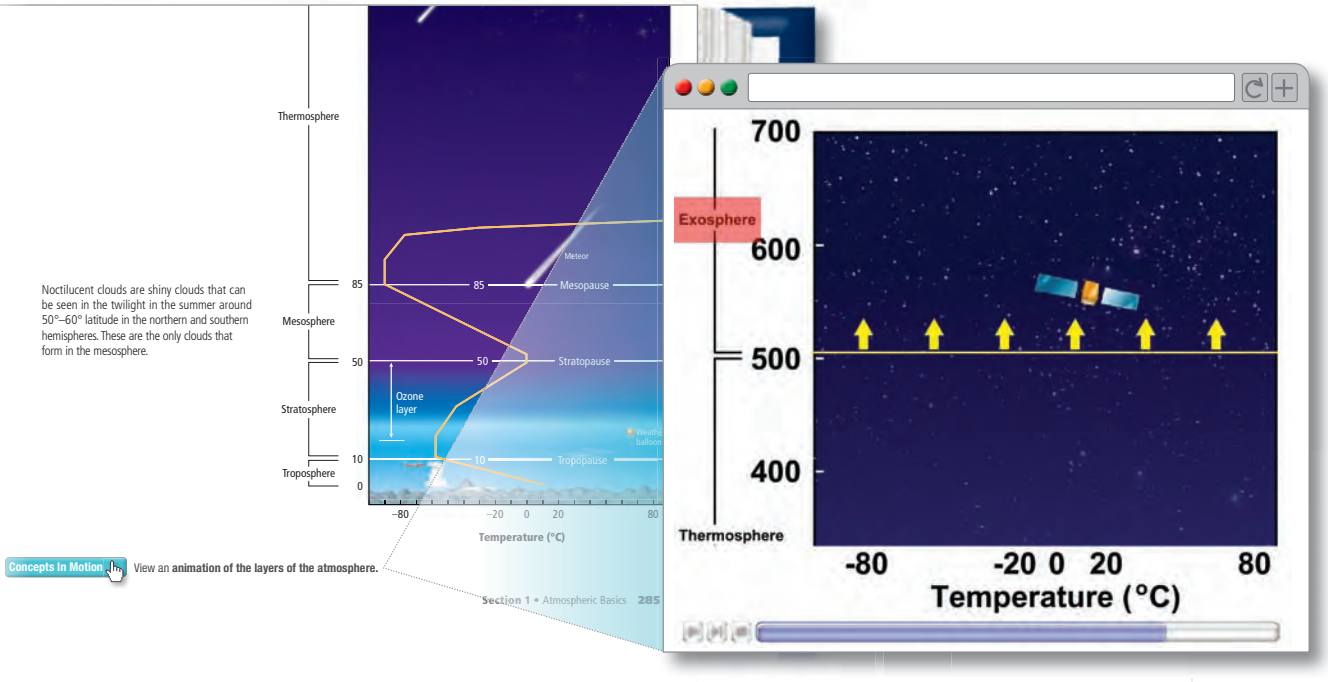
- **LaunchLABs**
- **MiniLABs**
- **GeoLABs**

Online, editable lab worksheets from the iLab Station will let your teacher tailor the content to your specific needs.



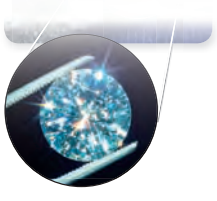
ANIMATIONS & STUDY TOOLS

Animations, assessments, and study tools provide opportunities for self-assessment, review, and additional practice.



Concepts In Motion

See earth science content come to life in **animated figures** and moving diagrams.



Watch a video about gems and minerals.

Video

Section Self-Check

Understand Main Ideas

1. MAIN IDEA **Formulate** a statement that explains the relationship between chemical elements and mineral properties.
2. **List** the two most abundant elements in Earth's crust. What mineral group do these elements form?
3. **Hypothesize** what some environmental consequences of mining ores might be.

Think Critically

4. **Hypothesize** why the mineral opal is often referred to as a mineraloid.
5. **Evaluate** which of the following metals is better to use in sporting equipment and medical implants: titanium—specific gravity = 4.5, contains only Ti; or steel—specific gravity = 7.7, contains Fe, O, Cr.

WRITING IN Earth Science

6. Design a flyer advertising the sale of a mineral of your choice. You might choose a gem or industrially important mineral. Include any information that you think will help your mineral sell.

Section 2 • Types of Minerals 101

Video

Connect Earth science to the real-world with online **videos**.

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"The e-book includes VIDEOS, ANIMATIONS, and tools to help me LEARN."

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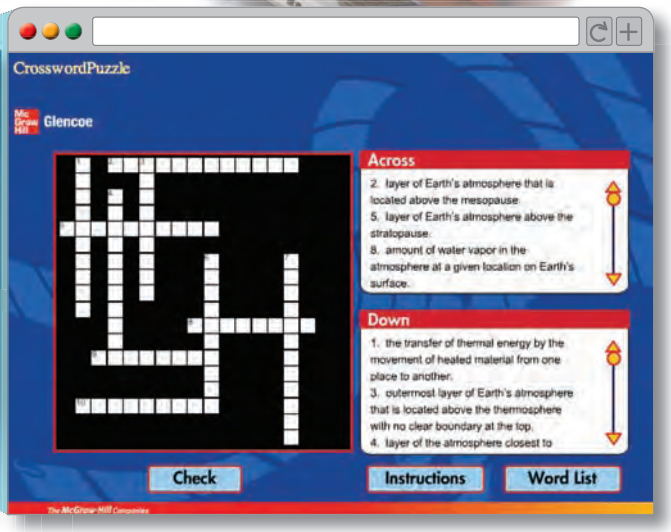
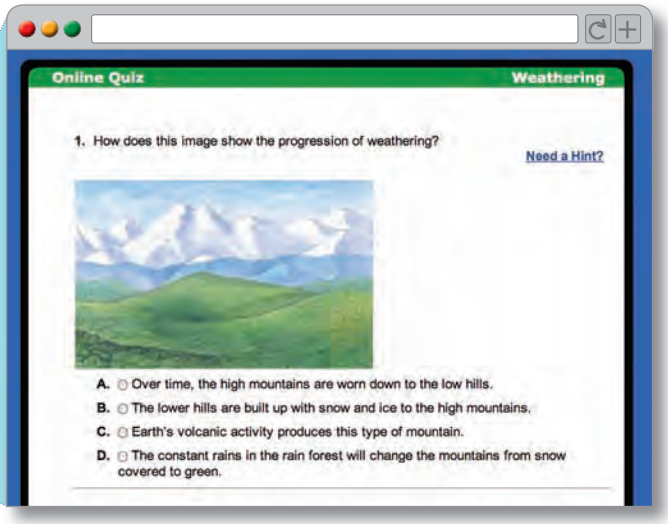


Vocabulary Practice

The **multilingual e-Glossary** and **vocabulary study tools** drive home important concepts.



Self-Check

Review questions for each section and chapter help you spot concepts that require additional study.

REAL-WORLD SCIENCE

Earth Science: Geology, the Environment, and the Universe **connects Earth science to your world. Throughout the text, find personal science connections, surprising examples of Earth science in careers, and connections to the environment.**

SECTION 3

Essential Questions

- What is the difference between stable and unstable air?
- How do low, middle, high, and vertical development clouds differ?
- How does precipitation form?

Review Vocabulary

condensation: process in which water vapor changes to a liquid

New Vocabulary

condensation nucleus
orographic lifting
cumulus
stratus
cirrus
precipitation
coalescence

Clouds and Precipitation

MAINIDEA Clouds vary in shape, size, height of formation, and type of precipitation.

EARTH SCIENCE 4 YOU

If you look up at the sky, you might notice differences among the clouds from day to day and hour to hour. Some clouds signal fair weather and others signal violent storms.

EARTH SCIENCE 4 YOU

at the beginning of each section connects Earth science content to your life.

Cloud Formation

A cloud can form when a rising air mass cools. Recall that Earth's surface heats and cools by different amounts in different places. This uneven heating and cooling of the surface causes air masses near the surface to warm and cool. As an air mass is heated, it becomes less dense than the cooler air around it. This causes the warmer air mass to be pushed upward by the denser, cooler air.

However, as the warm air mass rises, it expands and cools adiabatically. The cooling of an air mass causes water vapor in the air mass to condense. The condensation level is the height at which condensation occurs in an air mass. When a rising air mass reaches the condensation level, water vapor condenses and clouds form, as shown in **Figure 17.** A **condensation nucleus** is a particle in the atmosphere around which water vapor condenses.

Carbon dioxide Carbon dioxide, another variable gas, currently makes up about 0.038 percent of the atmosphere. During the past 150 years, measurements have shown that the concentration of atmospheric carbon dioxide has increased from about 0.028 percent to its present value. Carbon dioxide is also cycled between the atmosphere, the oceans, living organisms, and Earth's rocks.

The recent increase in atmospheric carbon dioxide is due primarily to the burning of fossil fuels, such as oil, coal, and natural gas. These fuels are burned to heat buildings, produce electricity, and power vehicles. Burning fossil fuels can also produce other gases, such as sulfur dioxide and nitrogen oxides, that can cause respiratory illnesses, as well as other environmental problems.

Ozone Molecules of ozone are formed by the addition of an oxygen atom to an oxygen molecule, as shown in **Figure 2.** Most atmospheric ozone is found in the ozone layer, 20 km to 50 km above Earth's surface, as shown in **Figure 3.** The maximum concentration of ozone in this layer—9.8×10^{12} molecules/cm^3—is only about 0.0012 percent of the atmosphere.

The ozone concentration in the ozone layer varies seasonally at higher latitudes, reaching a minimum in the spring. The greatest seasonal changes occur over Antarctica. During the past several decades, measured ozone levels over Antarctica in the spring have dropped significantly. This decrease is due to the presence of chemicals called chlorofluorocarbons (CFCs) that react with ozone and break it down in the atmosphere.

Atmospheric particles Earth's atmosphere also contains variable amounts of solids in the form of tiny particles, such as dust, salt, and ice. Fine particles of dust and soil are carried into the atmosphere by wind. Winds also pick up salt particles from ocean spray. Airborne microorganisms, such as fungi and bacteria, can also be found attached to microscopic dust particles in the atmosphere.

Environmental Connections

point out paragraphs that emphasize real-world environmental applications of Earth science.

CAREERS IN EARTH SCIENCE

Weather Observer A weather observer collects information for meteorologists about weather and sea conditions using weather equipment, radar scans, and satellite photographs. An education that includes biology, Earth science, environmental science, and geology is useful for a weather observer.

WebQuest

Atmospheric stability As an air mass rises, it cools. However, the air mass will continue to rise as long as it is warmer than the surrounding air. Under some conditions, an air mass that has started to rise sinks back to its original position. When this happens, the air is considered stable because it resists rising. The stability of air masses determines the type of clouds that form and the associated weather patterns.

Stable air The stability of an air mass depends on how the temperature of the air mass changes relative to the atmosphere. The air temperature near Earth's surface decreases with altitude. As a result, the atmosphere becomes cooler as the air mass rises. At the same time, the rising air mass is also becoming cooler. Suppose that the temperature of the atmosphere decreases more slowly with increasing altitude than does the temperature of the rising air mass. Then the rising air mass will cool more quickly than the atmosphere. The air mass will finally reach an altitude at which it is colder than the atmosphere. It will then sink back to the altitude at which its density is the same as the atmosphere, as shown in **Figure 18.** Because the air mass stops rising and sinks downward, it is stable. Fair weather clouds form under stable conditions.

READING CHECK **Describe** the factors that affect the stability of air.

Unstable air Suppose that the temperature of the surrounding air cools faster than the temperature of the rising air mass. In these conditions, the air mass will always be less dense than the surrounding air. As a result, the air mass will continue to rise, as shown in **Figure 18.** The atmosphere is then considered to be unstable. Unstable conditions can produce the type of clouds associated with thunderstorms.

Throughout the book,

CAREERS IN EARTH SCIENCE

demonstrates how the chapter content applies to real-world careers.

End-of-chapter features **highlight Earth science as it applies to careers, how it connects to the real world, and what today's scientists are doing to learn more about the planet.**


eXpeditions!

ON SITE: IN THE FOOTSTEPS OF DISASTER

On December 26, 2004, a massive earthquake rattled the seafloor of the Indian Ocean. A tsunami was generated by the earthquake, which devastated the landscape and killed almost 300,000 people in 12 countries. After humanitarian efforts were underway, many Earth scientists mobilized to collect data before the area was changed by cleanup efforts.

WRITING IN Earth Science

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Get an inside look at exciting places and scientists doing real-world Earth science investigations.


Earth Science & TECHNOLOGY

Mapping Disaster Zones

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Discover recent technological advancements that have influenced the field of Earth science.


Earth Science & ENVIRONMENT

Moon Rocks

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Earth Science & ENVIRONMENT

Explore the environmental issues that Earth scientists are working to understand and address.


Earth Science & SOCIETY

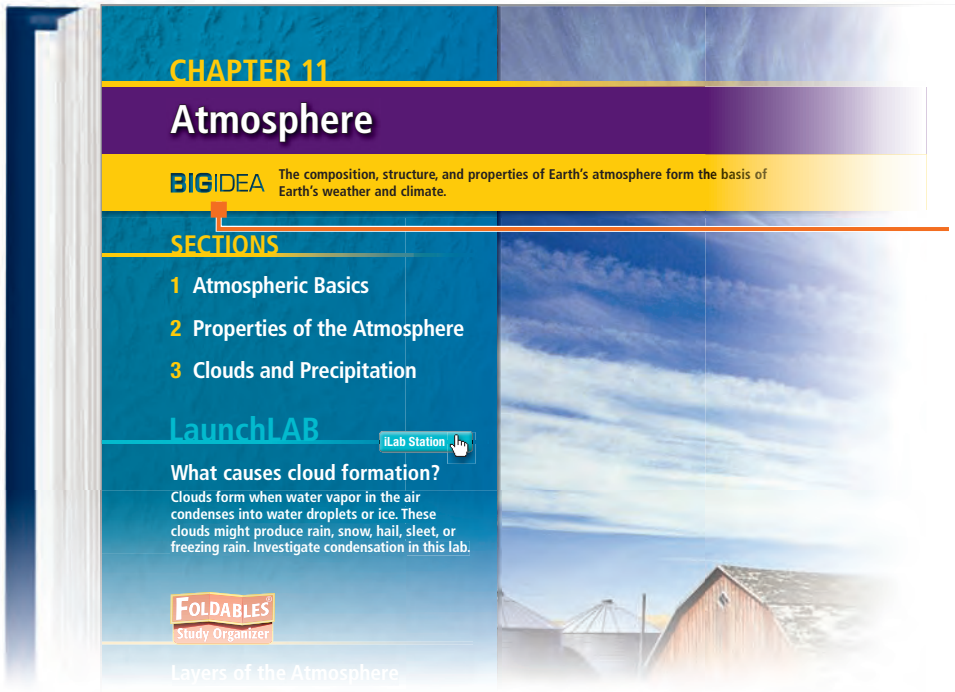
The World of Water

WRITING IN Earth Science

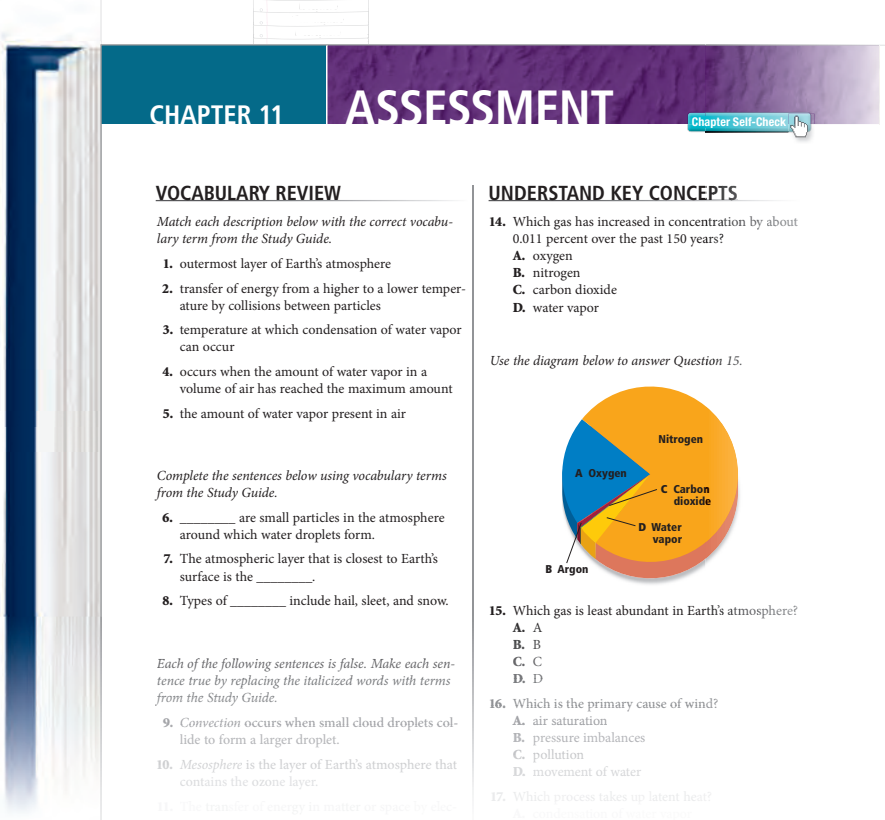
Earth Science & SOCIETY

Learn about Earth science in the news and sharpen your debating skills on complex issues in Earth science.

At the start of each chapter, you will see the BIGIDEA that will help you understand how what you are about to investigate fits into the big picture of science.



The BIGIDEA is the focus of the chapter. The labs, text, and other chapter content will build an in-depth understanding of these major concepts.



The Chapter Assessment will help you evaluate your understanding of the BIGIDEA.

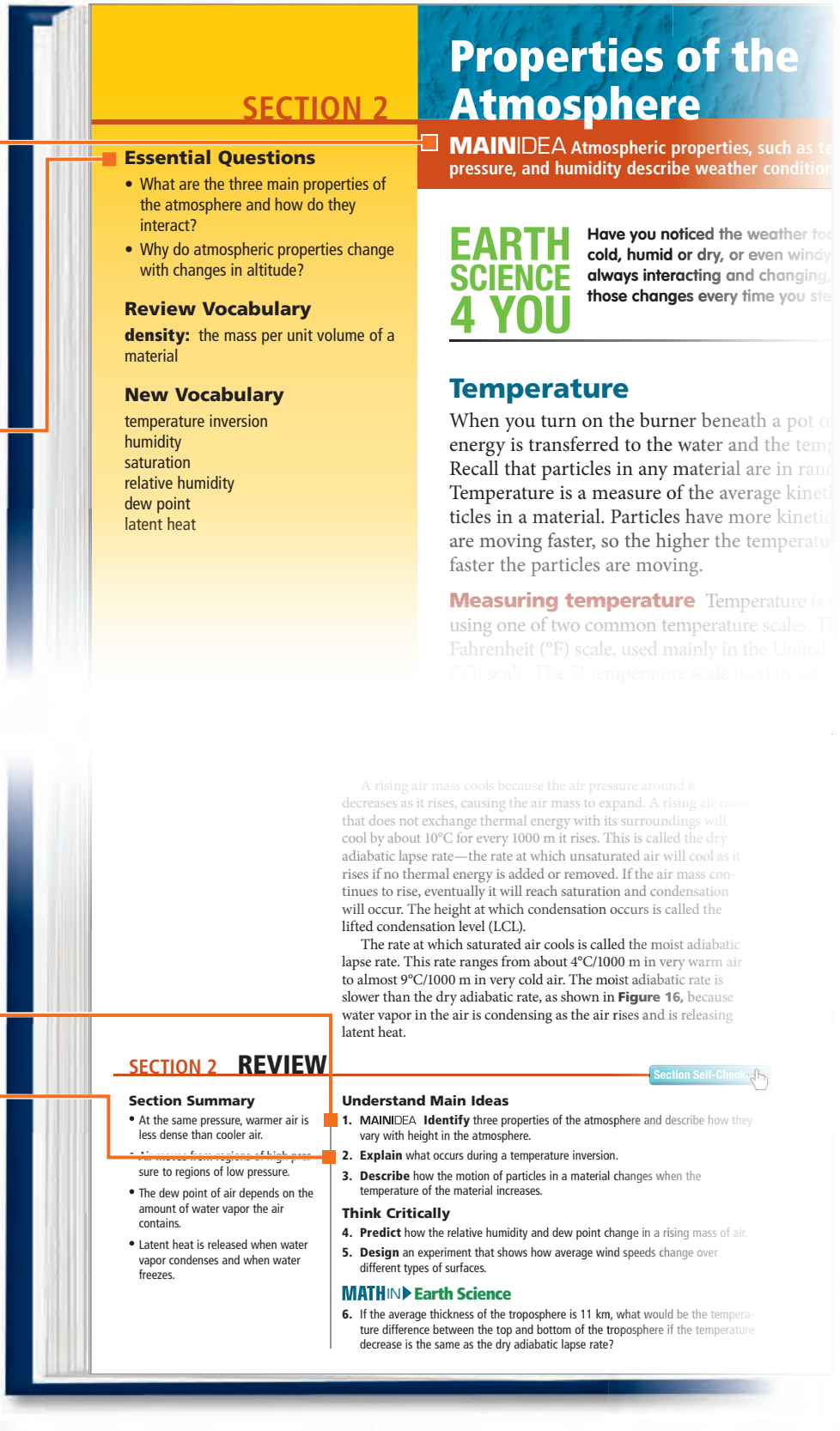
At the start of each section, you will find a reading preview that summarizes what you will learn while exploring the section.

The **MAIN**IDEA is the core concept covered in the section. Together, the Main Ideas from all the sections in the chapter support the chapter's Big Idea.

Essential Questions reflect the important goals of the section. Together, an understanding of these questions will lead toward understanding of the section's Main Idea.

In the Section Review, you will find a question that will help you to assess your understanding of the section's **MAIN**IDEA.

Essential Questions are assessed by the remaining review questions.



SECTION 2

Properties of the Atmosphere

MAINIDEA Atmospheric properties, such as te
pressure, and humidity describe weather condition

Essential Questions

- What are the three main properties of the atmosphere and how do they interact?
- Why do atmospheric properties change with changes in altitude?

Review Vocabulary

density: the mass per unit volume of a material

New Vocabulary

temperature inversion
humidity
saturation
relative humidity
dew point
latent heat

EARTH SCIENCE 4 YOU

**Have you noticed the weather to
cold, humid or dry, or even windy
always interacting and changing,
those changes every time you ste**

Temperature

When you turn on the burner beneath a pot o
energy is transferred to the water and the temp
Recall that particles in any material are in rand
Temperature is a measure of the average kineti
ticles in a material. Particles have more kinetic
are moving faster, so the higher the temperatu
faster the particles are moving.

Measuring temperature Temperature is
using one of two common temperature scales. Th
Fahrenheit (°F) scale, used mainly in the United
(°C) scale. The SI temperature scale used in sci

A rising air mass cools because the air pressure around it decreases as it rises, causing the air mass to expand. A rising air mass that does not exchange thermal energy with its surroundings will cool by about 10°C for every 1000 m it rises. This is called the dry adiabatic lapse rate—the rate at which unsaturated air will cool as it rises if no thermal energy is added or removed. If the air mass continues to rise, eventually it will reach saturation and condensation will occur. The height at which condensation occurs is called the lifted condensation level (LCL).

The rate at which saturated air cools is called the moist adiabatic lapse rate. This rate ranges from about 4°C/1000 m in very warm air to almost 9°C/1000 m in very cold air. The moist adiabatic rate is slower than the dry adiabatic rate, as shown in **Figure 16,** because water vapor in the air is condensing as the air rises and is releasing latent heat.

SECTION 2 **REVIEW**

Section Self-Check

Section Summary

- At the same pressure, warmer air is less dense than cooler air.
- Air moves from regions of high pressure to regions of low pressure.
- The dew point of air depends on the amount of water vapor the air contains.
- Latent heat is released when water vapor condenses and when water freezes.

Understand Main Ideas

1. **MAIN**IDEA **Identify** three properties of the atmosphere and describe how they vary with height in the atmosphere.
2. **Explain** what occurs during a temperature inversion.
3. **Describe** how the motion of particles in a material changes when the temperature of the material increases.

Think Critically

4. **Predict** how the relative humidity and dew point change in a rising mass of air.
5. **Design** an experiment that shows how average wind speeds change over different types of surfaces.

MATH IN Earth Science

6. If the average thickness of the troposphere is 11 km, what would be the temperature difference between the top and bottom of the troposphere if the temperature decrease is the same as the dry adiabatic lapse rate?

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Doug Wilson/CORBIS

Composition of Earth

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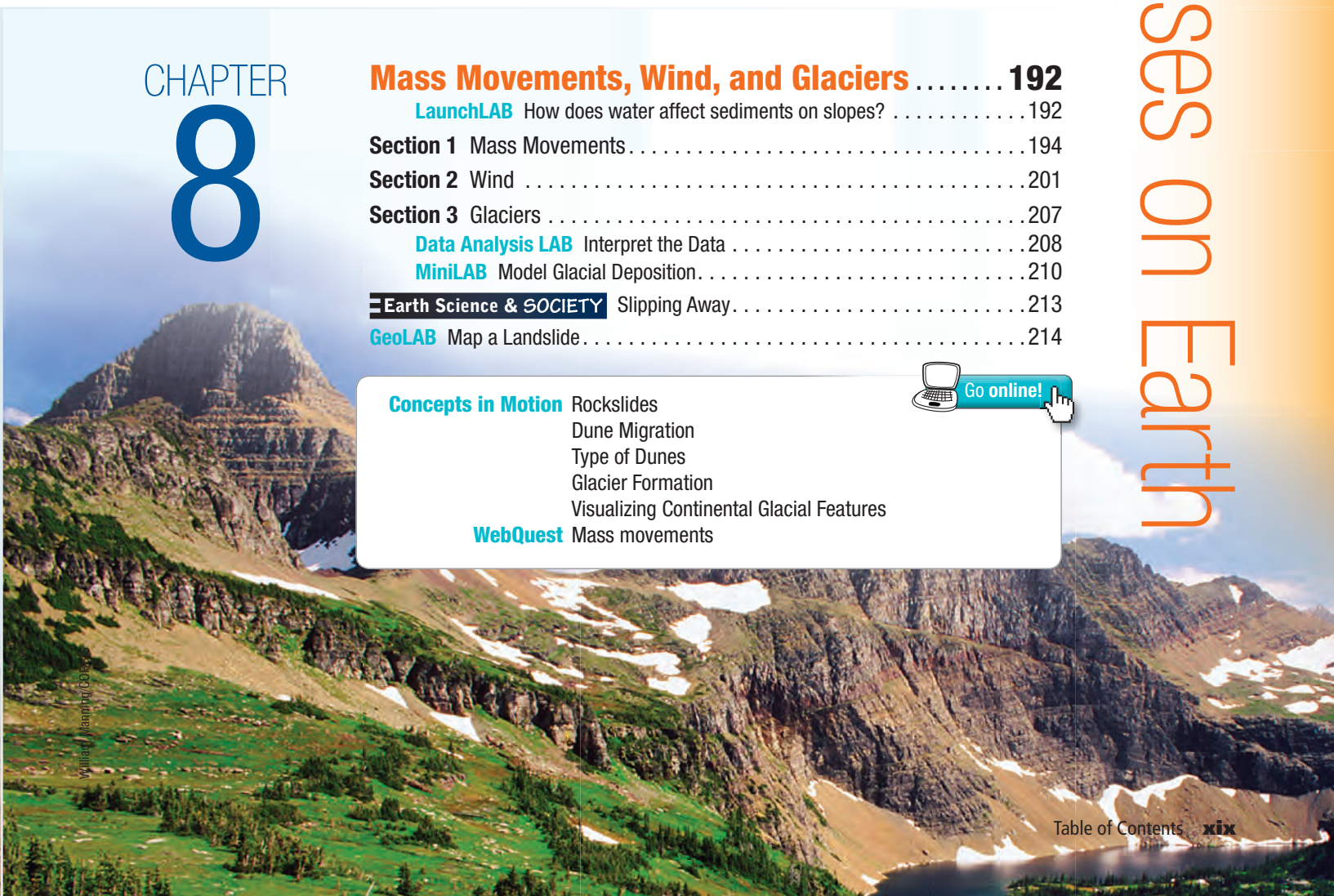

William Manning/Corbis

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G. Grob/zefa/CORBIS

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Karen Kasmauski/CORBIS

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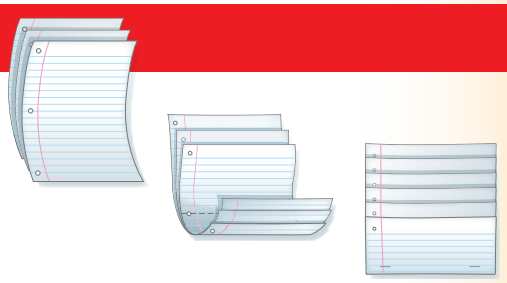
FOLDABLES®

by Dinah Zike

Folding Instructions

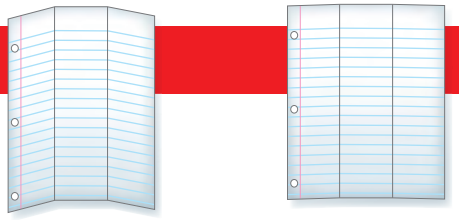
The following pages offer step-by-step instructions to make the Foldables study guides.

Layered-Look Book



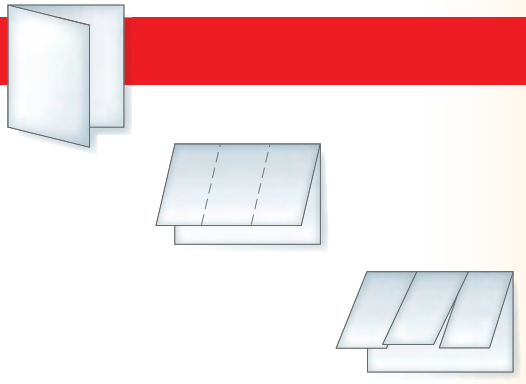
1. Collect three sheets of paper and layer them about 1 cm apart vertically. Keep the edges level.
2. Fold up the bottom edges of the paper to form 6 equal tabs.
3. Fold the papers and crease well to hold the tabs in place. Staple along the fold. Label each tab.

Trifold Book



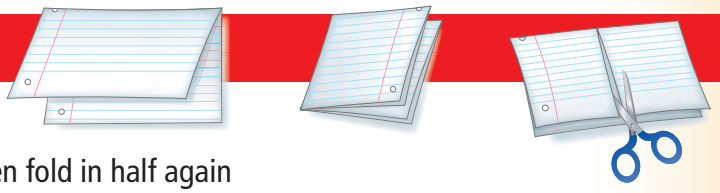
1. Fold a vertical sheet of paper into thirds.
2. Unfold and label each row.

Three-Tab Book



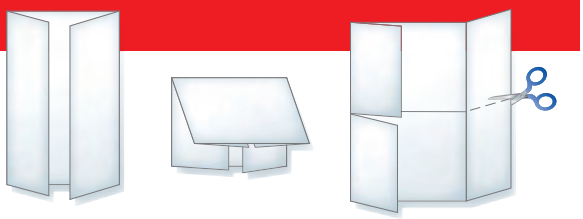
1. Fold a vertical sheet of paper from side to side. Make the front edge about 2 cm shorter than the back edge.
2. Turn length-wise and fold into thirds.
3. Unfold and cut only the top layer along both folds to make three tabs. Label each tab.

Two- and Four-Tab Books



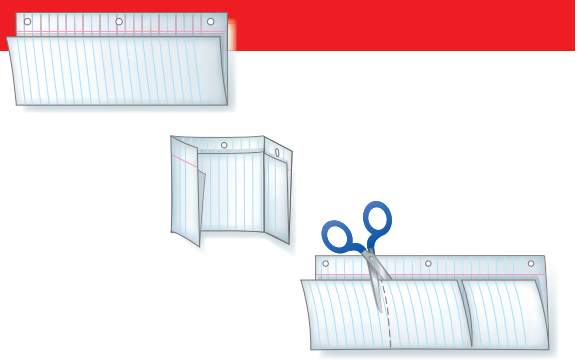
1. Fold a sheet of paper in half.
2. Fold in half again. If making a four-tab book, then fold in half again to make three folds.
3. Unfold and cut only the top layer along the folds to make two or four tabs. Label each tab.

Shutter-Fold and Four-Door Books



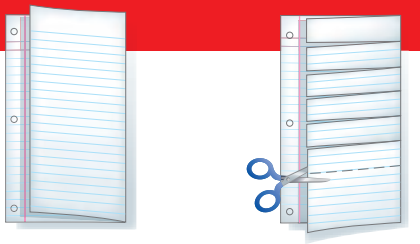
1. Find the middle of a horizontal sheet of paper. Fold both edges to the middle and crease the folds. Stop here if making a shutter-fold book. For a four-door book, complete the steps below.
2. Fold the folded paper in half, from top to bottom.
3. Unfold and cut along the fold lines to make four tabs. Label each tab.

Concept-Map Book



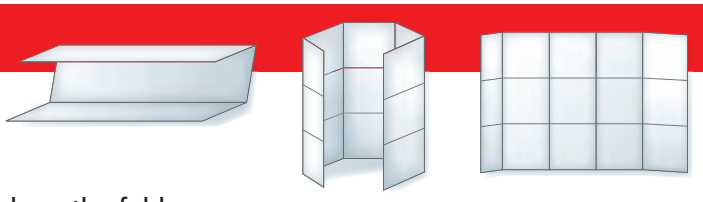
1. Fold a vertical sheet of paper from top to bottom. Make the top edge about 2 cm shorter than the bottom edge.
2. Turn length-wise and fold into thirds.
3. Unfold and cut only the top layer along both folds to make three tabs. Label the top and each tab.

Vocabulary Book



1. Fold a vertical sheet of notebook paper in half.
2. Cut along every third line of only the top layer to form tabs. Label each tab.

Folded Chart

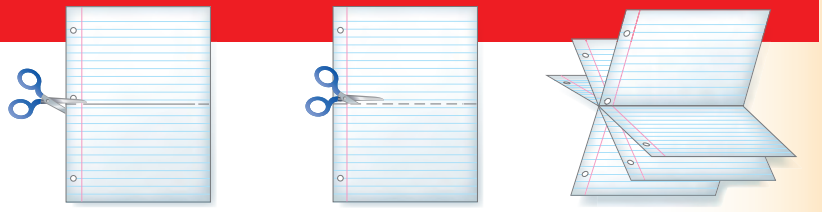


1. Fold a sheet of paper length-wise into thirds.
2. Fold the paper width-wise into fifths.
3. Unfold, lay the paper length-wise, and draw lines along the folds. Label the table.

Pocket Book

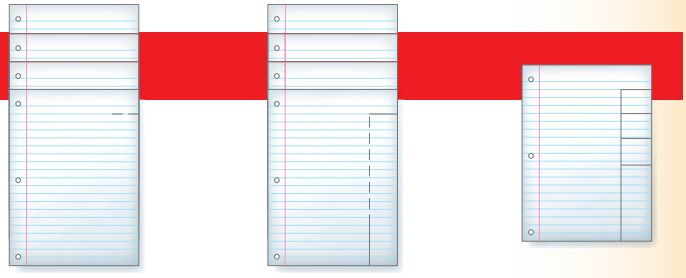
1. Fold the bottom of a horizontal sheet of paper up about 3 cm.
2. If making a two-pocket book, fold in half. If making a three-pocket book, fold in thirds.
3. Unfold once and dot with glue or staple to make two pockets. Label each pocket.

Bound Book



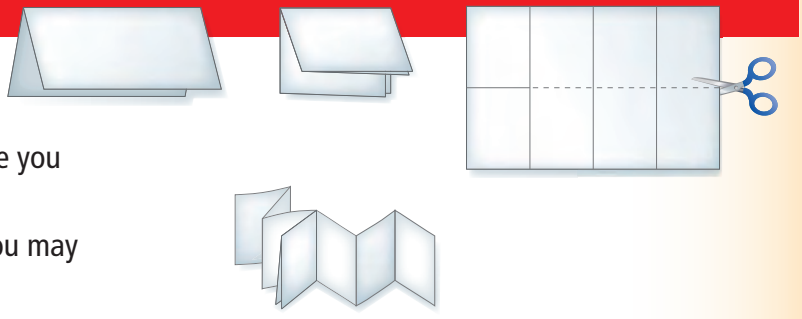
1. Fold several sheets of paper in half to find the middle. Hold all but one sheet together and make a 3-cm cut at the fold line on each side of the paper.
2. On the final page, cut along the fold line to within 3-cm of each edge.
3. Slip the first few sheets through the cut in the final sheet to make a multi-page book.

Top-Tab Book



1. Layer multiple sheets of paper so that about 2–3 cm of each can be seen.
2. Make a 2–3-cm horizontal cut through all pages a short distance (3 cm) from the top edge of the top sheet.
3. Make a vertical cut up from the bottom to meet the horizontal cut.
4. Place the sheets on top of an uncut sheet and align the tops and sides of all sheets. Label each tab.

Accordion Book



1. Fold a sheet of paper in half. Fold in half and in half again to form eight sections.
2. Cut along the long fold line, stopping before you reach the last two sections.
3. Refold the paper into an accordion book. You may want to glue to double pages together.