# **INTRODUCTION** to Gateways

## A Word to the Teacher

### Before You Begin

*Gateways to Science* (*Gateways*) is not just a textbook; it is an instructional program designed around you, your middle school students, and the Texas Essential Knowledge and Skills (TEKS). It includes the structure, organization, balance, and presentation of content to meet the diverse needs of all students in the science classroom. Based 100% on the conceptual development of the state-mandated curriculum, the program promotes student success on the State of Texas Assessments of Academic Readiness (STAAR™), for which you and your students are held accountable.

*Gateways* is based on five guiding principles taken from the recommendations of the National Science Education Standards, the Benchmarks for Science Literacy, and other prominent works in the area of science education.

### Science is for all students.

All students can achieve success in science if given the opportunity. Multiple experiences spaced over several years are required to develop the understanding of most scientific concepts and processes.

### Learning science is an active process that includes both individual and social processing.

Effective science instruction requires both physical and mental activity on a regular and consistent basis. Students must have opportunities to develop understandings by sharing and refining their thinking individually and through peer interactions.

### Students must accept and share responsibility for their own learning.

Teachers must set expectations for each student to take responsibility for his or her work in both individual and group settings.

### Teachers must consistently model the habits of mind necessary for scientific literacy, including values, attitudes, communication skills, and critical thinking.

Curiosity, skepticism, honesty, willingness to communicate, and a strong persistence to think critically and solve problems must all be demonstrated and encouraged by the teacher.

### Curriculum, instruction, and assessment must be aligned.

Teachers must maximize every minute of instructional time by remaining true to a close alignment among the components of curriculum, instruction, and assessment.

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## A Word to the Teacher

### Areas of Study

Each grade level of *Gateways* is divided into four major units of study—

- Matter and Energy
- Force, Motion, and Energy
- Earth and Space
- Organisms and Environments

These four units of *Gateways* are based on the specific reporting categories for the Middle School Science STAAR. Instructional time in *Gateways* is directly proportional to the number of items per STAAR objective as displayed in the table below.

| Middle School Science STAAR Reporting Category | Number of Items on STAAR |
|---|---|
| (1) Matter and Energy | 14 |
| (2) Force, Motion, and Energy | 12 |
| (3) Earth and Space | 14 |
| (4) Organisms and Environments | 14 |
| Scientific Investigation and Reasoning | Embedded within the categories. |

| Gateways Unit | Weeks of Instruction |
|---|---|
| Matter and Energy | 10 |
| Force, Motion, and Energy | 5 |
| Earth and Space | 13 |
| Organisms and Environments | 3 |
| Embedded throughout every 5 E lesson of every unit. | |

## Student Edition

The lessons in the student edition are organized in a five-step learning sequence called the 5 E Model of Instruction. This sequence has proven to be a successful way for all students to actively learn science as well as other content. The model suggests that students rely on both prior experiences and firsthand knowledge gained from new explorations whenever they learn something new or understand something familiar in greater depth.

### Engage

The first E introduces students to a new lesson. During these brief activities, students will make connections between something they learned in the past and something new they are about to learn. Students bring prior knowledge about how the world works, but it is sometimes based on limited experiences and sometimes on misconceptions.

### Explore

The second E has students actively explore what they are learning. Students work as a team to plan, share, and discuss ideas as they learn about the topic. These activities are often, but not always, lab investigations. Experiences must occur before explanations. Students acquire a common set of experiences that allow them to help each other understand the concept through social interaction.

### Explain

The third E puts students into meaningful discussions with their peers and teacher. After sharing information, students revise their thinking and record a science notebook entry that reflects their new understanding. When students engage in meaningful discussions with other students and the teacher, they can pool their explanations based on observations, construct new understandings, and have a clear focus for additional learning.

### Elaborate

The fourth E has students apply or broaden their knowledge by using it in a different situation. These activities include making products, reading to learn, and additional lab investigations. Providing additional active learning opportunities for students to incorporate into their mental construct allows them to confirm and expand their understanding.

### Evaluate

The fifth E gives students an opportunity to show what they have learned and are able to do. These activities allow both the student and the teacher to monitor and reflect on progress. In learner-centered instruction, it is important for students to be aware of their own progress as an outcome of instruction.

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Throughout *Gateways,* students are required to maintain a written science notebook or interactive notebook. The student edition asks students to record their thoughts, observations, collected data, drawings, and other information on a regular basis.

The back of the student edition includes an appendix that provides information and scoring rubrics for many of the learning strategies that are employed throughout the 5 E lessons.

## Instructional Strategies

*Gateways* uses active, varied instructional approaches during the units of study. Students learn the "whys and hows" of science rather than just the "whats and whens." The built-in variety of instructional strategies helps motivate both teachers and students, while the built-in consistency of the lesson structure provides a familiar, nonthreatening learning environment.

### Strategies for Activating Prior Knowledge

#### Brainstorming

Brainstorming is a process used to generate ideas for individuals or for groups. There are no "dumb ideas." Sometimes seemingly foolish ideas serve as a catalyst for other ideas. Brainstorming is not a debate, and it is not an evaluation of ideas. The quantity of brainstormed ideas is more important than the quality.

Possible organizational strategies to involve everyone in the process:

- Teacher announces that everyone must generate three ideas on three separate sticky notes. Sticky notes are brought into a small-group discussion; all ideas are added to the group's list.
- A round-robin session involves every student contributing one idea to a group listing. Students may have permission to pass after the first round and the session continues until all group members have passed during a round.

Useful guidelines for brainstorming (Harmin, 1994):

- Accept every idea without judgment. Unusual ideas may generate new and valuable ideas.
- Write all ideas as they are offered. No judgment is involved at this point. Keep open minds during brainstorming.
- Generate ideas quickly. High energy and quick pace can lead to creativity and unusual ideas. If ideas are generated too fast for one recorder, utilize two or more recorders alternating writing during the process.

#### Mental Imagery

Research shows that engaging students in the creation of nonlinguistic representations stimulates and increases activity in the brain. The most direct way to generate nonlinguistic representation is to simply create a mental picture (Marzano, Pickering, & Pollock, 2001).

## Strategies for Creating Learner-Centered Instruction

### Stations

Classroom design and arrangement can directly facilitate or interfere with the learning climate in the classroom. Good spatial definition can help students feel secure by specifying for them where the structured learning areas begin and end. The spatial definition can define circulation patterns in the room during lab investigations, which also can define appropriate interaction patterns and help to guide students' work and behaviors. The way the stations are designed can ease the transition from one instruction activity to another.

Stations can be arranged visually to focus students' attention by—

- Using labels and signs to designate areas
- Using colors to attract visual attention and define spaces
- Taping lines on the floor or wall to define different work areas
- Moving furniture to define spatial boundaries
- Displaying group work, like a poster, to designate that group's space

Stations set up in the classroom should be arranged so that students have easy access to each other, to the teacher, and to the materials they need for the specific learning assignment (Johnson, Johnson, & Holubec, 1994).

### Cooperative Learning

Cooperative learning involves students working together to find success by accomplishing shared goals and involves students separated into small groups. The small groups work to increase each student's learning as well as the group's learning. Cooperation among students supports retention, motivation, task focus, achievement, and higher level thinking and reasoning. Working together, students develop a group relationship that is personal, social, and academic. Group work strengthens social competencies, supports student self-esteem, and enhances an individual's ability to cope with stress and adversity (Johnson et al, 1994).

Traditional cooperative learning in the science classroom involves students working together to achieve a common success. The group shares a common purpose that motivates each member beyond individual interests. Group members hold one another accountable for the quality of work accomplished. Group members promote each other's success by helping, explaining, and sharing. Group members are required to develop social skills to work effectively as a team. Groups can analyze how effectively goals are accomplished and can often summon the necessary motivation to increase the quality of learning. Ultimately, grouping encourages students to perform at a higher academic level than they probably would have if they were to work alone.

## Lab Grouping

Students should be assigned to groups when they work together. One of the main reasons to use grouping is to ensure that each student actively participates (Johnson et al., 1994). Some decisions that must be made about lab groups:

Determining the size of the group—

- Shorter time periods need small groups.
- Available materials or the specific nature of investigation may determine group size.
- Four students in a lab group support 12 interactions and help with role assignments:
    - Principal investigator: leads discussion to maintain group's focus and brings group to consensus
    - Materials manager: obtains and returns materials
    - Recorder: maintains group's written record; makes sure others keep individual records when needed
    - Reporter: presents group's work
- With fewer than four students, the reporter/recorder roles can merge; with more than four students, several can serve as recorders.

Assigning students to lab groups—

- A decision must be made to group homogeneously or heterogeneously.
- Advantages to heterogeneous grouping:
    - Multiple perspectives and problem-solving methods
    - Increased cognitive disequilibrium to stimulate learning
    - More frequent give-and-take of explanations
    - Enhanced quality of reasoning and discussion
    - Increased long-term retention
- Heterogeneous groups are often randomly assigned but can be teacher organized to maximize specific effects to accommodate isolated students, at-risk learners, disruptive behaviors, etc.

Keeping lab groups together—

- Over the course of a semester, students should have the opportunity to work with different classmates within a lab group.
- Groups should remain stable long enough to at least complete the specific lab tasks and recognize success.
- Students can be told that grouping assignments will change and that they will ultimately have the opportunity to work with everyone, or nearly everyone, in the class.

## Jigsaw/Expert Group

Jigsaw is a cooperative learning activity in which each student in a group is assigned a task to complete for the group. Each student becomes an "expert" on the designated portion of the topic or concept. Just as in a jigsaw puzzle, each piece is needed for completion of the puzzle. Each student's input is also essential for completion and full understanding of the learning experience.

## Think-Pair-Share

Students may pose a question or pick a topic, or the topic may be chosen by the teacher and presented to the students (Kagan, 1989). Students are directed to:

- Think about what you know. Write it down.
- Pair with a partner to share what you know and gain more information. Write it all down.
- Share with the whole group. Make a group listing of what is known.

## Gallery Walk

A gallery walk is a learner-centered activity that can be used in a variety of ways. It can be used as a connection to learning, a review activity, or a closing celebration. A gallery walk connects students to the learning experience in interactive ways. The teacher assigns a direction to move and the activity can be done as individuals or in small groups. Music is optional as students walk around the room to record responses or observations.

## Anticipation Guide

Anticipation guides (Herber, 1978; Buehl, 2009) are an effective way to activate prior knowledge about a concept before reading a selection. Based on past experiences, students respond to several statements that are related to the concept or reading selection. Students either agree or disagree with each statement prior to reading and are able to explain their choices with a partner or a group. This strategy provokes students' curiosity to find out if they are correct or wrong and to investigate further through reading the selection. After reading, students go back to the statements to decide whether or not they still agree with their original choices. These guides can be used with a variety of learning materials, including video clips.

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### Strategies for Organizing Information

Learning is more powerful when students routinely take information presented in one format and represent it in an alternative way. Learning and retention can be improved by integrating information from both the verbal and the visual-spatial forms of representing and organizing information.

### Concept Mapping

A concept map visually displays information by using main ideas and labeled lines. The concept map identifies relationships between important ideas and concepts, and it demonstrates a deeper, conceptual student understanding. Many students find it easier to make sense of information when it is presented in a visual format. The concept map can help students to organize information by compressing, focusing, identifying connections, and supporting interpretation.

- Select a unit of work for concept mapping.
- Identify the major/minor concepts. Each concept may be put onto a separate piece of paper in order to rearrange them.
- Rank the concepts from most general to most specific.
- Arrange the most general concept at the top.
- Link this concept to the most specific concepts using straight lines.
- Label all lines with linking words that explain the relationship. Maps usually, but not always, read from top to bottom.
- Crosslinks can be used to show even more connections and relationships (Skoog & Lien, 1988).

### Notebooking

Keeping a science notebook is an effective way for students to save information about experiences for future use and provides a way for students to reflect upon those experiences (Marcarelli, 2010). The process of notebooking:

- Creates a space for students to reflect about experiences and encourages insight into activities
- Allows students opportunities to create
- Encourages students to process what they are learning
- Allows for students' free flow of ideas and feelings
- Gives a broader perspective over time and encourages students to reread and identify recurring themes
- Provides students with a safe format to communicate in a healthy and constructive way
- Involves student expression and exploration of thought

An interactive notebook is another tool students use in activating prior knowledge, recording learning experiences, and revising their thinking about the topic or concept. The input is the content learned, and the output is reflective thought gained through learning experiences. Benefits of the use of interactive notebooks are developing students' thinking skills, increasing communication, and differentiating instruction (Marcarelli, 2010).

### Venn Diagrams and T-Charts

Having students identify similarities and differences among concepts being learned enhances their understanding of and ability to use knowledge (Marzano et al., 2001). The use of a simple T-chart to have students organize their initial thinking while identifying the similarities and differences can be useful. A more sophisticated graphic called a Venn diagram has students display the similarities between elements in the intersection between two overlapping circles. The differences are placed in the parts of each circle that do not intersect.

### Physical Models, Simulations, and Drawings

In general, physical models are concrete representations of knowledge, while simulations are representations of a process. Drawings may represent knowledge, process, or both. Models, simulations, and drawings are powerful ways to generate nonlinguistic representations in the mind. Each time students engage in transferring information into a new format that makes their thinking visible to others, their understanding increases.

### Digital Cameras in the Science Classroom

Digital cameras can serve several purposes in the science classroom. To help students build vocabulary skills, have students take photographs to represent science terms being studied. Or introduce photos to students, asking them to identify science terms represented in images. Digital cameras can be used as data collection devices and as tools for creating digital collections of items such as leaves or insects.

## Teacher Edition

Teacher pages include a materials list, basic instructions for each lesson, facilitation questions and answers, hints and suggestions for implementation, snapshot visuals of handouts and reproducible masters from the Teacher Resource CD, and answers to the questions and activities in the student edition. Pages from the student edition are embedded throughout the lesson to allow for ease of use when observing directives and activities. The *Gateways* Features page illustrates these components.

## Teacher Resource CD

The CD included with each teacher edition of *Gateways* includes reproducible masters, lab station cards, manipulatives, and handouts for student distribution. Reproducible masters for assessments are also located on the CD. Assessments include Curriculum-Based Assessments (CBAs) that follow each unit. CBAs are written to both address the specific curriculum learned during a particular unit of study and spiral back to reinforce development of scientific investigations and reasoning skills.

# **INTRODUCTION** to Gateways

## *Gateways to Science* Features


### Safety Alert Icon
reminds teacher and students of safe lab practices.

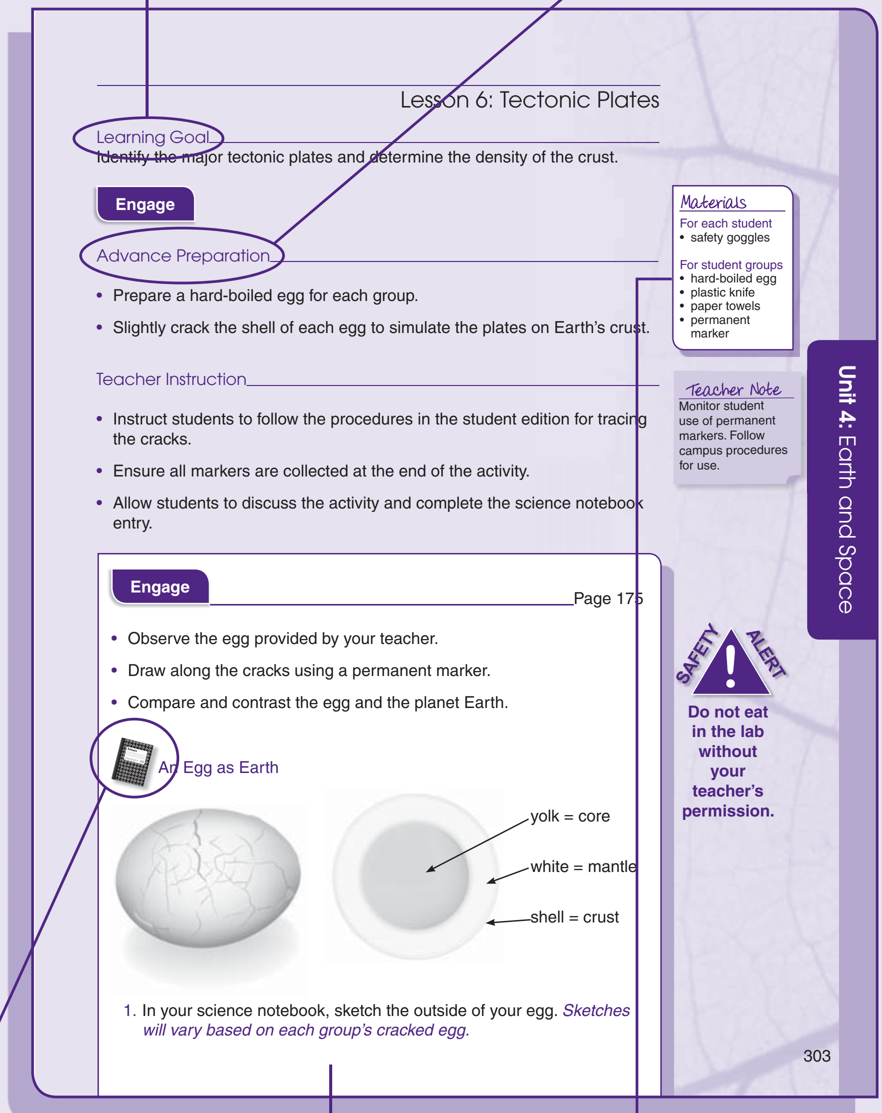

### Lab Rotation Icon
signals students to prepare for lab station activities.

### Stations


### Station Descriptors
summarize for students lab activities by station.

### Learning Goal
provides a brief outlook of lesson purpose.

### Advance Preparation
allows for preplanning to ensure lesson goes smoothly.



Lesson 6: Tectonic Plates

Learning Goal

Identify the major tectonic plates and determine the density of the crust.

**Engage**

Advance Preparation

- Prepare a hard-boiled egg for each group.
- Slightly crack the shell of each egg to simulate the plates on Earth's crust.

Teacher Instruction

- Instruct students to follow the procedures in the student edition for tracing the cracks.
- Ensure all markers are collected at the end of the activity.
- Allow students to discuss the activity and complete the science notebook entry.

Materials
For each student
- safety goggles

For student groups
- hard-boiled egg
- plastic knife
- paper towels
- permanent marker

Teacher Note
Monitor student use of permanent markers. Follow campus procedures for use.

**Unit 4:** Earth and Space

**Engage** Page 175

- Observe the egg provided by your teacher.
- Draw along the cracks using a permanent marker.
- Compare and contrast the egg and the planet Earth.

An Egg as Earth

yolk = core
white = mantle
shell = crust

1. In your science notebook, sketch the outside of your egg. *Sketches will vary based on each group's cracked egg.*

SAFETY ALERT
**Do not eat in the lab without your teacher's permission.**

303

### Science Notebook Icon
quickly indicates the need for students to use a science notebook.

### Student Pages
are embedded in all lessons for ease of use and include answers to student edition.

### Materials List
aids in lesson preparation.

## UNIT 2: Matter and Energy

Lesson 7: Elements and Their Symbols

### Facilitation Questions

- What method was used to find the volume of the ring? *The displacement method was used to find the volume of the ring.*
- What is a pure substance? *A pure substance is not mixed with any other substance.*
- What other properties can you use to describe pure gold? *Accept appropriate answers. Some answers might include solid, yellowish, metal.*

**Facilitation Questions** assist in guiding and scaffolding instruction.

**Materials**

For student groups

- RM 14
- small, labeled resealable plastic bag
- large plastic resealable bag containing the following items:
  - list of items found in the bag (*RM 14*)
  - piece of aluminum foil
  - iron nail
  - copper wire
  - zinc tack (can be purchased at a hardware store)
  - lead weight (can be purchased from the fishing department)
  - piece of sulfur (see note)
  - plastic spoon
  - paper towel
  - eraser
  - cotton ball
  - marker
  - plastic toy
  - golf ball
  - branch or twig
- chart paper
- markers

**Explore**

**5 Es** are clearly labeled to help keep track of lesson progress.

### Advance Preparation

- Place sulfur in a small, labeled resealable plastic bag, such as a jewelry bag, before placing into the large resealable plastic bags.
- Prepare large resealable plastic bags with items listed on *RM 14: List of Items in Bag*.

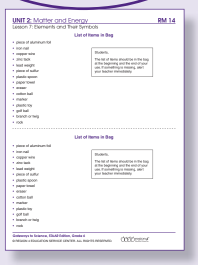
### Teacher Instruction

- Place students in groups of 2–3.
- Instruct students to complete the science notebook entry.
- Monitor student groups and redirect as needed.
- Display student charts so that students can move around the room and read other groups' charts during a gallery walk.
- Instruct students to leave their science notebooks at the table and move as a group to the next group's table to observe their classification and justification. Students should not write on their poster or make any changes.
- Allow students 1–2 minutes at each poster. Continue alerting students to move to the next group until they return to their original seat.

**Teacher Note**

Check with the school nurse to make sure no students are allergic to sulfur.

**Teacher Note** provides helpful tips and information.




82

## UNIT 2: Matter and Energy

Lesson 7: Elements and Their Symbols

**Materials**

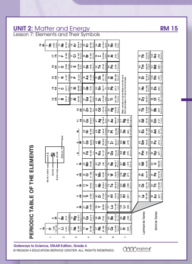
For each student

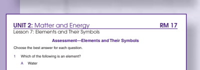
- RM 15
- RM 17

**Evaluate**

### Teacher Instruction

- Provide students with *RM 15: The Periodic Table* to use during the assessment.
- Instruct students to complete *RM 17: Assessment—Elements and Their Symbols.*




### RM 17 Answer Key

1. D
2. G
3. A
4. H
5. A

**Reproducible Master (RM) Snapshots and Answer Keys** offer an at-a-glance view. RM Answer Keys are placed in lesson to reduce the amount of printed materials.

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