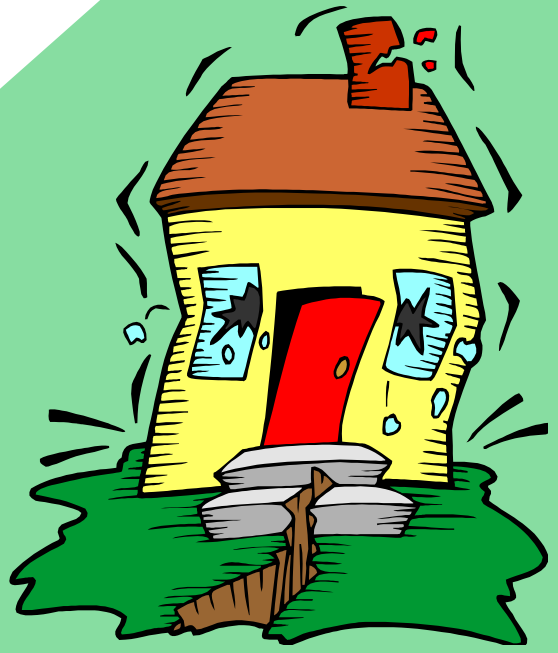
EARTHQUAKES

CHAPTER 6



THE BIG IDEA

Earthquakes cause seismic waves that can be devastating to humans and other organisms.

Lesson 1: Earthquakes and Plate Boundaries

- **Most earthquakes occur at plate boundaries when rocks break and move along faults.**

Lesson 2: Earthquakes and Seismic Waves

- **Earthquakes cause seismic waves that provide valuable data.**

Lesson 3: Measuring Earthquakes

- **Data from seismic waves are recorded and interpreted to determine the location and size of an earthquake.**

Lesson 4: Earthquake Hazards and Safety

- **Effects of an earthquake depend on its size and the types of structures and geology in a region.**

LESSON 1: EARTHQUAKES AND PLATE BOUNDARIES

Most earthquakes occur at plate boundaries when rocks break and move along faults.

What you'll learn:

- **Explain what an earthquake is.**
- **Describe how faults and earthquakes are related.**
- **Understand that most earthquakes occur at plate boundaries.**

So What?!

Understanding what causes earthquakes helps scientists identify where they are likely to occur in the future.

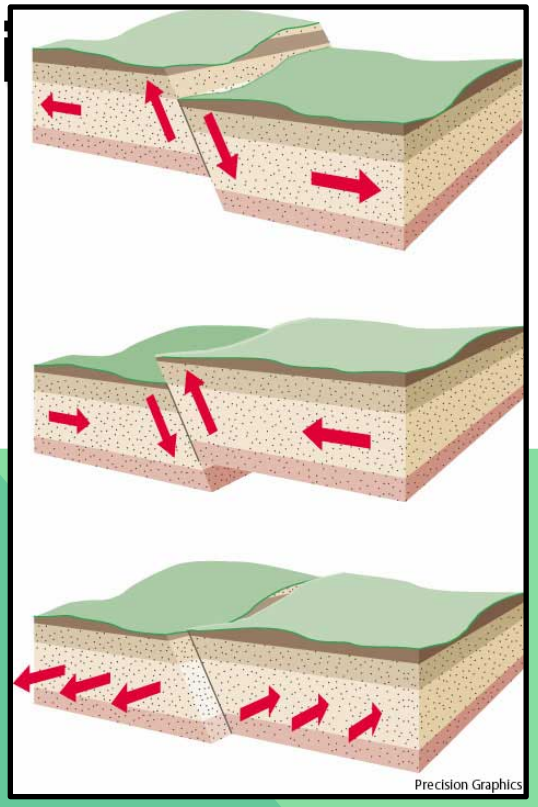
REVIEW VOCABULARY

fault **A fracture in rock along which rocks on one side have moved relative to rocks on the other si**

Normal

Reverse

Strike-Slip



S.A.F.

NEW VOCABULARY

Earthquake	**Rupture and sudden movement of rocks along a fault.**
Elastic Strain	**Energy stored as a change in shape.**
Focus	**Place on a fault where rupture and movement begin.**

ACADEMIC VOCABULARY

Interact **To act on each other**

*** Lithospheric plates interact at different boundaries and produce earthquakes.**

WHAT IS AN EARTHQUAKE?

Sequence the changes in energy that occur leading up to an earthquake.

Heat energy moves through Earth's mantle by convection.

↓

Some of the heat energy is transformed into kinetic energy.

↓

Kinetic energy is stored as elastic strain.

↓

When rocks cannot change shape anymore, faults break.

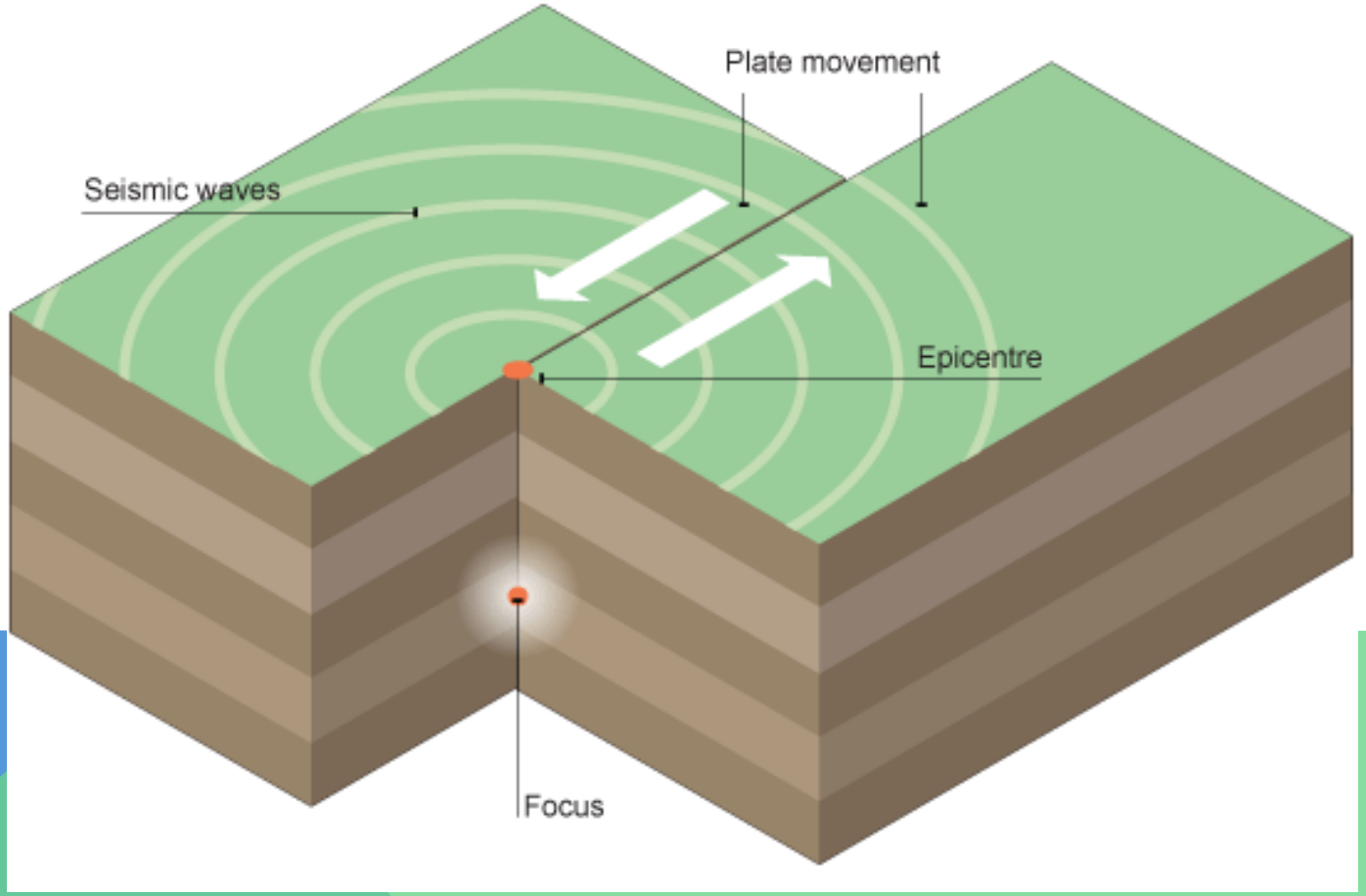
WHAT IS AN EARTHQUAKE?

Summarize what happens after elastic strain builds up in rocks.

When elastic strain builds up, rocks rupture where they are weakest **. Either** a new fault will form **, or the rupture will occur** along an older fault **.**

WHAT IS AN EARTHQUAKE?

Model the spread of seismic waves from the focus of an earthquake. Use arrows to show how waves spread.



SUMMARIZE IT!

Summarize the two main ideas of the above sections.

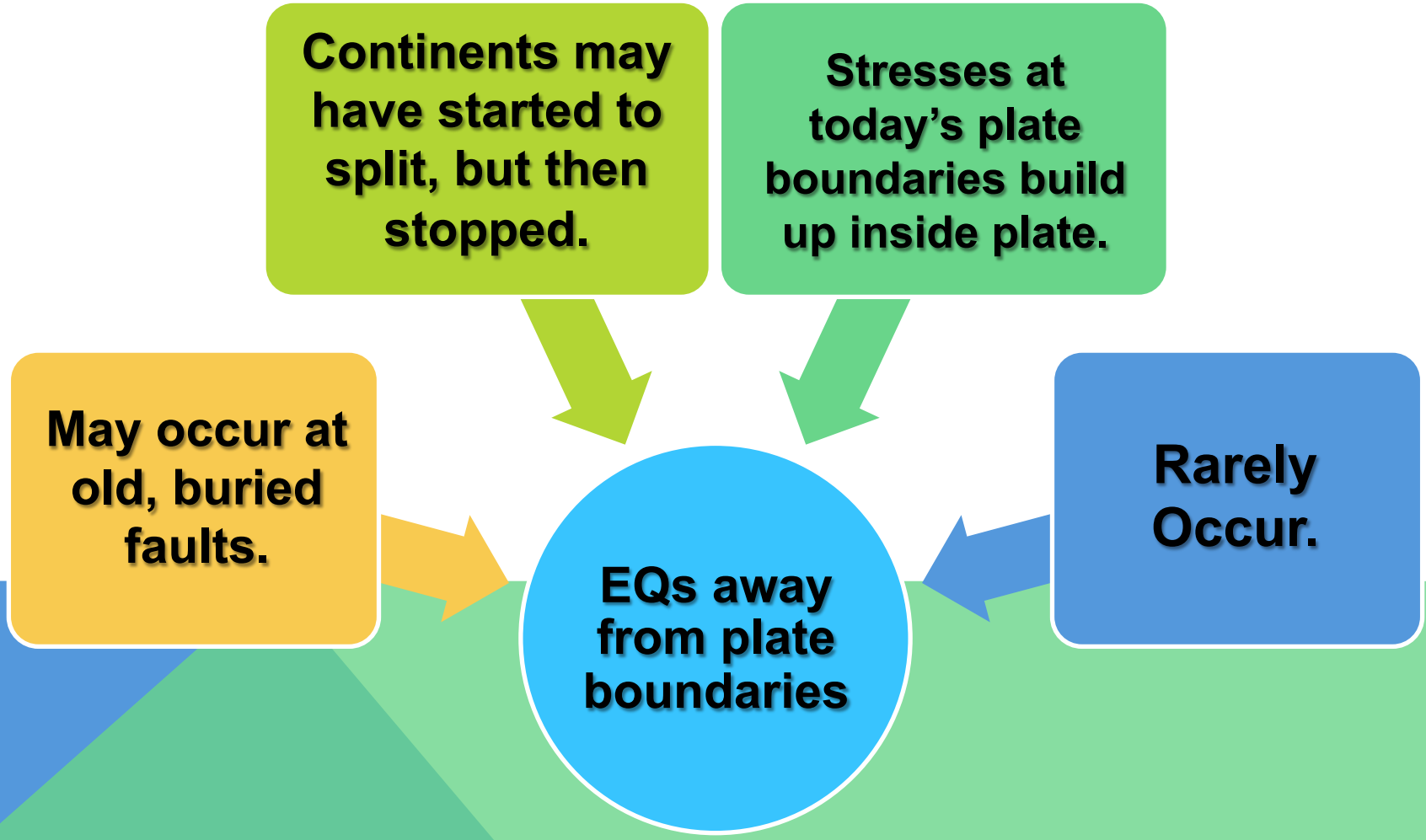
PLATE BOUNDARIES & E.Q.s

Distinguish between the types of earthquakes that occur at each type of plate boundary.

	Divergent Boundary	Convergent Boundary	Transform Boundary
Type of Stress	tension	compression	shear
Type of Fault	normal	reverse	Strike-slip
Magnitude of Earthquake	Relatively small	Largest; most devastating EQs	Can be severe

PLATE BOUNDARIES & E.Q.s

Organize information about earthquakes that occur away from plate boundaries. Complete the concept map.



SUMMARIZE IT!

Summarize the main ideas of the above section with two bullet points.

LESSON 1 Review

Summarize

Create your own lesson summary as you write a script for a **television news report.**

1. **Review** the text after the **red** main headings and write one sentence about each. These are the headlines of your broadcast.
2. **Review** the text and write 2–3 sentences about each **blue** subheading. These sentences should tell *who, what, when, where,* and *why* information about each **red** heading.
3. **Include** descriptive details in your report, such as names of reporters and local places and events.
4. **Present** your news report to other classmates alone or with a team.

ELA6: LS 1.4

Standards Check

Using Vocabulary

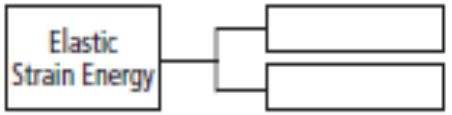
1. Use the words *focus* and *earthquake* in the same sentence. 1.d
2. In your own words, write a definition for *elastic strain.* 1.d

Understanding Main Ideas

3. What is an earthquake? 1.d
   - **A.** elastic strain stored in rocks
   - **B.** a wave traveling through the crust
   - **C.** rupture and movement along a fault
   - **D.** a fault at a convergent plate boundary
4. **Give an example** of a common object that can store elastic strain energy. 1.d
5. **Explain** why the deepest earthquakes occur at convergent plate boundaries. 1.e
6. **Compare and contrast** a fault and a fault zone. 1.e

Applying Science

7. **Simulate** the buildup and release of elastic strain energy using a wooden stick. 1.d
8. **Describe** Draw a diagram like the one below. Describe two ways elastic strain energy is released during an earthquake. 1.d



Science Online

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LESSON 2: EARTHQUAKES AND SEISMIC WAVES

Earthquakes cause seismic waves that provide valuable data.

What you'll learn:

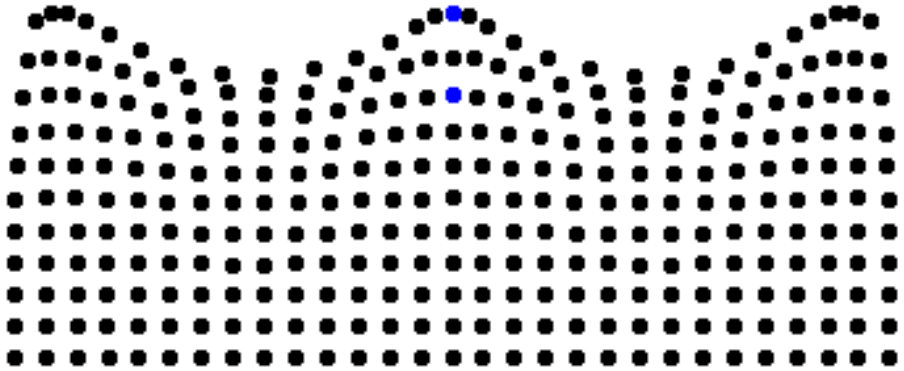
- **Explain how energy released during earthquakes travel in seismic waves.**
- **Distinguish among primary, secondary, and surface waves.**
- **Describe how seismic waves are used to investigate Earth's interior.**

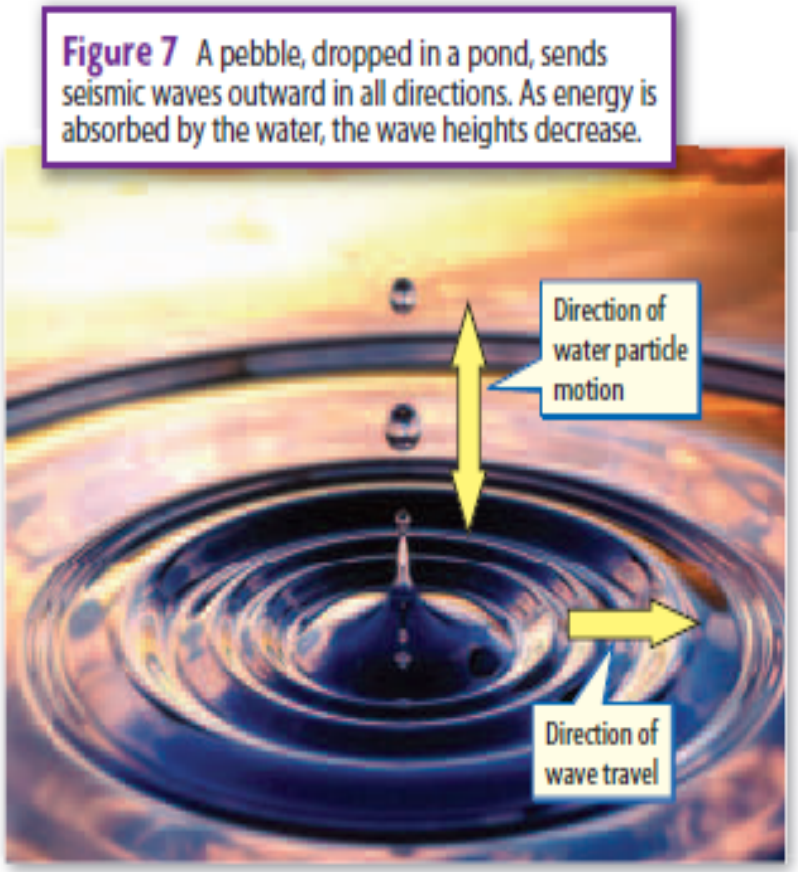
So What?!

Scientists can locate the epicenter of an earthquake by analyzing seismic waves.

REVIEW VOCABULARY

wave - A wave transfers energy from place to place.





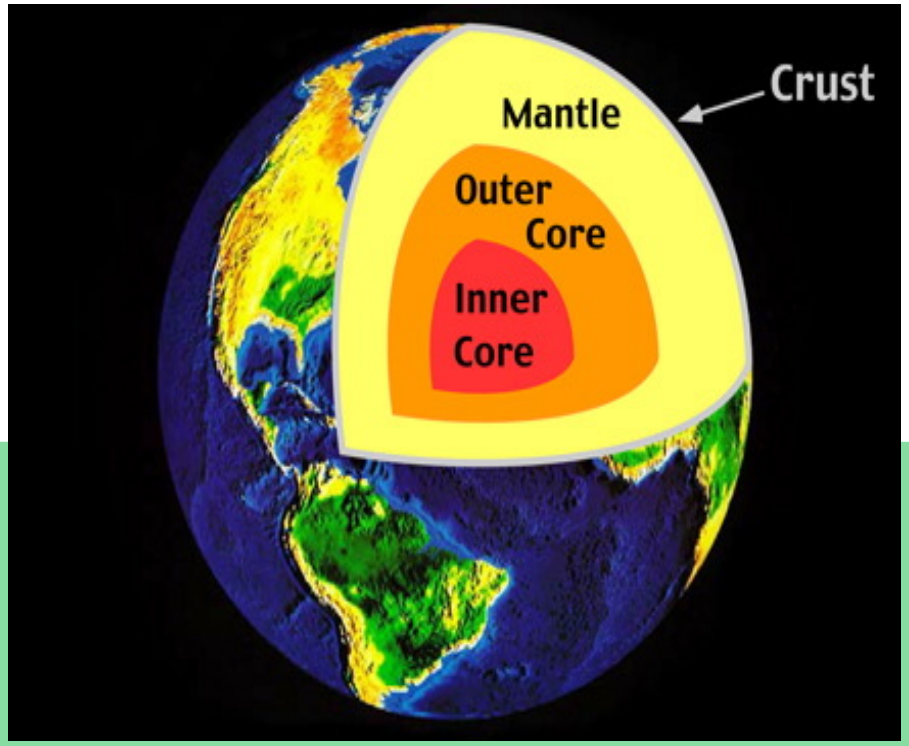
NEW VOCABULARY

Primary Wave	**Compressional wave with particle motion in the same direction the wave travels.**
Seismic Wave	**Wave of energy produced at the focus of an earthquake.**
Secondary Wave	**Shearing wave with particle motion perpendicular to the direction of wave travel.**
Epicenter	**Point on Earth's surface directly above an earthquake focus.**

ACADEMIC VOCABULARY

Internal - **Existing within the limits or surface of something.**

Scientists study the <u>internal</u> structure of Earth.



WHAT ARE SEISMIC WAVES?

Model how energy travels during an earthquake as seismic waves.

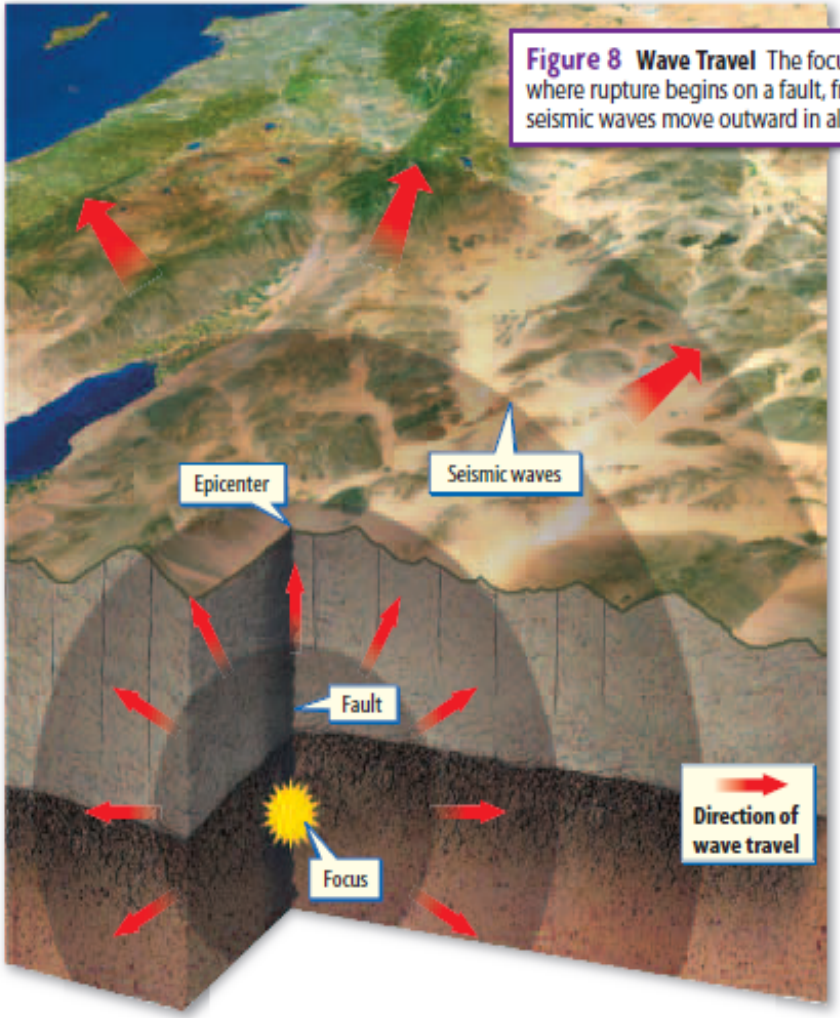
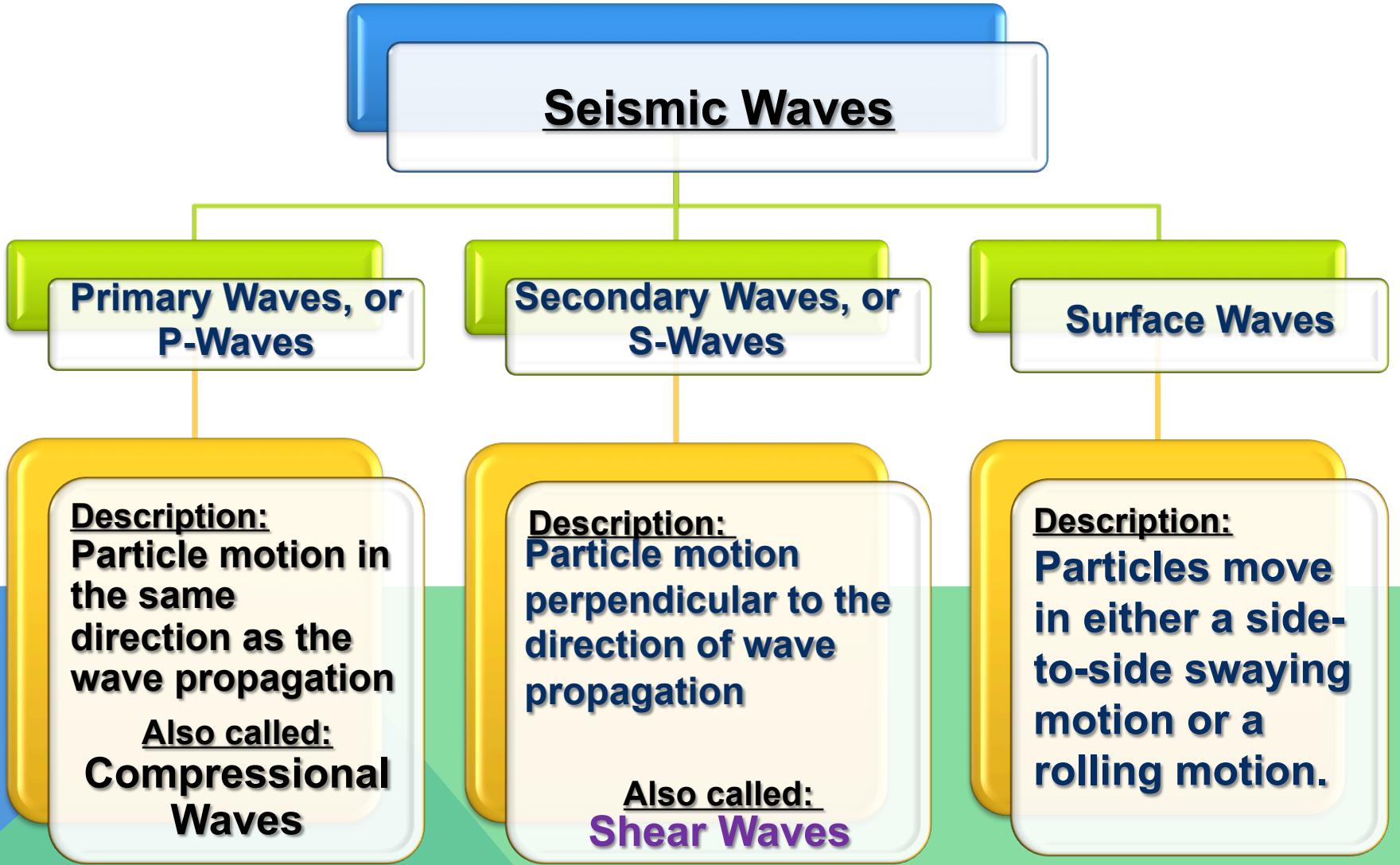


Figure 8 Wave Travel The focus is the point where rupture begins on a fault, from which seismic waves move outward in all directions.

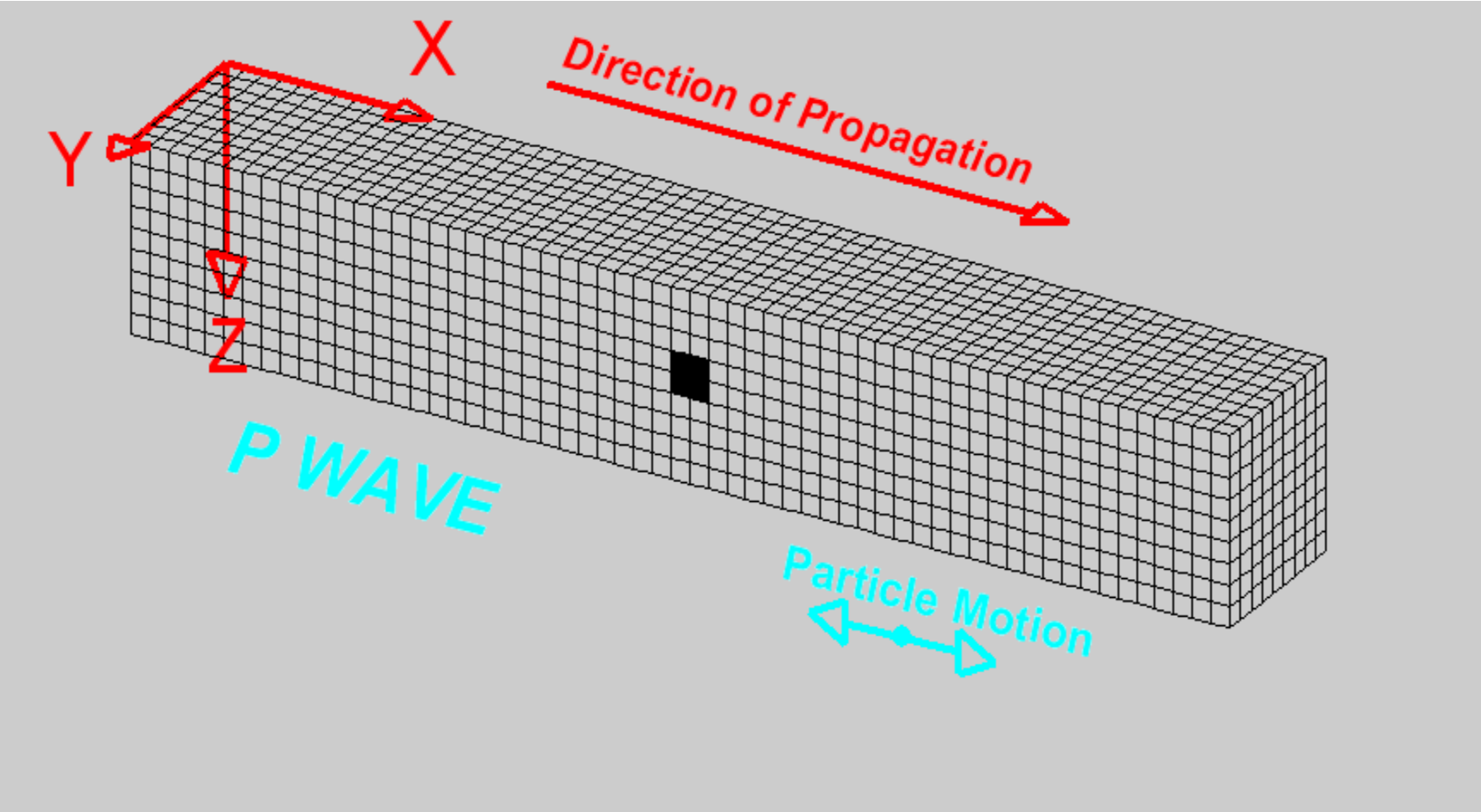
Diagrams should show the amount of energy decreasing as distance from the epicenter increases.

TYPES OF SEISMIC WAVES

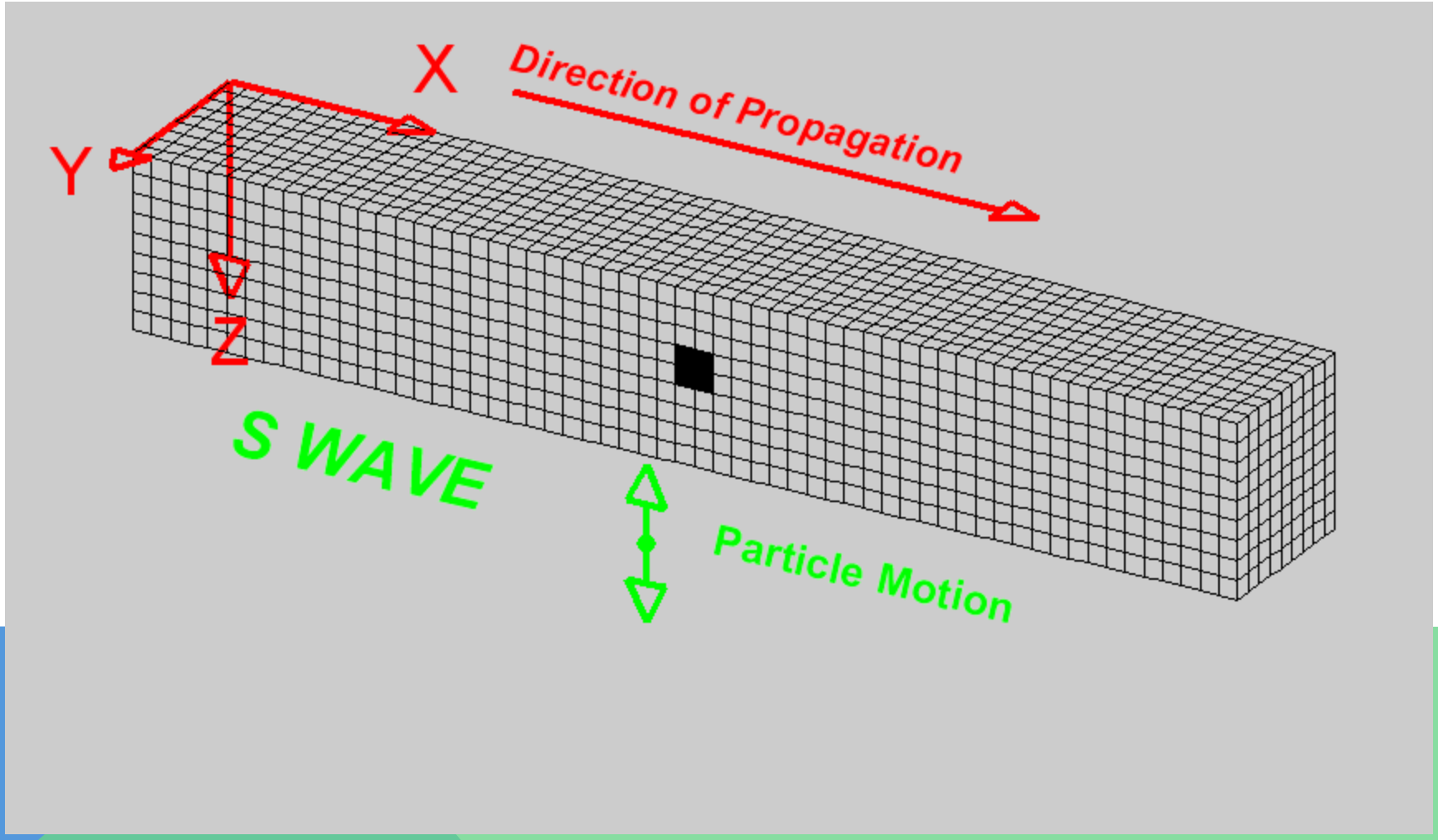
Classify the three types of seismic waves..



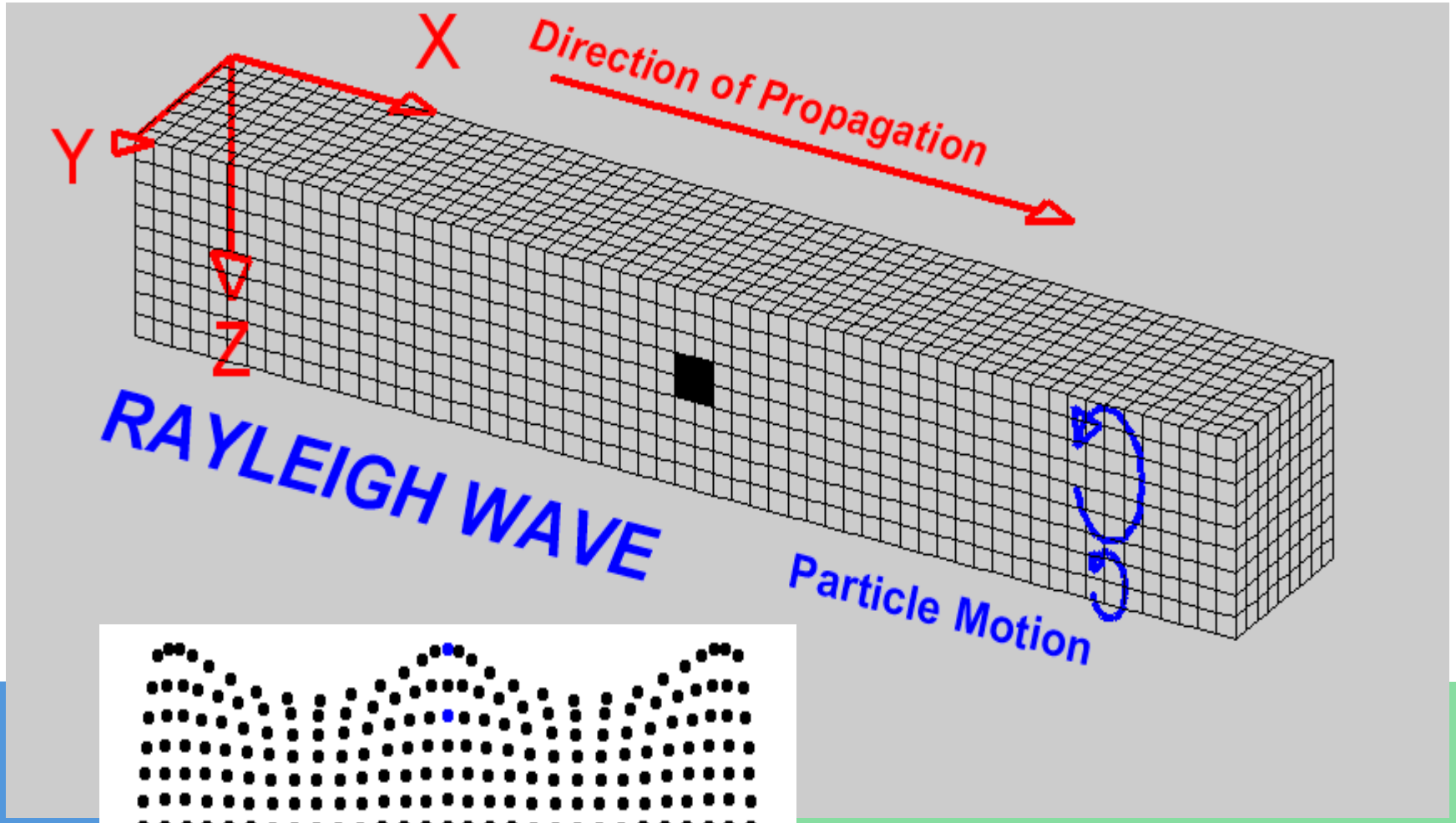
Primary Wave (P-Wave)



Shear Wave (S-Wave)



Surface Wave



SUMMARIZE IT!

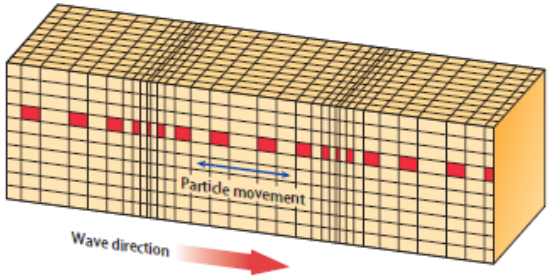
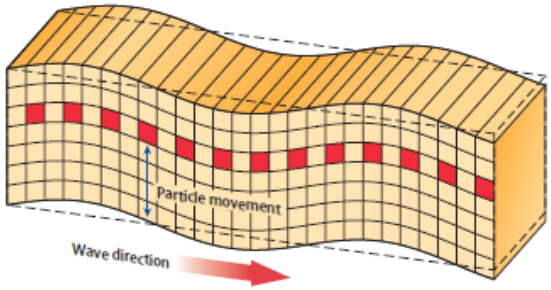
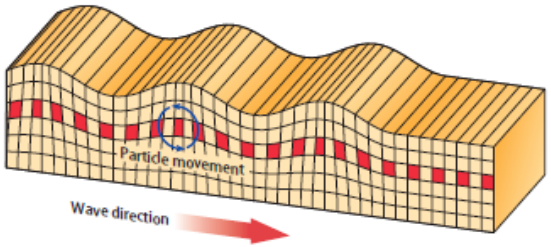
Rephrase the two main ideas from the above sections in your own words.

USING SEISMIC WAVE DATA

Model how P-waves, S-waves, and surface waves travel in an earthquake.

Concepts in Motion
Interactive Table Organize information about seismic waves at ca6.msscience.com

Table 1 Types of Seismic Waves

Seismic Wave	Description
P-Waves  • cause rock particles to vibrate in same direction that waves travel • fastest seismic wave • first to be detected and recorded by scientific instruments • travel through both solids and fluids	
S-Waves  • cause rock particles to vibrate perpendicular to direction that waves travel • slower than P-waves • detected and recorded after P-waves • only travel through solids	
Surface Waves • cause rock particles to move with a side-to-side swaying motion or rolling motion • slowest seismic wave • generally cause the most damage at Earth's surface	

1

2

3

Stick this table in your notes on Science Notebook p. 61.

Be sure to show that P-waves will arrive first, followed by S-eaves, and then surface waves.

USING SEISMIC WAVE DATA

Outline discoveries scientists have made using seismic waves.

I. Internal Structure

A. Waves bounce or bend as they approach a new layer.

B. Rock densities make waves curve as they pass through Earth.

II. Shadow Zone

A. Definition: area that receives no seismic waves

B. S-waves pass only through solids, so outer core must be liquid.

USING SEISMIC WAVE DATA

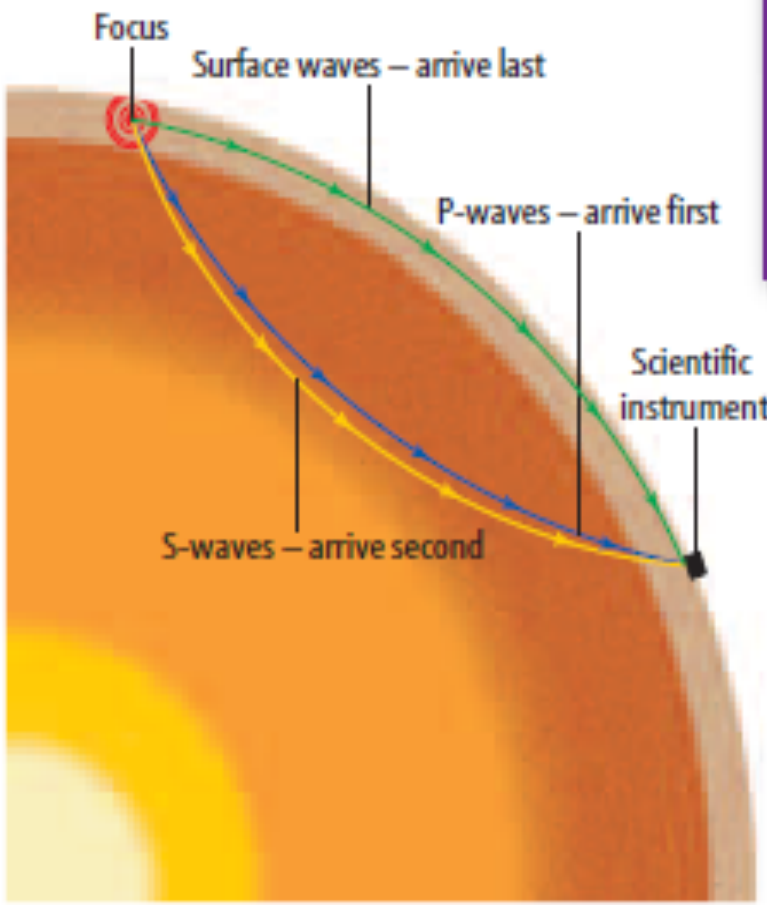
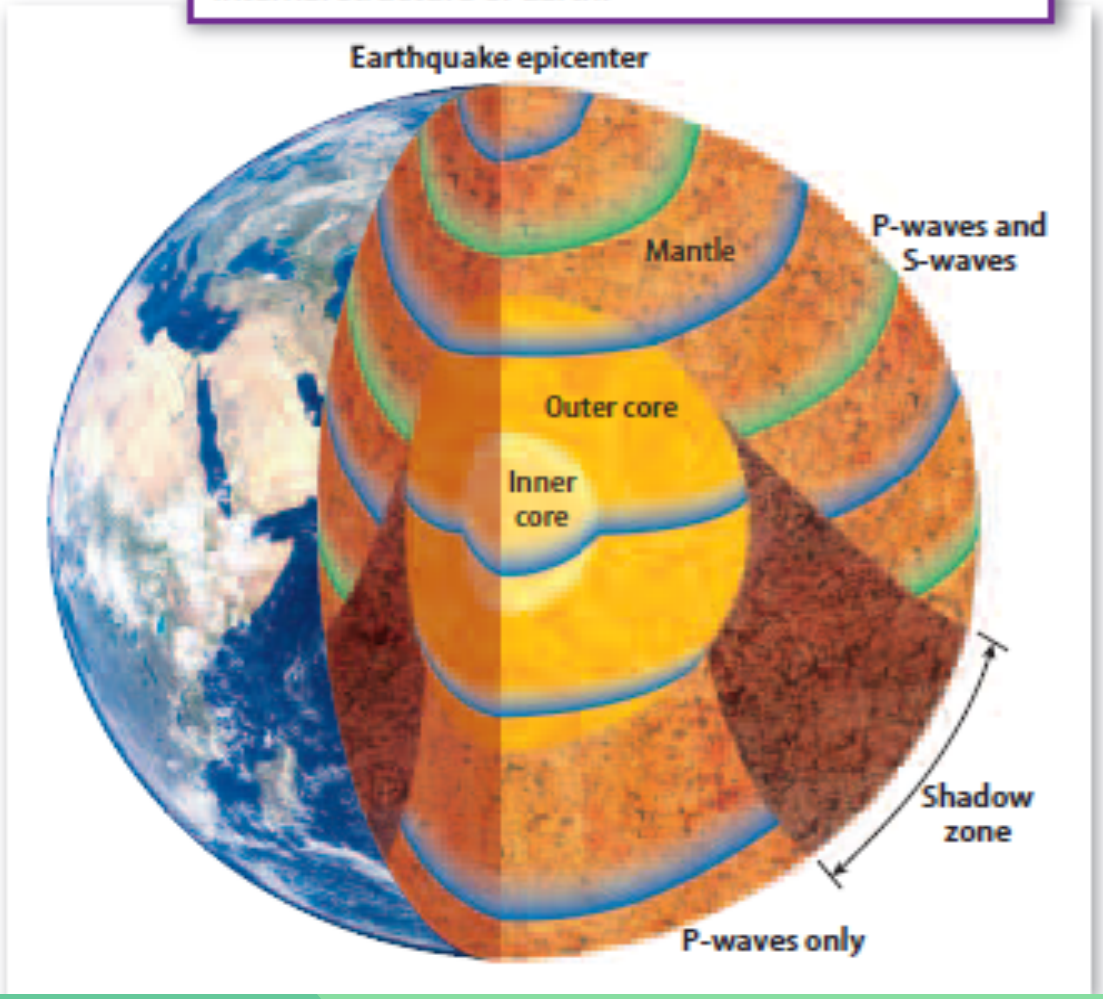


Figure 9 Different types of seismic waves start at the same location, but move at different speeds.

Identify which seismic wave wave first reached the instrument.

USING SEISMIC WAVE DATA

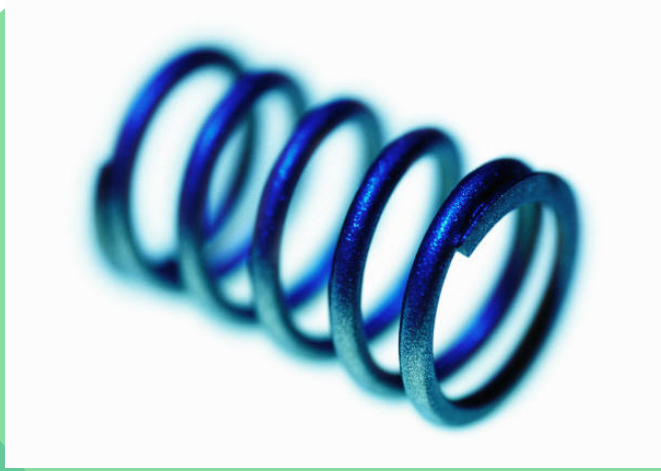
Figure 10 Earth's Layers The paths and speeds of P-waves and S-waves help scientists determine the internal structure of Earth.



SUMMARIZE IT!

Summarize the main ideas of the above sections.

Click on the spring for a virtual slinky lab!



LESSON 2 Review

Summarize

Create your own lesson summary as you organize an **outline.**

1. **Scan** the lesson. Find and list the first **red** main heading.
2. **Review** the text after the heading and list 2–3 details about the heading.
3. **Find** and list each **blue** subheading that follows the **red** main heading.
4. **List** 2–3 details, key terms, and definitions under each **blue** subheading.
5. **Review** additional **red** main headings and their supporting **blue** subheadings. List 2–3 details about each.

ELA6: R 2.4

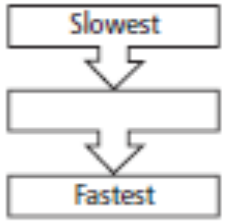
Standards Check

Using Vocabulary

1. Distinguish between a *primary wave* and a *secondary wave.* 1.g
2. In your own words, write a definition for the word *epicenter.* 1.g

Understanding Main Ideas

3. How do surface waves move rock particles? 1.g
   - **A.** parallel to direction of wave travel
   - **B.** rolling motion or side-to-side
   - **C.** perpendicular to direction of wave travel
   - **D.** diagonally
4. **Give an example** of how seismic waves provide valuable scientific data. 1.g
5. **Describe** what happens to the energy of seismic waves as the distance from the focus increases. 1.g
6. **Sequence** Draw a diagram like the one below. Arrange the types of seismic waves in order of increasing wave speed. 1.g



Applying Science

7. **Illustrate** the vibration direction and the direction of travel for an S-wave. 1.g
8. **Hypothesize** what happens to P-waves and S-waves when they encounter magma. 1.g

Science Online

For more practice, visit **Standards Check** at ca6.mssclence.com.

LESSON 3: MEASURING EARTHQUAKES

Data from seismic waves are recorded and interpreted to determine the location and size of an earthquake.

What you'll learn:

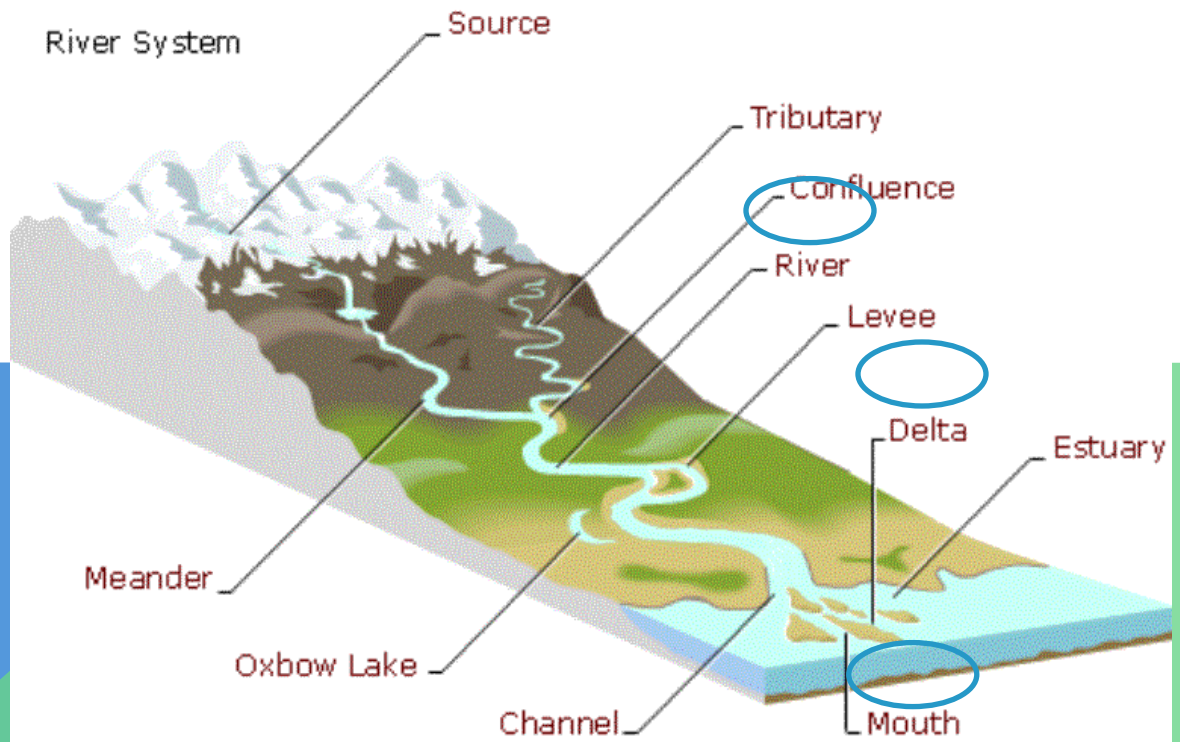
- **Explain how a seismograph records an earthquake.**
- **Understand how to locate an earthquake's epicenter.**
- **Distinguish among ways earthquakes are measured.**

So What?!

Measuring earthquakes helps scientists understand how and where they occur.

REVIEW VOCABULARY

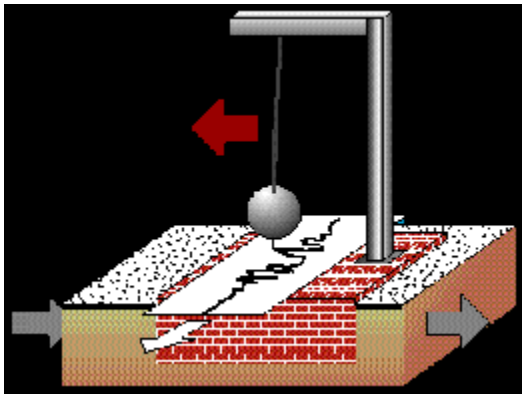
sediment — **Rock material that is broken down into smaller pieces or that is dissolved in water.**



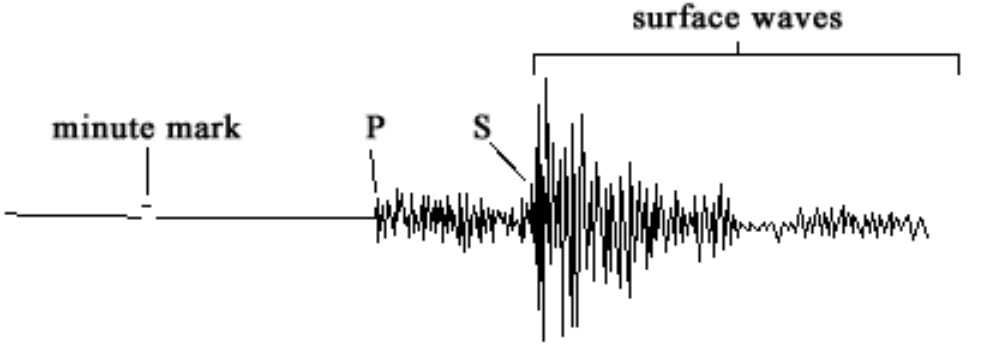
As water runs down the mountain through the river, it picks up <u>sediments</u> from along the banks and carries them to the mouth.

NEW VOCABULARY

seismograph — **Instrument used to record and measure movements of the ground caused by seismic waves.**



seismogram — **Paper record of seismic waves.**



ACADEMIC VOCABULARY

indicate - To demonstrate or point out with precision.

The points on the graph indicate the temperatures calculated over a period of time.

HOW ARE E.Q.s MEASURED?

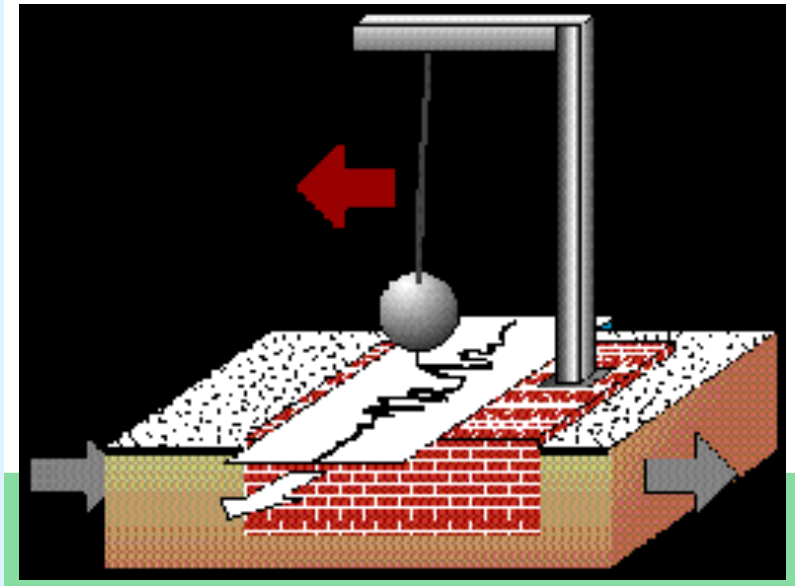
Analyze how scientists determined the size of the December 2004 Indian Ocean earthquake.

Scientists measured how much the rock moved along the fault and measured the heights of the seismic waves.

HOW ARE E.Q.s MEASURED?

Summarize how a mechanical seismograph works.

When seismic waves shake the ground, the pen and pendulum in the seismograph remain still as the drum holding the paper moves. The pen records the motion on the drum.



LOCATING AN EPICENTER

Sequence the steps scientists use to locate the epicenter of an earthquake.

Find the difference in the arrival times of the P- and S- waves

Plot the P-wave and S-wave arrival time differences against time. Use the graph to find the distance to the epicenter.

Plot the distance on a map. Draw a circle with a radius equal to that distance.

Plot distances from at least three (3) seismographs. The place where the circles interact is the epicenter.

SUMMARIZE IT!

Summarize one main idea from each section above.

MEASURING EQ SIZE

Distinguish between the scales used to measure the magnitude of earthquakes.

Richter Magnitude Scale	Moment Magnitude
Scale is based on: seismogram records **Magnitude values:** Range from 0 to 9; each increase of one number equals 10 times the ground shaking and about 30 times the energy.	**Scale is based on:** The amount of energy released; calculated using ❖ the size of the fault rupture, ❖ how much it slips, and ❖ the strength of broken rocks.

EARTHQUAKE INTENSITY

Analyze factors that affect earthquake intensity.

Factors that affect intensity

Factor: Distance from the epicenter

Effect: Energy is absorbed and spread, so intensity decreases as distance increases.

Factor: Local geology

Effect: Loose sediments or fill shake more violently than rocks do.

SUMMARIZE IT!

Highlight the main ideas of each section above in the following passage.

Scientists use magnitude scales to measure the movement and energy released by earthquakes, and intensity to describe how much damage earthquakes cause. The Richter scale measures the amount of movement recorded on a seismogram. The moment magnitude is determined by the amount of energy released. It varies with the distance from the epicenter and the geology of the area.

LESSON 4: EQ HAZARDS & SAFETY

Effects of an earthquake depend on its size and the types of structures and geology in a region.

What you'll learn:

- **Describe the various hazards from earthquakes.**
- **Give examples of ways to reduce earthquake damage.**
- **List ways to make your classroom and home more earthquake safe.**

So What?!

Preparing for an earthquake can save lives and reduce damage to property.

REVIEW VOCABULARY

San Andreas Fault

Fault zone that forms a transform plate boundary between the Pacific Plate and the North American Plate (p. 224)

NEW VOCABULARY

liquefaction	**Process in which earthquake shaking makes loose sediment behave like liquid**
tsunami	**Ocean wave caused by earthquakes**

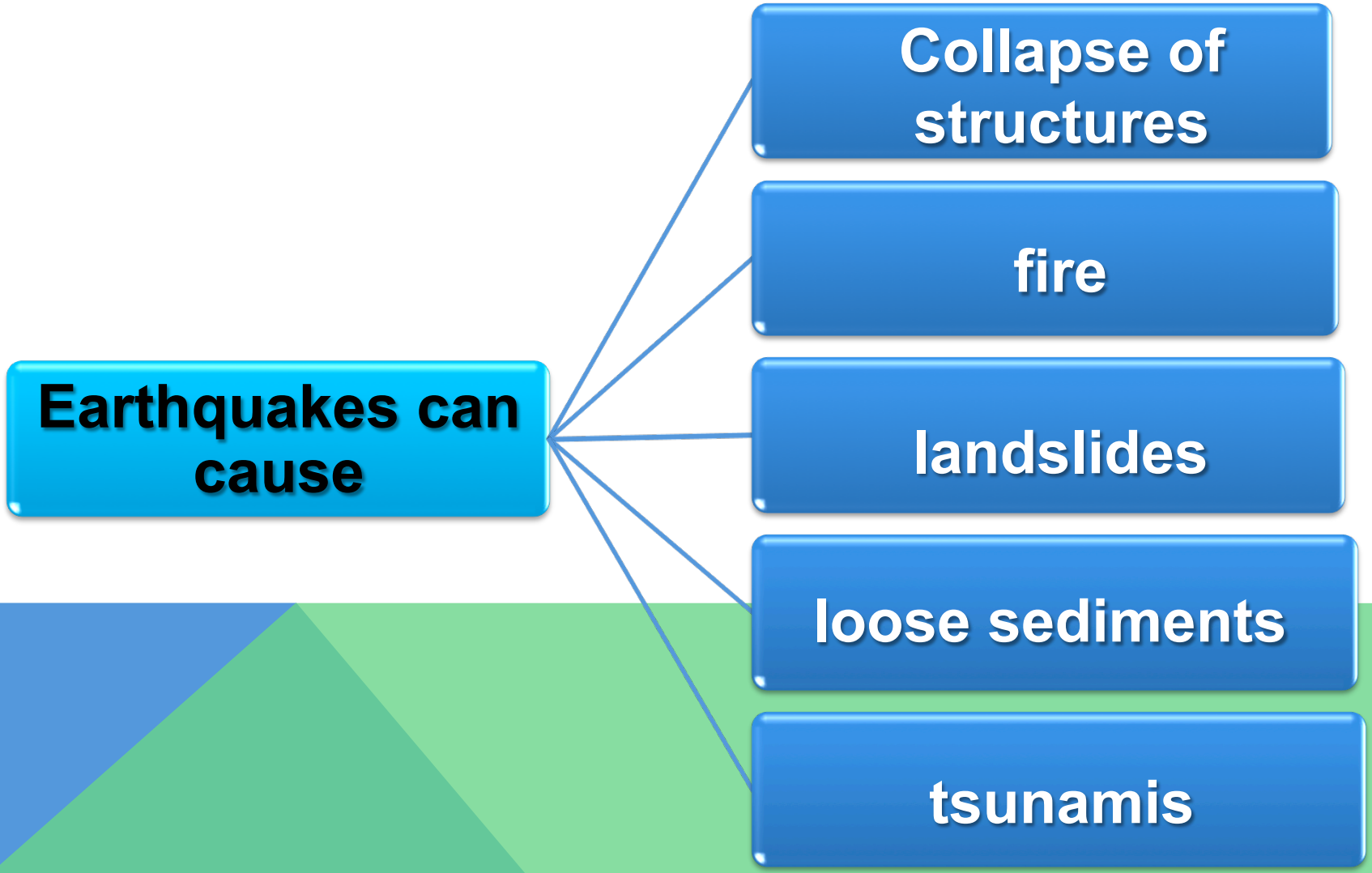
NEW VOCABULARY

securely Free from risk of loss.

*The bank keeps its funds securely protected.

EARTHQUAKE HAZARDS

Identify five hazards that might result from an earthquake.



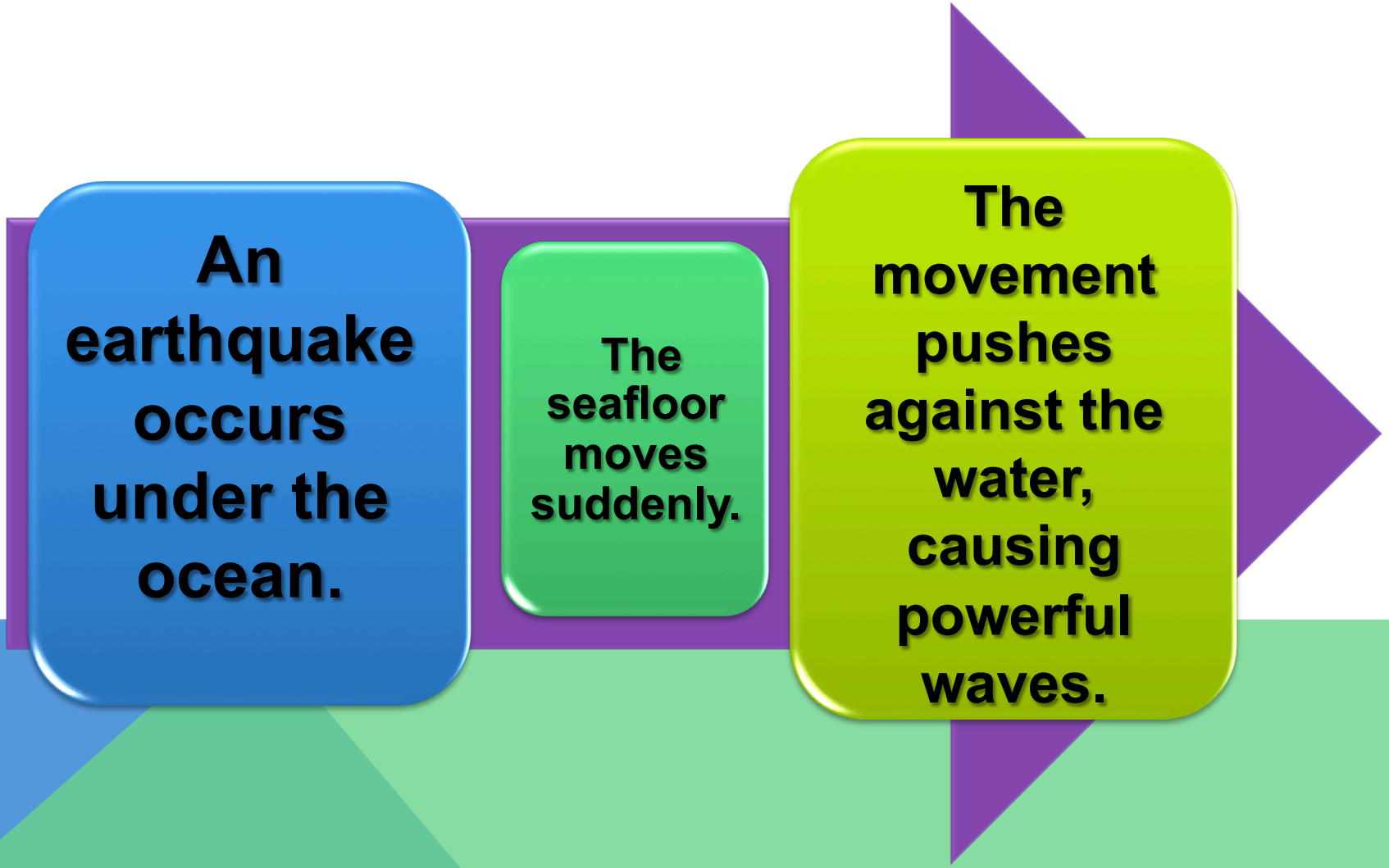
EARTHQUAKE HAZARDS

Explain how liquefaction occurs and how it damages buildings.

Liquefaction occurs when shaking from an earthquake causes wet soil to act like a liquid. When liquefaction occurs in soil under buildings, buildings sink into the soil and collapse.

EARTHQUAKE HAZARDS

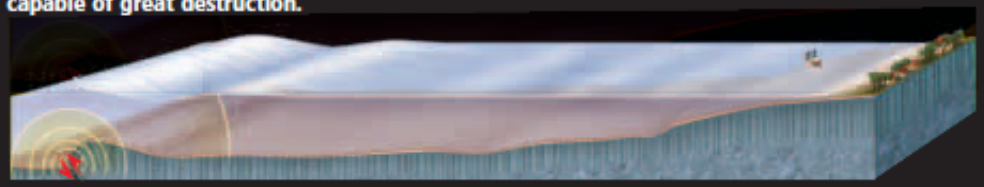
Sequence the events that cause a tsunami.



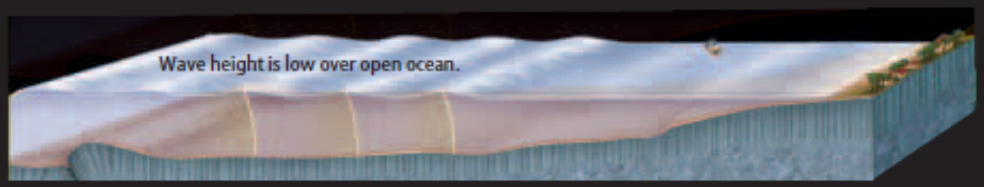
Visualizing Tsunamis

Figure 21

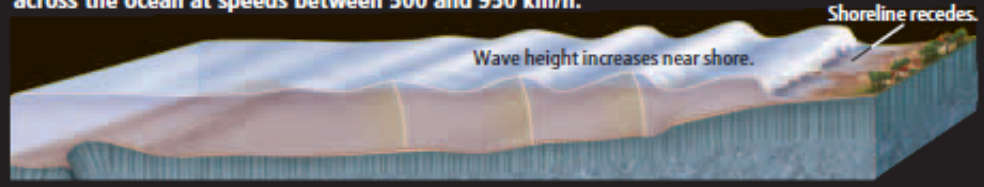
The diagrams below show the development of a tsunami—an ocean wave that usually is generated by an earthquake and is capable of great destruction.



Sudden up or down movement along an underwater fault causes powerful waves that are transferred to and spread across the water's surface.

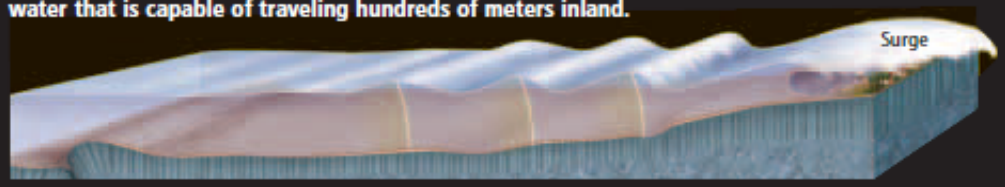


Tsunami waves are less than 1 meter high in deep water and travel across the ocean at speeds between 500 and 950 km/h.



When a tsunami wave reaches shallow water, friction slows it down and causes it to roll up into a wall of water—sometimes 30 m high. Just before the tsunami crashes to shore, the water near a shoreline may move rapidly outward toward the sea.

The tsunami wave crashes into the shoreline, causing a surge of water that is capable of traveling hundreds of meters inland.



AVOIDING EQ HAZARDS

Summarize how scientists determine the risk of earthquake hazards in an area.

Scientists use geologic maps to identify areas with loose sediment and other places where landslides, liquefaction, or tsunamis are likely to occur.

SUMMARIZE IT!

Summarize the main ideas of the above sections.

E.Q.s & STRUCTURES

Outline how building planning can help reduce loss of life during an earthquake.

I. Types of buildings

A. Buildings made of flexible materials generally suffer less damage than buildings made of brittle material.

B. Single-story buildings are less susceptible to damage than taller buildings.

II. Earthquake-resistant structures

A. Some new buildings are supported by flexible, circular moorings.

B. In other buildings, steel rods are used to reinforce building walls.

EARTHQUAKE SAFETY

Model tips for staying safe during and after an earthquake.

Indoors	Outdoors
❖ Move away from windows & objects that can fall. ❖ Take shelter in an interior doorway or under a sturdy table or desk. ❖ Have adults shut off water and gas if damaged.	❖ Stay in the open, away from power lines. ❖ Stay away from damaged buildings and beaches.

SUMMARIZE IT!

Summarize two main ideas of the above sections of this lesson.