



Module 1 Dynamic Earth

Lesson 1- Moving Continents

Alfred Wegener (1912)



Continental drift hypothesis

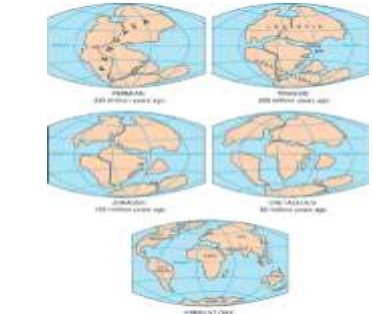
The continents were matching forming a supercontinent, Pangaea.

Science 250 million years ago

The **Pangaea** split and drifted apart to form the continents we know today.

Evidence of Continental Drift

- 1-Continents can match to form one continent (Pangaea)
- 2- He discovered the same types of fossils on separated continents (Mesosaurus- Glossopetris)
- 3- Rocks and mountains that are formed at similar times are on separated continents.
- 4 - Glacial scratches in all the southern continents which is too warm to have ice.
- 5- Coal deposits in Antarctica, it means once it has tropical climate.



Why did scientists argued continental drift hypothesis?

Because Wegener couldn't explain how continents moved.





Lesson Check: Moving Continents

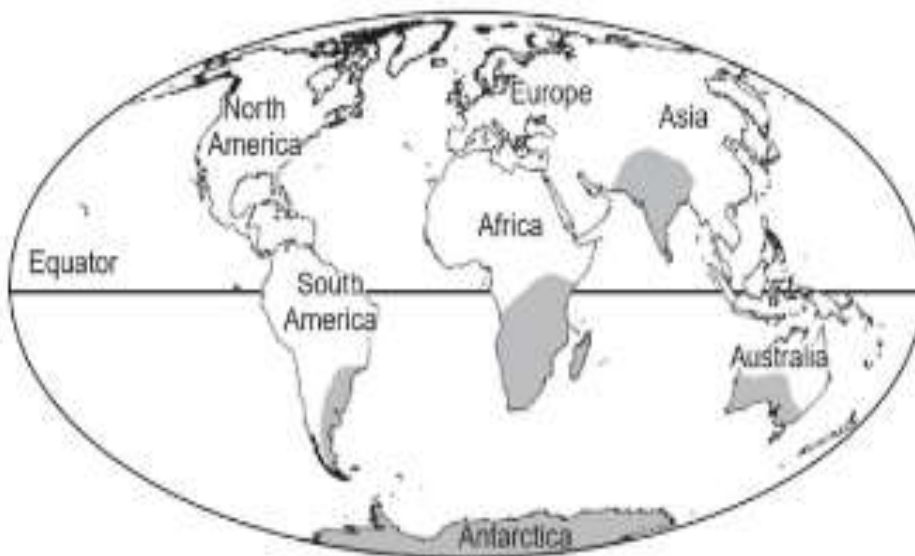
- 1) The presence of the same _____ on several continents supports the hypothesis of continental drift.
 - ☐ fossils
 - ☐ rocks
 - ☐ neither a nor b
 - ☐ both a and b
- 2) Some early mapmakers thought that the coastline of South America matched the coastline of Asia.
 - ☐ True
 - ☐ False
- 3) Scientists at the time rejected Wegener's hypothesis of continental drift because he could not explain how or why Earth's continents move.
 - ☐ True
 - ☐ False
- 4) A lack of explanation for continental drift prevented many scientists from accepting that a single supercontinent called _____ once existed.
 - ☐ Glomar
 - ☐ Glossopteris
 - ☐ Pangaea
 - ☐ Wegener
- 5) Matching _____ on different continents are evidence for continental drift.
 - ☐ river systems
 - ☐ rock structures
 - ☐ weather patterns
 - ☐ wind systems
- 6) _____ is a fossil fern that helped support Wegener's hypothesis of continental drift.
 - ☐ Gondwanaland
 - ☐ Kannemeyeri
 - ☐ Mesosaurus
 - ☐ Glossopteris




7) Wegener believed that the continents were assembled as part of a supercontinent about ____ years ago.

- ☐ 250 million
- ☐ 350 million
- ☐ 450 million
- ☐ 550 million

8) The map shows where glaciers existed 250 million years ago.



Key	
	Location of glaciers 250 mya

Which explanation is supported by the data in the map?

- ☐ Glaciers formed in the locations shown on the map because of a change in climate that caused the southern hemisphere to experience an ice age.
- ☐ Glaciers at one time covered most of the continents in the world, but the glaciers melted and the areas on the map are places where glaciers still remain.
- ☐ There is evidence of glaciers in the areas identified on the map because the current climate in those areas still supports glacier formation.
- ☐ There is evidence of glaciers in the areas identified on the map because the continents were once located near a polar region, but then over time the continents moved apart.



Lesson 2- Development of a Theory

Plate Tectonics Theory

Earth's surface is made of rigid plates of rock, that move

How Plates Move?

Plates are moving because of **convection currents** in the mantle which pushes and pulls tectonic plates.

Ocean Floor Topography

1- Mid-Ocean Ridges

Mid-ocean ridges are mountain ranges found in the middle of the ocean floor.

EXAMPLE

The Mid-Atlantic Ridge—runs through the center of the Atlantic Ocean

2- Ocean Trench

Is a deep and long groove in the ocean floor.

The Mariana Trench in the Pacific Ocean is the deepest landform on Earth.

3- Seafloor spreading

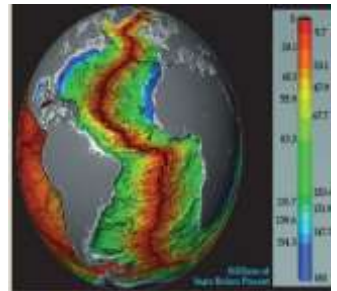
Seafloor spreading is the process by which new oceanic crust continuously forms along mid-ocean ridges

Magma

Melted rock beneath the Earth's surface.

Lava

Hot molten rock that reaches Earth's surface



INVESTIGATION

Seafloor Spreading

GO ONLINE Watch the video *Seafloor Spreading*.

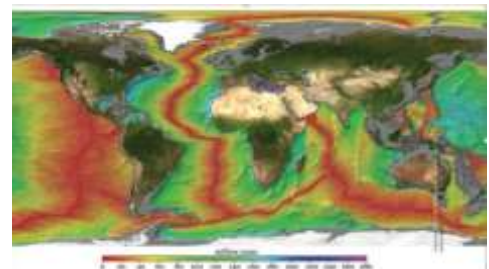
What causes Earth's crust to spread?

Hot rock rises, heated by Earth's core. Near the surface, the rock spreads in two directions and goes sideways.



An isochron map

uses colors to show how old the rocks are. In the map shown, the youngest rocks are red.





Lesson Check: Development of a Theory

1) As new seafloor moves away from an ocean ridge, the seafloor cools and becomes less dense than the material beneath it.

- ☐ True
- ☐ False

2) The youngest rocks on the ocean floor are located ____.

- ☐ A) near continents
- ☐ B) at mid-ocean ridges
- ☐ C) far from mid-ocean ridges
- ☐ D) near Asia

3) Which of the following best explains the age of oceanic crust and ocean-floor features?

- ☐ A) seafloor spreading
- ☐ B) continental drift
- ☐ C) subduction
- ☐ D) crystallization

4) New ocean crust is continually formed at ____.

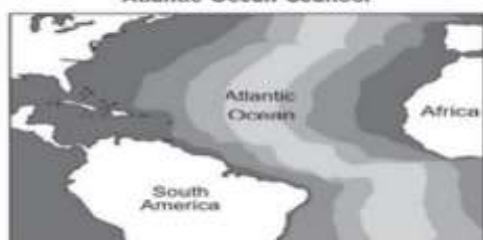
- ☐ A) mid-ocean ridges
- ☐ B) trenches
- ☐ C) subduction zones
- ☐ D) ocean basins

5) The theory of _____ explains how new crust is created at mid-ocean ridges.

6) What new technology was used to map the seafloor beginning in the 1940s and 1950s?

8) The map shows the ages of rocks found on the Atlantic Ocean seafloor.

Ages of Rocks on the Atlantic Ocean Seafloor



Key	
118.1 – 180.0 million years before present	
56.0 – 118.0 million years before present	
20.2 – 56.0 million years before present	
0 – 20.2 million years before present	

a. Identify the process that causes the pattern of rock data shown in the map.



Lesson 3- Shaping Earth's Surface

Tectonic Plate Boundaries

1-Convergent Boundaries

Is where two plates move toward each other

2-Divergent Boundaries

Is where two plates move apart each other

3-Transform Boundaries

Is where tectonic plates slide past each other



Subduction zone

The area where one plate slides under another

Types of Mountains

1- Fault Mountains

When tectonic plates move apart, the tension and stress create faults.

Mountains that form on fault lines are **Fault-Block Mountains**.

Example

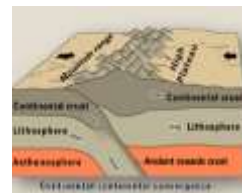
Mid-Ocean Ridge Mountains




2-Fold Mountains

At convergent boundaries, the compression forces that compress the Earth's crust form fold mountains.

1-At subduction zone. Example: Andes Mountains

2-Because of colliding continental plates.



	Divergent Boundaries	Convergent Boundaries	Transform Boundaries
Movement of plates	Move away from each other	Move towards each other	Slide past each other
type of forces occurs?	Tension force	Compression force	Shear force
Topography (can form)	1- New ocean crust 2- Fault mountains 3-Volcanoes	1-Fold mountains 2- Trench 3-Volcanoes 4- Earthquake	1-Faults 2-Earthquake
Example	Mid-ocean ridge	Andes mountains Mariana trench Volcanic arc	San Andreas fault
			



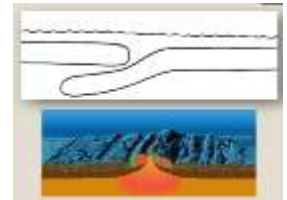
Volcano

Is an opening in Earth's crust that magma flows through.

Volcano Formation

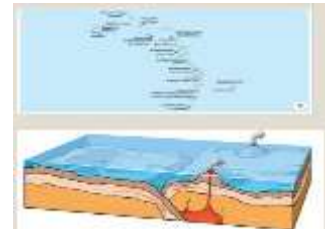
1-Volcanoes form when one tectonic plate subducts below another.
(on land or underwater)

- 2- Volcanoes occur at divergent plate boundaries to form mid-ocean ridges. (underwater) More than 60% of all volcanoes are underwater



Volcanic Arc

A volcanic arc is a group of volcanoes that form above a subduction zone in a circular shape.



Earthquake

Is the sudden movement of rocks along a break in Earth's crust.

Fault Zone

An area of many fractured pieces of crust along a large fault

What is the effect of Earthquake?

1- Earthquakes can cause **Landslides**.
A rapid downhill movement of rock and soil.

- 3- **A Tsunami** is a group of huge waves reaching up to 30 m in height. Tsunamis happen when an earthquake occurs underwater.



Other ways Earth's surface changes

1. Craters

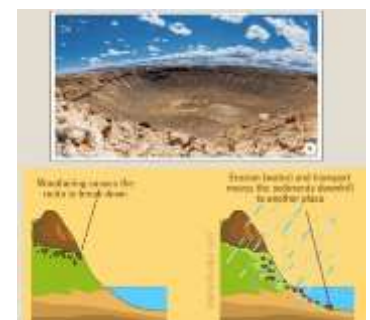
Are very large dips in the ground that form when meteorites, asteroids, or other large objects from space crash into Earth.

2-Weathering and erosion

Are slow processes that change Earth's surface.

Weathering causes rocks to break down by water, plants, and animals.

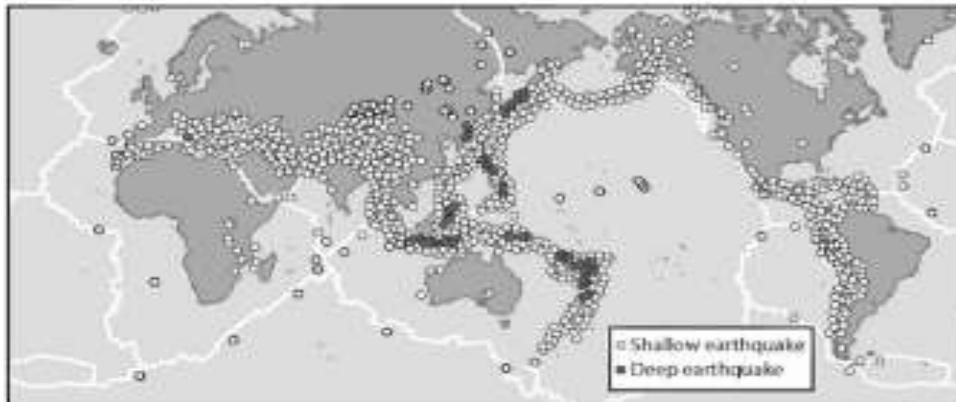
Erosion moves the broken pieces of rock by wind, water, or gravity.





Lesson Check: Shaping Earth's Surface

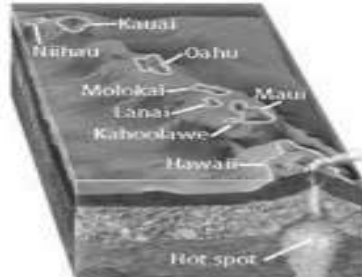
- 1) The driving forces of tectonic plates are related to convection currents in Earth's ____.
- ☐ A) crust
 - ☐ B) mantle
 - ☐ C) inner core
 - ☐ D) outer core
- 2) ____ are formed when two continental plates collide.
- ☐ A) Volcanoes
 - ☐ B) Strike-slip faults
 - ☐ C) Mountain ranges
 - ☐ D) Rift valleys
- 3) At an oceanic-oceanic convergent plate boundary, ____.
- ☐ A) new crust is created
 - ☐ B) old crust is recycled by subduction
 - ☐ C) old crust is deformed or fractured
 - ☐ D) plates slide past one another
- 4) What type of mountains are formed when molten rock erupts onto Earth's surface and hardens?
- ☐ A) uplifted mountains
 - ☐ B) fold mountains
 - ☐ C) volcanic mountains
 - ☐ D) fault-block mountains
- 5) Looking at the figure that shows world-wide earthquake distribution, the white lines represent plate boundaries. Which statement is true?



- ☐ A) Earthquakes always occur along plate boundaries.
- ☐ B) Earthquakes most frequently occur along plate boundaries.
- ☐ C) Earthquakes rarely occur along plate boundaries.
- ☐ D) Earthquakes never occur along plate boundaries.



- 6) Volcanoes can form over a plume, or rising current of hot mantle. As a tectonic plate slowly moves over a plume, a volcano will form and then become extinct as it moves away from the hot spot. Then the next volcano will form. If the hot spot shown made all the islands in the figure, is the plate pictured below moving toward you or away from you?



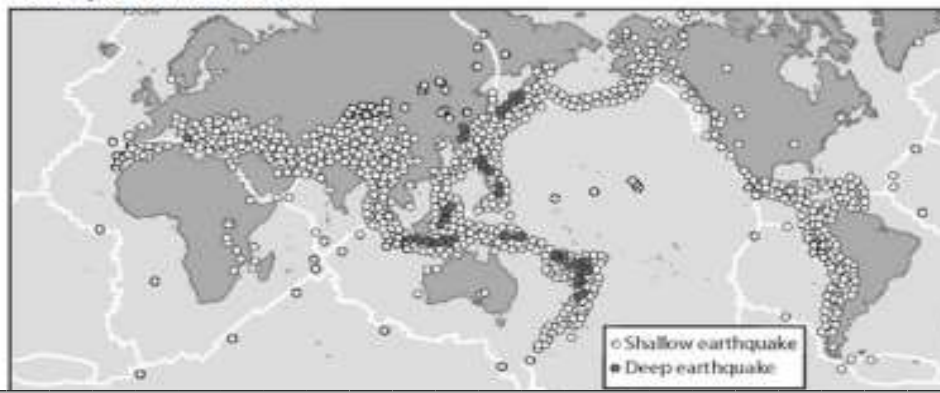
- ☐ A) The plate is moving toward me.
- ☐ B) The plate is moving away from me.
- ☐ C) There is no way to tell.
- ☐ D) It is stationary.
- 7) Fault-block mountains occur where ____.
- ☐ A) compression squeezes the crust
- ☐ B) tension pulls the crust apart
- ☐ C) tension squeezes the crust
- ☐ D) compression pulls the crust apart

- 8) Look at the figures showing the distribution of volcanoes and earthquakes. Why do volcanoes and earthquakes occur in so many of the same areas?

Volcano Distribution

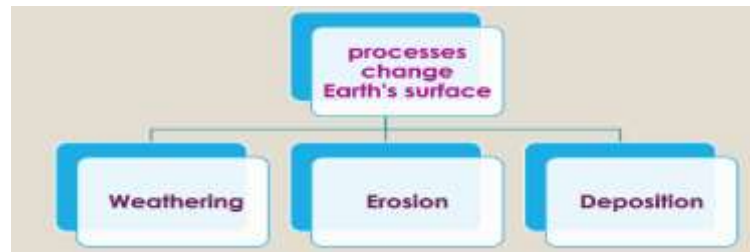


Earthquake Distribution



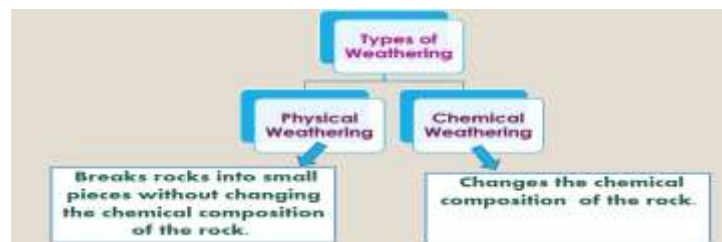


Lesson 4- Changing Earth's Surface



Weathering

The process that breaks down rocks and changes Earth's surface



Factors of physical weathering

- 1- Animals can break rocks by digging around them.
- 2- Plant roots can get into the holes in rocks and break them.
- 2- As water and wind move it can break up rocks

Factors of chemical weathering

- 1- Water and acid react with rocks to dissolve minerals in the rock.
- 2- Carbon dioxide in the air reacts with water to form a weak acid. This acid reacts with rocks such as (Limestone) on Earth's surface and underground forming Caves.

Erosion

Is the processes of moving the small pieces of rock from one place to another

Erosion's Factors

Wind, water, glaciers, or gravity.

Deposition

Is the processes by which eroded materials are laid down.

Deposition's Factors

Wind, water, glaciers, or gravity.





Examine how this beach changes from one photo to the next below.



1. How did this beach change over time?

The beach has become narrower. The space between the water and the buildings has decreased over time.

2. What do you think caused these changes?

As waves crashed onto the beach, sand was removed by the water and carried to new locations.

Water Erosion and Deposition

water flows quickly down the mountain. The fast-moving water carves **V-shaped valleys** in the mountain.

As the stream reaches lower ground, the water loses energy and speed, so the stream path becomes curvier, called a **Meander**.

Here, more sediment deposition occurs.

Wind Erosion and Deposition land features

1- Sand Dunes

Sand dunes formed because of wind erosion and deposition.

The shape of dunes depend on the wind direction, it can migrate in the direction the wind blows

2- Loess

Loess is silt and clay deposits.

Wind picks up fine-grain sediment and redeposit it as thick layers of dust called loess

3- Arches

Sand blasts at the rock over millions of years. The sand wears away softer rock to create an arch.

4- Scoured and sandblasts rocks

Wind can bombard rocks on the surface with windblown sand. Many such rocks take on a smooth, polished appearance as sharp, rough spots are smoothed by debris.





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Glaciers Erosion and Deposition land features

Glaciers

Are large, thick sheets of ice that move across land..

Types of Glaciers

- 1- **Alpine glaciers** form in the mountains and flow downhill.
- 2- **Continental glaciers** cover large areas of land.

As glaciers move over land, they leave grooves and scratches in the rocks.

As glaciers melt, they deposit the sediment they are carrying, called till.

Till

Is a mixture of various sizes of sediment.



Glaciers Features



THREE-DIMENSIONAL THINKING

Explain how the mountains and the valley in the image above would be different if a glacier had not passed through.

The valley would likely be V-shaped (formed by a river) instead of U-shaped (formed by a glacier). There would not be ridges carved into the mountains, so you would not see features such as horns, arêtes, cirques, and hanging valleys.



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Lesson Check: Changing Earth's Surface

1) Wind and rain can break down exposed rock.

- ☐ True
- ☐ False

2) What happens when sediment eroded by water, ice, and wind slows down or stops moving?

- ☐ A) The sediment is deposited in a new location.
- ☐ B) The sediment continues to erode.
- ☐ C) The sediment instantly turns into soil.
- ☐ D) The sediment mixes with other sediment to become rock.

3) Where do erosion and deposition occur in a river?

- ☐ A) Erosion occurs where fast-moving river water picks up soil and moves it downstream. Deposition occurs where a river current slows as it enters a larger body of water and drops the soil.
- ☐ B) Deposition occurs where fast-moving river water picks up soil and moves it downstream. Erosion occurs where a river current slows as it enters a larger body of water and drops the soil.
- ☐ C) A river erodes land. There is no deposition.
- ☐ D) A delta forms at the mouth of a river from deposition. There is no erosion.

4) Chemical weathering happens fastest under which conditions?

- ☐ A) low temperature
- ☐ B) abundant water
- ☐ C) glaciation
- ☐ D) sparse plant growth

5) How is water a weathering agent?

- ☐ A) It dissolves minerals in rocks.
- ☐ B) It grinds and polishes rock by moving particles against it.
- ☐ C) It grows on rocks to break the rock apart.
- ☐ D) It is not a weathering agent.

6) _____ determines the amount of runoff.

- ☐ A) The amount of vegetation
- ☐ B) The amount of rain
- ☐ C) The slope of the land
- ☐ D) all of the above

7) Mechanical weathering _____.

- ☐ A) breaks apart rocks by physical processes
- ☐ B) occurs when chemical reactions dissolve or change the minerals in rocks
- ☐ C) occurs when iron is exposed to oxygen and water
- ☐ D) none of the above

8) Chemical weathering _____.

- ☐ A) is caused by freezing and thawing
- ☐ B) breaks apart rocks by physical processes
- ☐ C) occurs when chemical reactions dissolve or change the minerals in rocks
- ☐ D) none of above



- 9) A satellite camera in space took this picture of northwestern Algeria, showing an impact crater, sedimentary rock layers, and a stream channel flowing out of the crater. Algeria is at the northern end of the African continent. The Algerian landscape includes a large portion of the Sahara Desert and two mountain ranges.

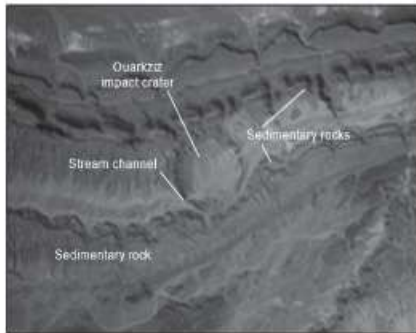
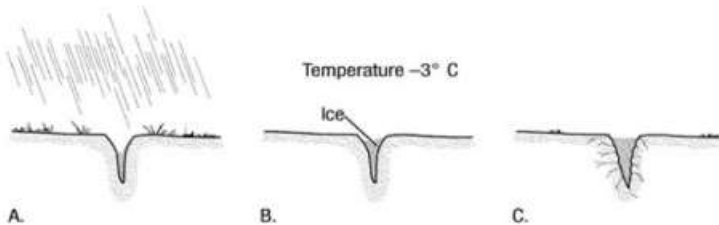


Image courtesy of the Earth Science and Remote Sensing Unit, NASA Johnson Space Center

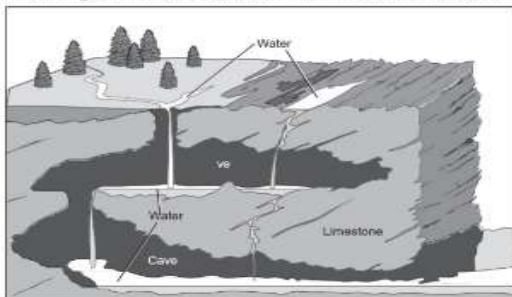
Based on evidence in the picture, how has this area been affected by geologic processes?

- ☐ A) An ancient stream channel left deposits that built up over time to form the sedimentary rocks surrounding the stream. A meteorite's impact changed the direction that the stream flowed, which led to mountain ranges forming downstream from the crater.
- ☐ B) Lava flows from volcanic eruptions created sedimentary rock layers; heavy rains formed a stream channel; and a meteorite's impact evaporated the stream water, leaving the area without a water source and creating a desert.
- ☐ C) A meteorite impacted Earth, creating a low-lying area where water filled in to create a stream channel. The stream channel carried sediment with it, eventually forming the surrounding layers of sedimentary rock.
- ☐ D) Layers of sediments were compacted to form sedimentary rock; a meteorite impacted Earth after the sedimentary layers were formed; and water erosion formed a stream channel from the meteorite's impact zone.

- 10) Explain how weathering is occurring in A, B, and C.



- 11) The diagram shows caves in a limestone rock formation.



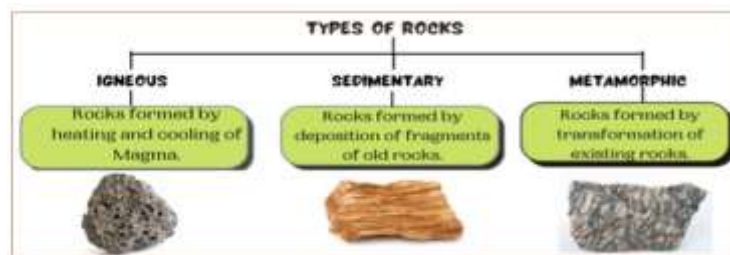
Describe how caves form in limestone, using evidence from the diagram.



Lesson 5- The Cycling of Earth's Materials

What is the difference between minerals and rocks

Mineral	Rock
Is a naturally occurring, inorganic solid with a definite chemical composition and definite arrangement of atoms.	A solid mixture of minerals or organic matter

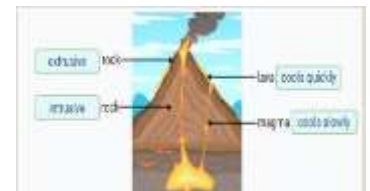


Crystallization

Occurs when particles dissolved in a liquid, such as lava or magma, solidify and form crystals.

The types of igneous rocks

	Extrusive Igneous Rock	Intrusive Igneous Rock
Definition	Are rocks formed when lava cools and crystallizes on Earth's surface.	Are rocks formed when magma cools and crystallizes below Earth's surface.
Texture	Small crystals	Large crystals
Example	Obsidian	Diorite - Granite



Sedimentary Rocks Formation

Sedimentary Rocks are formed from sediments (is broken rock material, minerals, and organic matter)



Steps of sedimentary rocks formation

1- Deposition

Is the settling of eroded materials.

Deposition occurs through glaciers, wind, and water.

2- Lithification

Is the process through which sediment turns into rock.

Lithification occurs through:

1- Compaction

Is decreasing the space between grains because of the weight from the layers of sediment.

2- Cementation

Occurs when minerals dissolved in surrounding water crystallize between grains of sediment.

Types of Sedimentary Rocks

1- Clastic Sedimentary Rocks

Form when sediment pieces stick together. Clasts are broken rock fragments that form clastic rocks.

2- Chemical Sedimentary Rocks

Water can only hold a certain amount of dissolved solids. When the water evaporates, the solids form mineral crystals.

3- Biochemical Sedimentary Rocks

When marine organisms die and drop to the seafloor, the minerals in their shells form biochemical sedimentary rocks.



Shale is a clastic sedimentary rock.



Chert is a chemical sedimentary rock.



Seashells in the sediment of limestone.

3- Metamorphic Rocks

Forms when temperature and pressure combine and change the texture, mineral composition, or chemical composition of a rock.

How does the flow of **energy** from Earth's hot interior drive the formation of metamorphic rock?

The temperature change the texture, mineral composition, or chemical composition of a rock.



Rock Cycle

Is the change of one rock type into another rock type through natural processes.

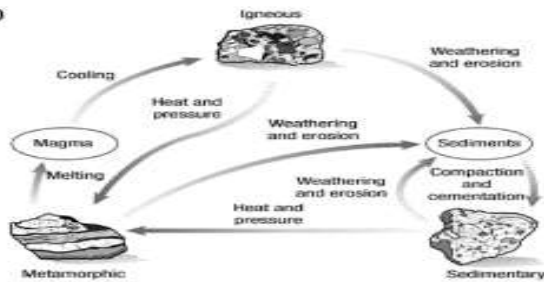
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Lesson Check: The Cycling of Earth's Materials

1)



Sedimentary rocks are changed to sediments by ____.

- ☐ A) compaction
- ☐ B) weathering and erosion
- ☐ C) cementation
- ☐ D) heat and pressure

2) Igneous rocks form from ____ when it cools.

- ☐ A) magma
- ☐ B) lava
- ☐ C) neither a nor b
- ☐ D) both a and b

3) Foliated rocks are distinguished by ____.

- ☐ A) layers
- ☐ B) lack of layers
- ☐ C) large mineral grains
- ☐ D) air holes

4) The crystals that form in slowly cooled magma produce ____ mineral grains.

- ☐ A) tiny
- ☐ B) invisible
- ☐ C) fine-grained
- ☐ D) large

5) Which statement is correct regarding metamorphic rock formation?

- ☐ A) The temperature inside Earth is cooler which allows metamorphic rocks to form more quickly.
- ☐ B) Small pieces of rocks are buried, squeezed, and cemented together.
- ☐ C) Weathering and erosion cause rocks to break down to form metamorphic rocks.
- ☐ D) The deeper into Earth's crust, the higher the pressure that forms metamorphic rocks.

6) The rock cycle can change the sedimentary rock limestone into ____ through metamorphosis.

- ☐ A) conglomerate
- ☐ B) gneiss
- ☐ C) granite
- ☐ D) marble



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- 7) Rocks can change throughout many different processes through the rock cycle. All of the following change rocks on Earth's surface except _____.
- ☐ A) melting
 - ☐ B) weathering
 - ☐ C) deposition
 - ☐ D) compaction
- 8) A student uses a candle to model the process of an existing rock becoming an igneous rock. Which procedure **best** demonstrates the formation of an igneous rock?
- ☐ A) Melt the candle in a dish on a hotplate and keep it in liquid form.
 - ☐ B) Break the candle into small pieces and crush the small pieces until they stick together.
 - ☐ C) Place books on top of the candle to apply pressure, and then heat it so its composition changes.
 - ☐ D) Hold the lit candle over a small dish, and then let the melted candle wax that drops into the dish cool and harden.



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Module 2 Natural Hazards

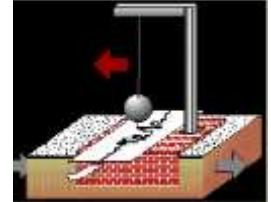
Lesson 1- Earthquake Risks

Earthquake

Occurs when the ground shakes suddenly to release the stress buildup.

Seismograph

Is a digital instrument used for measuring earthquake waves.



Where do earthquakes occur?



Earthquakes can occur anywhere between Earth's surface and depths of greater than 600 km.

Earthquake Scales

1- Richter magnitude scale

2- Moment magnitude scale

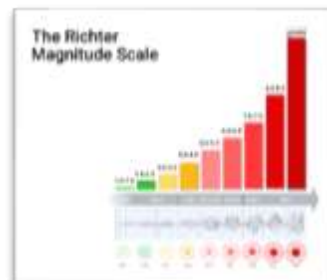
3- Modified Mercalli intensity scale

Earthquake scale measure its **Magnitude** (Is the amount of energy released by an earthquake.

1- Richter magnitude scale

Is a numerical rating system that measures the magnitude, of the seismic waves produced by an earthquake.

Each increase of 1 unit on the scale magnitude represents **10 Times** the amount of shaking
Each increase of 1 unit on the scale represents **32 Times** the amount of Energy



Richter Magnitude	Event (Ex. 6.0 at Yucca)	Other Information
0-1	Not felt by people	Not felt by people
2	Not felt by people	Not felt by people
3	Not felt by people	Not felt by people
4	Not felt by people	Not felt by people
5	Not felt by people	Not felt by people
6	Not felt by people	Not felt by people
7	Not felt by people	Not felt by people
8	Not felt by people	Not felt by people
9	Not felt by people	Not felt by people

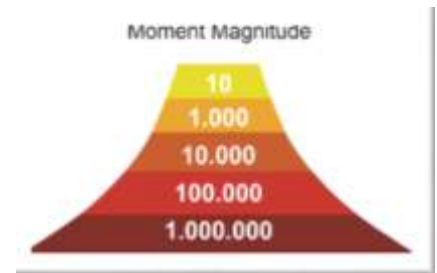


2- Moment Magnitude Scale

Is a rating scale that measures the energy released by an earthquake
It taking into account

- 1- The size of the fault that breaks
- 2- The motion that occurs along the fault
- 3- The strength of the rocks

It is more accurate.



3- Modified Mercalli Intensity Scale

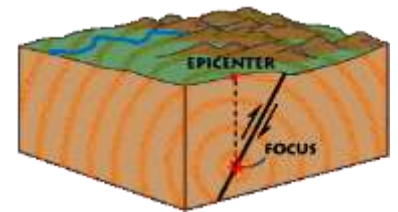
Scale measures earthquake intensity based on descriptions of the earthquake's effects on people and structures.

The scale ranges from I, when shaking is not noticeable, to XII, when everything is destroyed.



The factors that affect the amount of damage caused by an earthquake

- 1- Strength of the earthquake
- 2- The nature of surface materials, the design of structures
- 3- The distance to the **Epicenter** (The point on Earth's surface directly above where the energy released from the earthquake)



Earthquake Hazards

1- Pancaking

resulting debris look like a stack of pancakes

2- Building height.

Structural failure can result because of the height of a building.

3- Local geology

In an area covered by loose sediment, ground motion is exaggerated.

Land and Soil Failure It is occur because of

1- Liquefaction

(Is the act of wet soil like a liquid)

2- Landslide

Is the rapid downhill movement of soil, loose rocks, and boulders.



Tsunami

A tsunami is a large ocean wave generated by vertical motion of the seafloor during an earthquake.

A tsunami can be caused by an underwater earthquake.





Lesson Check: Earthquake Risks

1) The surface along which the crust moves is called a fracture.

☐ True

☐ False

2) _____ is responsible for most of the damage buildings suffer during earthquakes.

3) The forces that move tectonic plates also move rocks along the fault. _____

☐ True

☐ False

4) The larger the force applied to a fault, the smaller the chance of a large earthquake. _____

☐ True

☐ False

5) For the Richter scale, each increase on the scale represents ten times the amount of ground motion recorded on the seismogram. How much more motion is there for a magnitude 7 earthquake than a magnitude 4 earthquake?

☐ A) 3 times

☐ B) 30 times

☐ C) 1000 times

☐ D) 3000 times

6) Which scale would be used to classify an earthquake based on a description found in ancient writings?

☐ A) Modified Mercalli Scale

☐ B) Richter Scale

☐ C) moment magnitude scale

☐ D) all of the above

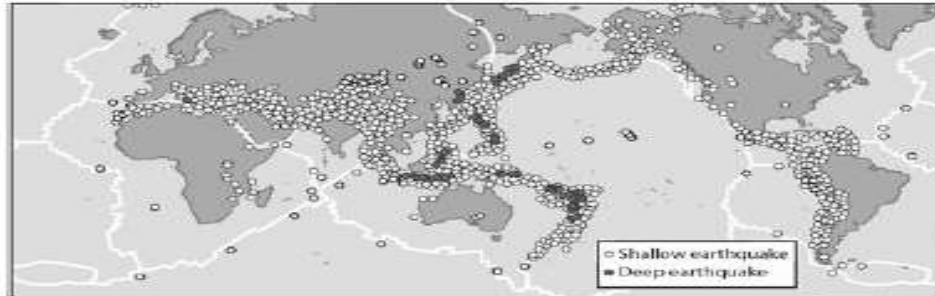


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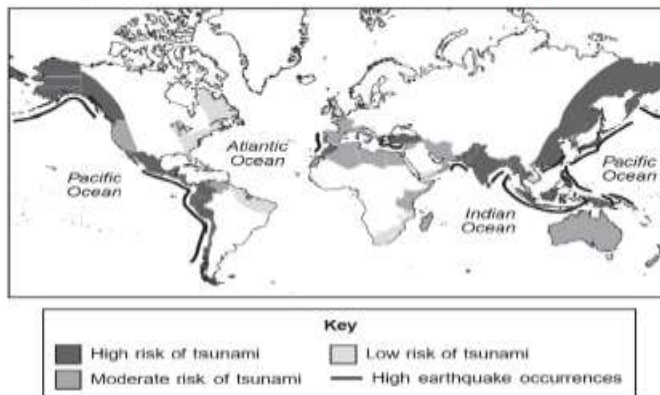
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- 7) Looking at the figure that shows world-wide earthquake distribution, the white lines represent plate boundaries. Which statement is true?



- ☐ A) Deep earthquakes are more common than shallow earthquakes.
- ☐ B) Shallow earthquakes are more common than deep earthquakes.
- ☐ C) Shallow earthquakes and deep earthquakes are equally common.
- ☐ D) Shallow earthquakes do not occur along plate boundaries, but deep earthquakes do.
- 8) When the force on rocks is great enough, they break, producing vibrations called ____.
- ☐ A) faults
- ☐ B) earthquakes
- ☐ C) strains
- ☐ D) stresses
- 11) Tsunamis are huge waves generated by sudden movement of the ocean floor as the result of an earthquake. To help predict tsunamis, scientists monitor earthquakes along the ocean floor. The map shows the risk level of tsunamis around the world.



Based on the map, which solution would be the most effective use of technology for monitoring tsunami threats?

- ☐ A) lookout towers located along the coastlines, with cameras that search for waves moving toward the beaches
- ☐ B) sets of buoys located at various distances and depths from the shoreline that measure changes in water level after an earthquake
- ☐ C) satellites in space that monitor changes in ocean-water temperature
- ☐ D) computer-generated maps that show earthquake strength and location, and the speed and wave height of past tsunamis



Module 2 Natural Hazards

Lesson 2-Volcano Risks

Location of Volcanoes

Most volcanoes form along the edges of plate boundaries.

The volcanoes associated with plate boundaries form two major belts.

1- Ring of Fire

It represents an area of earthquake and volcanic activity that surrounds the Pacific Ocean.

2- Alpine Belt

This belt is smaller than the Pacific Ring of Fire and includes two well-known volcanoes in Italy (**Mount Etna and Mount Vesuvius**)

It is located between the Eurasian, African, and Arabian plates.



2- Hot Spots

Are volcanoes that are not associated with plate boundaries.

Hot rock at these areas is forced toward the crust where it melts partially to form hot spot volcanoes.

Example

The Hawaiian Islands are in the middle of the Pacific Plate



Volcanic Hazards

1- Mudflows

The thermal energy a volcano can melt snow and ice. This melt water can then mix with mud and ash on the mountain to form mudflows.



2- Lava Flows

Lava flows are usually slow moving, so they're rarely deadly. When the lava hardens, it can leave behind thick, black layers of rock. Farmland is lost and homes cannot be rebuilt.

3- Volcanic Ash

Volcano emits large volume of volcanic ash

1- Volcanic ash could disrupt air traffic

2- Cause serious breathing problems.





4- Volcanic Gases

The dissolved gases in magma include water vapor and small amounts of carbon dioxide and sulfur dioxide. A concentration of 3 percent can cause headaches. Concentrations of 15 percent can cause death.

5- Pyroclastic Flows

Are fast-moving avalanches of hot gas, ash, and rocks. Pyroclastic flows travel at speeds of more than 100 km/hr and have temperatures greater than 1000°C.



The effect of volcanic hazards

- 1-Volcanic ash can block sunlight and disrupt air travel.
- 2-Lava flows can cover large areas of land.
- 3-Volcanic gases can harm living things.
- 4-Pyroclastic flows can destroy communities and kill thousands of people.

Predicting Volcanoes

To predict a volcanoes, scientists monitor the following factors:

- 1- Earthquake activity
- 2- Changes in the tilt of the volcano and surrounding ground
- 3 - Gas emissions
- 4 - Lava samples
- 5 - Thermal changes in the volcano.

Monitoring Volcanoes

1- Gases

Scientists collect samples of gases released at vents of volcano, they analyse these samples in the lab.

Increases in certain gases can indicate a potential eruption.

2- Deformation

Scientists use **tiltmeters, GPS, and surveying equipment** to monitor the ground around volcanoes.

As magma rises toward Earth's surface, the ground might tilt, sink, or bulge from pressure.



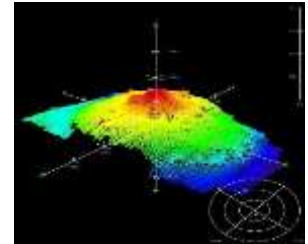
3- Ground Vibration

Earthquake activity beneath a volcano is an indicator of impending eruptions.

Scientists fix sensors near the vents of volcanoes to check seismic

4- Remote Sensing

Scientists use remote sensing to determine how much heat a volcano is emitting and to create 3-D maps of the area around a volcano. These data can be used to predict where lava might flow and how hot it will be.



5- Lava Collection

Samples are collected and immediately cooled in a container to prevent contamination from the surrounding air.

Samples of lava help scientists learn about the properties of magma before it erupts, and to compare samples from other volcanoes to identify patterns.

Lesson Check: Volcano Risks

- 1) Locations where volcanoes form far from plate boundaries are called _____.
- 2) Today, people are never killed by volcanic eruptions.
☐ True
☐ False
- 3) Which of the following is NOT studied by geologists to predict volcanic eruptions?
☐ A) ground deformation
☐ B) earthquake swarms
☐ C) change in shape of the volcano
☐ D) animal behavior
- 4) Which statement accurately describes a pyroclastic flow?
☐ A) Pyroclastic flows move at speeds of more than 100 km/hr and have temperatures over 1,000°C.
☐ B) Pyroclastic flows occur when the snow and ice of the summit are melted and mix with the ash and mud on the mountain.
☐ C) Pyroclastic flows move very slowly, and are rarely deadly.
☐ D) Pyroclastic flows move very quickly but are relatively cool.
- 5) How many volcanoes erupt each year, on average.
☐ A) less than 5
☐ B) around 20
☐ C) around 60
☐ D) more than 100



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6) The Hawaiian Islands are examples of volcanoes that are associated with a _____.

- ☐ A) convergent plate boundary
- ☐ B) divergent plate boundary
- ☐ C) transform plate boundary
- ☐ D) hot spot

7) A _____ often forms a mountain when layers of lava and volcanic ash erupt and build up.

- ☐ A) caldera
- ☐ B) volcano
- ☐ C) dike
- ☐ D) batholith

8) Ash, lava, and _____ erupt from the crater of a volcano.

11) Students conducted research on volcanoes to learn about typical signs of potential volcanic eruptions. Based on their research, they created the data table below. Then they asked some of their classmates to use this information to predict which volcano listed in the table is most likely to erupt next.

Volcano Observations

	Volcano 1	Volcano 2	Volcano 3	Volcano 4
Seismic Activity	Medium earthquakes, but infrequent	Small earthquakes increasing in frequency	Small, regular earthquakes	Small, infrequent earthquakes
Ground Swelling	None	Increase by 11 centimeters	Increase by few millimeters	None
Presence of Vapors	Low levels of CO ₂ recently detected	CO, methane, and others recently detected	None	None
History of Eruption	Not known	Last eruption 300 years ago	Last eruption 50 years ago	Not known

Their classmates make the following predictions:

- Caeley predicts Volcano 1 will erupt next.
- Justine predicts Volcano 2 will erupt next.
- Renée predicts Volcano 3 will erupt next.
- Angela predicts Volcano 4 will erupt next.

Whose prediction is supported by the data?

- ☐ A) Caeley's, because Volcano 1 has the most intense seismic activity.
- ☐ B) Justine's, because Volcano 2 has more than one piece of evidence of change in activity.
- ☐ C) Renee's, because Volcano 3 erupted most recently.
- ☐ D) Angela's, because Volcano 4 shows the fewest signs of normal volcanic activity.



Module 2 Natural Hazards

Lesson 3- Severe Weather Risks

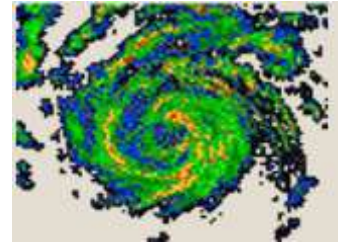
Severe Weather

These events, such as floods, droughts, hurricanes, and tornados

1- Hurricane

Is an intense tropical storm with winds exceeding 119 km/h.

A hurricane can produce strong winds, lightning, and even tornadoes.



MATH Connection

4. Because hurricanes resemble the shape of a circle, you can use geometry to approximate their size. What is the area of a hurricane that has a radius of 150 km?

$$A = \pi r^2$$

$$A = \pi \times (150 \text{ km})^2$$

$$A = 70,686 \text{ km}^2$$

MATH Connection

5. Hurricane Sandy had a radius of 804 km. What is the circumference of the hurricane?

$$C = 2\pi r$$

$$C = 2 \times \pi \times (804 \text{ km})$$

$$C = 5,052 \text{ km}$$

Hurricane Formation

- 1-Hurricane begins as a thunderstorm above the ocean
- 2- Hurricane gets more energy from water vapor and warm air to become a tropical storm
- 3- Tropical storm gets more water and energy to become hurricane



Hurricane Monitor

Meteorologists use satellites, ships, radar, and buoys to collect data.

Data are put into computer models to help scientists predict the storm's path and how strong it will become

Hurricane's scale

The strength of hurricanes is rated on

The Saffir–Simpson hurricane scale.

The scale is based (Wind strength

- Damage caused by hurricanes)

Category	Wind Speed	Damage
1	119–154 km/h (74–96 mph)	Minimal damage: unroofed mobile homes and poorly constructed homes. Some coastal flooding and minor power outages occur.
2	154–177 km/h (96–110 mph)	Minor damage to buildings, roofs, glass, and vehicles. Some mobile homes are destroyed. Flooding occurs along the coast. Some power outages. Some damage to trees and crops.
3	177–200 km/h (110–125 mph)	Major damage to buildings, roofs, and vehicles. Some mobile homes are destroyed. Flooding occurs along the coast. Significant damage to trees and crops. Some power outages.
4	200–249 km/h (125–155 mph)	Severe damage to buildings, roofs, and vehicles. Many mobile homes are destroyed. Flooding occurs along the coast. Significant damage to trees and crops. Many power outages.
5	≥ 249 km/h (≥ 155 mph)	Extreme damage to buildings, roofs, and vehicles. Most mobile homes are destroyed. Flooding occurs along the coast. Significant damage to trees and crops. Many power outages.

Done By: Nehal Abdelhamid Mohamed – Al Shawamekh school



Hurricane can cause

Wind – Waves - Rain - Storm surge - Tornadoes

Tornado

A violent rotating column of air in contact with the ground

Tornado Scale



(thepointblank.com • 6877264)

Table 1 Enhanced Fujita Damage Intensity Scale		
Category	Wind Speed	Damage
EF-0	105–137 km/h (65–85 mi/h)	Light Damage Chimneys are damaged; tree branches are broken; shallow-rooted trees are toppled.
EF-1	138–177 km/h (86–110 mi/h)	Moderate Damage Roof surfaces are peeled off; windows are broken; tree trunks are snapped.
EF-2	178–218 km/h (111–135 mi/h)	Considerable Damage Roof structures are damaged; manufactured homes are destroyed.
EF-3	219–266 km/h (136–165 mi/h)	Severe Damage Roofs and some walls are torn from structures; small buildings are destroyed; most trees in forests are uprooted.
EF-4	267–322 km/h (166–200 mi/h)	Devastating Damage Some structures are lifted from their foundations and blown some distance. Cars also are blown some distance. Large debris becomes airborne.
EF-5	>322 km/h (>200 mi/h)	Incredible Damage Strong frame houses are lifted from foundations; reinforced concrete structures are damaged. Automobile-sized debris becomes airborne. Trees are completely debarked.

Table 1 Tornadoes are described and categorized according to the damage they cause.

Tornado Damage

On the Enhanced Fujita Damage Intensity Scale,

EF-0 tornadoes cause light damage, breaking tree branches and damaging billboards.

EF-1 though **EF-4** tornadoes cause moderate to devastating damage, including tearing roofs from homes, derailing trains, and throwing vehicles in the air.

EF-5 tornadoes cause incredible damage, such as demolishing concrete and steel buildings and pulling the bark from trees.

A. Large debris becomes airborne.		D. Manufactured homes are damaged.	
B. Small buildings are destroyed.		E. Trees are completely debarked.	
C. Tree branches are broken.		F. Windows are broken.	

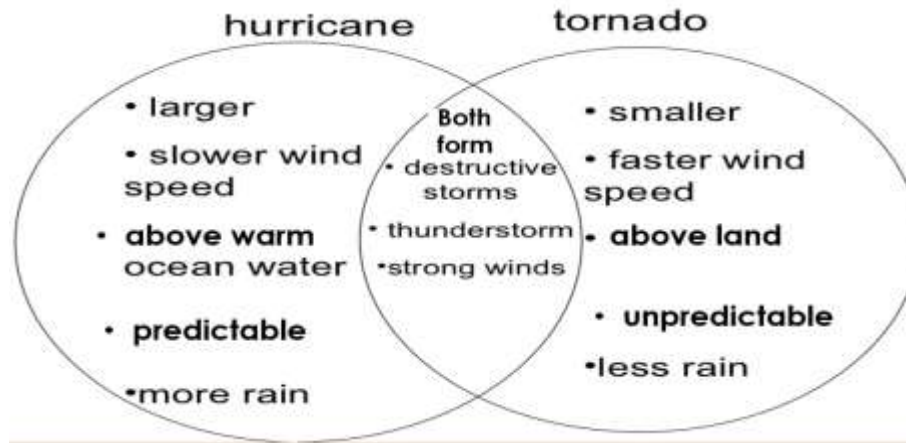
Enhanced Fujita Damage Intensity Scale		
Category	Wind Speed	Damage
EF-0	105-137 km/h	C
EF-1	138-177 km/h	F
EF-2	178-218 km/h	D
EF-3	219-266 km/h	B
EF-4	267-322 km/h	A
EF-5	>322 km/h	E



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Tornado Safety

1- Go inside a sturdy building.

2- Go to the basement.

3- Go to interior room on the lowest floor and get under a sturdy piece of furniture.

Lesson Check: Severe Weather Risks

1) The figure below is an illustration of a tornado.



- ☐ True
- ☐ False

2) When severe weather conditions already exist, a(n) _____ is issued.

- ☐ A) warning
- ☐ B) advisory
- ☐ C) watch
- ☐ D) station model

3) The map of the United States shows an area where most tornadoes occur. This area is known as _____.





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5) Which classification of tornado on the Enhanced Fujita scale does the most damage?

- ☐ A) EF0
- ☐ B) EF2
- ☐ C) EF4
- ☐ D) EF5

6) A severe weather watch means which of the following?

- ☐ A) The conditions are right for severe weather, but it is not occurring yet.
- ☐ B) Severe weather is occurring.
- ☐ C) Severe weather has passed through and it is now safe to go outside.
- ☐ D) Severe weather is likely to occur during the current season.

7) Mr. Peterson had been very busy, but found a day to relax. He knew that the following day would be just as hectic as the days before. He described his relaxing day as "the eye of the storm." To which type of severe weather was Mr. Peterson comparing his life?

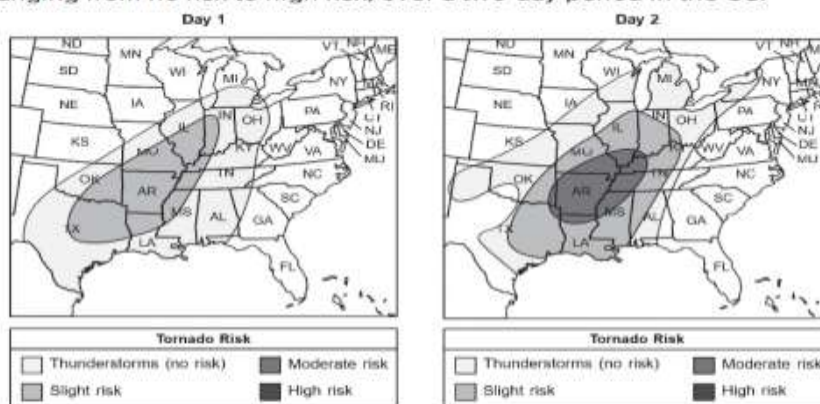
- ☐ A) hurricane
- ☐ B) tornado
- ☐ C) thunderstorm
- ☐ D) blizzard

8) Even though the speed in tornado winds is often higher than the speed in hurricane winds, hurricanes cause much more general damage. Why?

- ☐ A) Hurricanes are much bigger than tornadoes.
- ☐ B) Hurricanes last longer than tornadoes.
- ☐ C) Hurricanes are also associated with flooding, since they cause high waves and heavy rainfall.
- ☐ D) all of the above

9) A _____ occurs when a large volume of water overflows its boundaries.

11) Meteorologists use technology such as satellite images, radar, and computers to track severe weather that may form tornadoes. With this information, emergency responders use cell phones to protect and alert people to severe weather. These maps show the risk of tornadoes, ranging from no risk to high risk, over a two-day period in the US.



Which prediction for Day 3 is **best** supported by the data in the maps?

- ☐ A) Satellite weather-tracking cameras will be focused on Florida (FL).
- ☐ B) Tornado warning alerts will be sent to cell phones throughout Arkansas (AR).
- ☐ C) Radar images will show an increasing risk of tornadoes throughout Texas (TX).
- ☐ D) Severe-weather computer simulations will indicate a high risk of tornadoes throughout Kansas (KS).