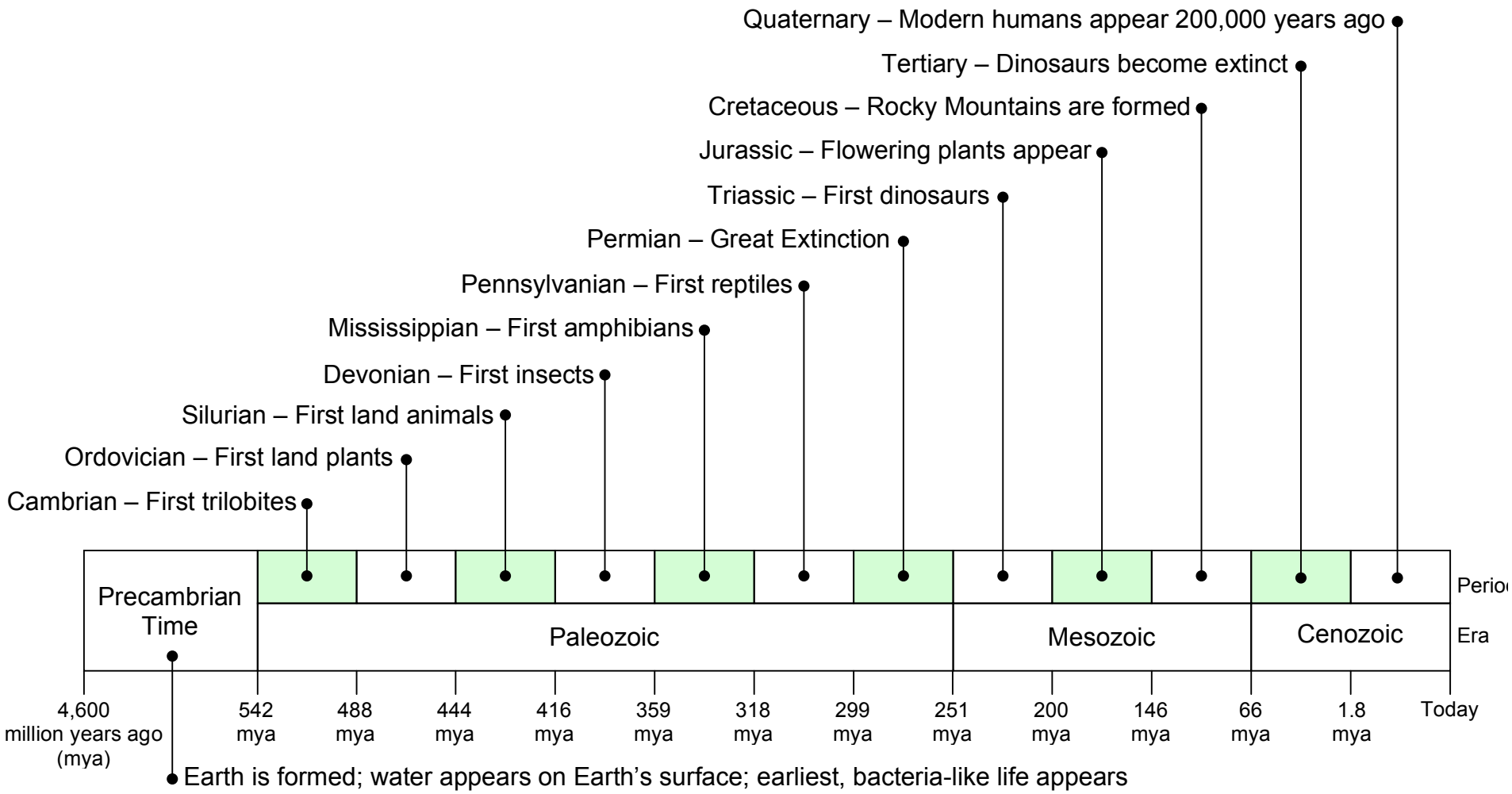
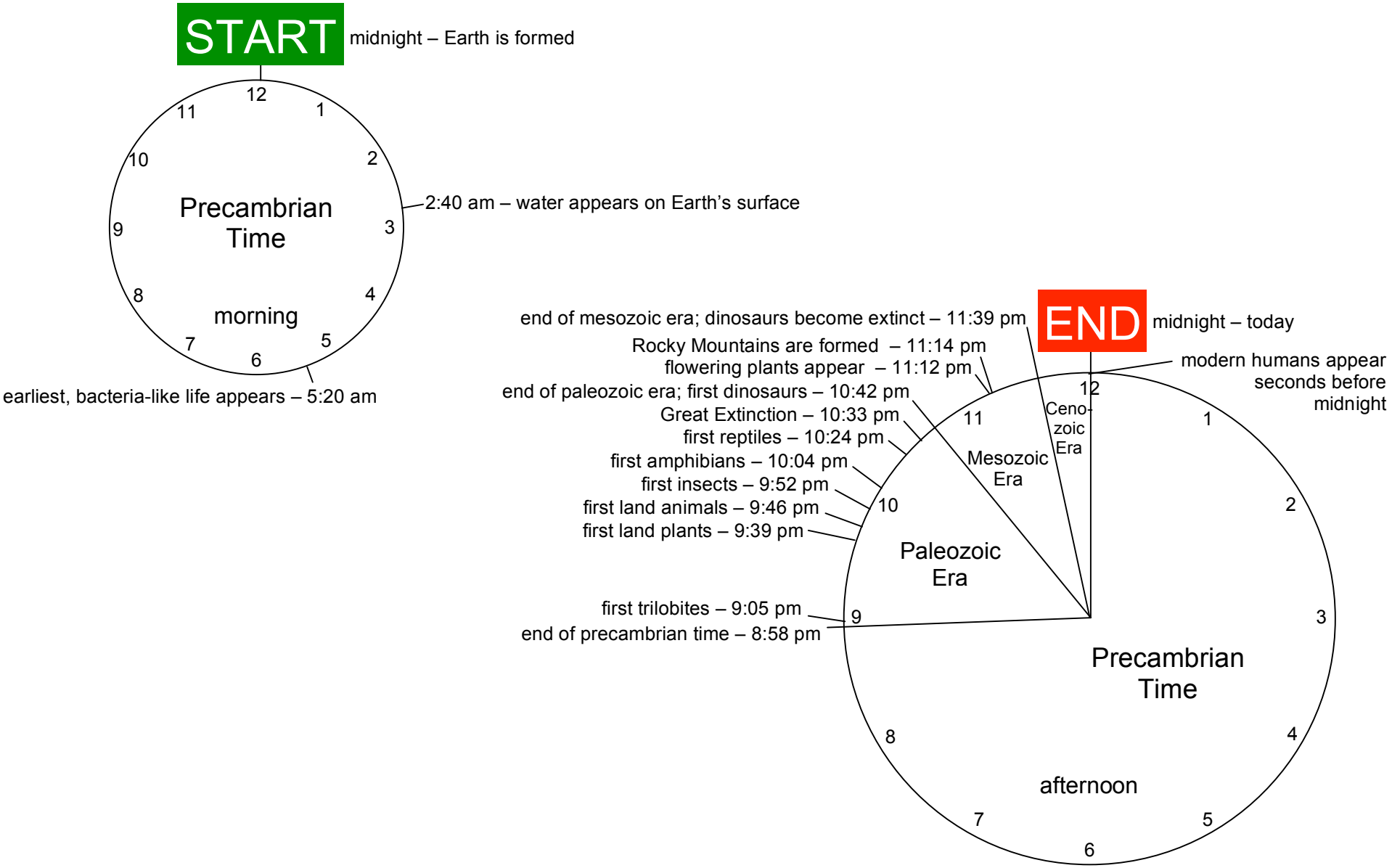
Compare Time Scales – Numeric Scale – Table 1

Era	Period	Dates (mya = million years ago)	Major Event
Cenozoic	Quaternary	1.8 mya to today	Modern humans appear (200,000 years ago)
	Tertiary	66 to 1.8 mya	Dinosaurs become extinct (66 mya)
Mesozoic	Cretaceous	146 to 66 mya	Rocky Mountains are formed (144 mya)
	Jurassic	200 to 146 mya	Flowering plants appear (150 mya)
	Triassic	251 to 200 mya	First dinosaurs (245 mya)
Paleozoic	Permian	299 to 251 mya	Great Extinction (270 mya)
	Pennsylvanian	318 to 299 mya	First reptiles (300 mya)
	Mississippian	359 to 318 mya	First amphibians (350 mya)
	Devonian	416 to 359 mya	First insects (400 mya)
	Silurian	444 to 416 mya	First land animals (420 mya)
	Ordovician	488 to 444 mya	First land plants (450 mya)
	Cambrian	542 to 488 mya	First trilobites (540 mya)
Precambrian Time		4,600 to 542 mya	Earliest, bacteria-like life appears (3,500 mya) Water appears on Earth's surface (4,000 mya) Earth is formed (4,600 mya)

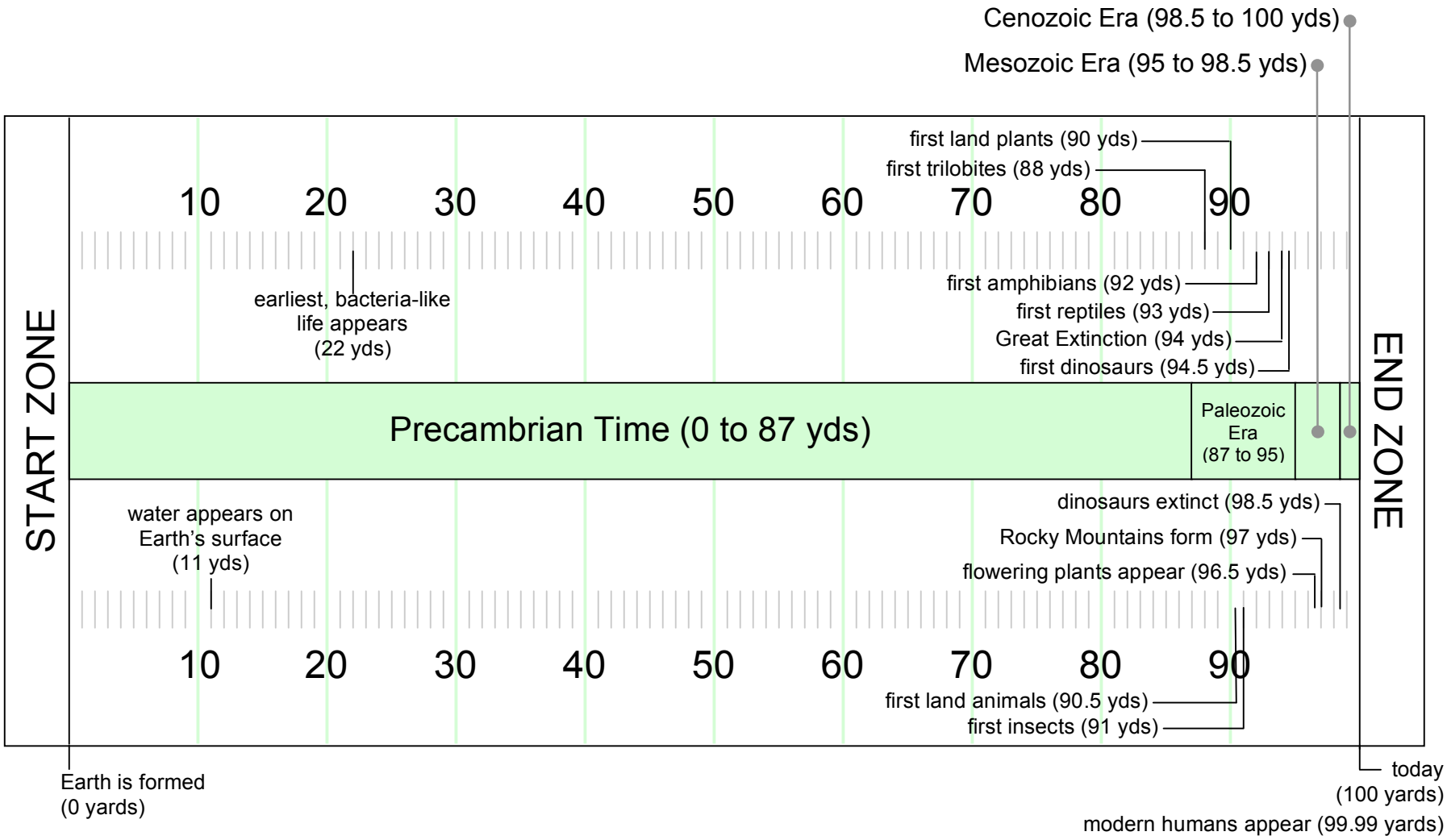
Compare Time Scales – Numeric Scale – Timeline 2



Compare Time Scales – Proportional Scale – Clock 3



Compare Time Scales – Proportional Scale – Football Field 4



Compare Numeric Time Scales 5

	Table	Timeline
Where in the diagram does it say Earth is formed?		
Where in the diagram is today?		
Look at the three eras and precambrian time. At first glance, which looks like it lasted longest?		
When did precambrian time begin?		
When did precambrian time end?		
How long did precambrian time last?		
When did the paleozoic era begin?		
When did the paleozoic era end?		
How long did the paleozoic era last?		
When did modern humans appear?		

Compare Proportional Time Scales 6

	Clock	Football Field
Where in the diagram does it say Earth is formed?		
Where in the diagram is today?		
Look at the three eras and precambrian time. At first glance, which looks like it lasted longest?		
At what point does precambrian time begin?		
At what point does precambrian time end?		
How much of the diagram is precambrian time?		
At what point does the paleozoic era begin?		
At what point does the paleozoic era end?		
How much of the diagram is the paleozoic era?		
At what point do modern humans appear?		

Diamond

Mineral

Diamond is a natural solid that is made entirely of carbon. It forms when very high temperature and pressure cause carbon atoms to form crystals. It is the hardest mineral on Earth.

color: pale yellow or colorless
common uses: jewelry; tools for cutting & drilling
density: 3.5 g/cc
hardness: 10

Coal

Rock

Coal is a natural solid that forms when the buried remains of trees and ferns are exposed to heat and pressure. It is made mostly of organic carbon, with varying amounts of sulfur, hydrogen, oxygen, and nitrogen. Coal has an amorphous structure.

color: black or brownish black
common uses: fuel; generating electricity
density: varies
type: metamorphic

Calcite

Mineral

Calcite is a natural solid that is made of calcium carbonate. The chemical formula for calcium carbonate is $CaCO_3$. Calcite is an inorganic solid that is noted for its almost perfect cleavage, which means that it splits along smooth surfaces.

color:	colorless or white to tan	density:	2.7 g/cc
common uses:	cement; building materials; soil treatment	hardness:	3

Limestone

Rock

Limestone is a natural solid that forms when the shells of sea creatures are pressed tightly together. It is made mostly of calcite, with varying amounts of other minerals like quartz and aragonite. Limestone has a crystalline structure.

color:	white to tan or gray	density:	varies
common uses:	crushed stone; cement; building materials	type:	sedimentary

Quartz

Mineral

Quartz is a natural solid that is made of silicon dioxide. The chemical formula for silicon dioxide is SiO_2. Quartz forms when molten rock that contains a lot of silica cools slowly and forms large crystals.

color: colorless or white
common uses: jewelry; glass; computer chips
density: 2.6 g/cc
hardness: 7

Granite

Rock

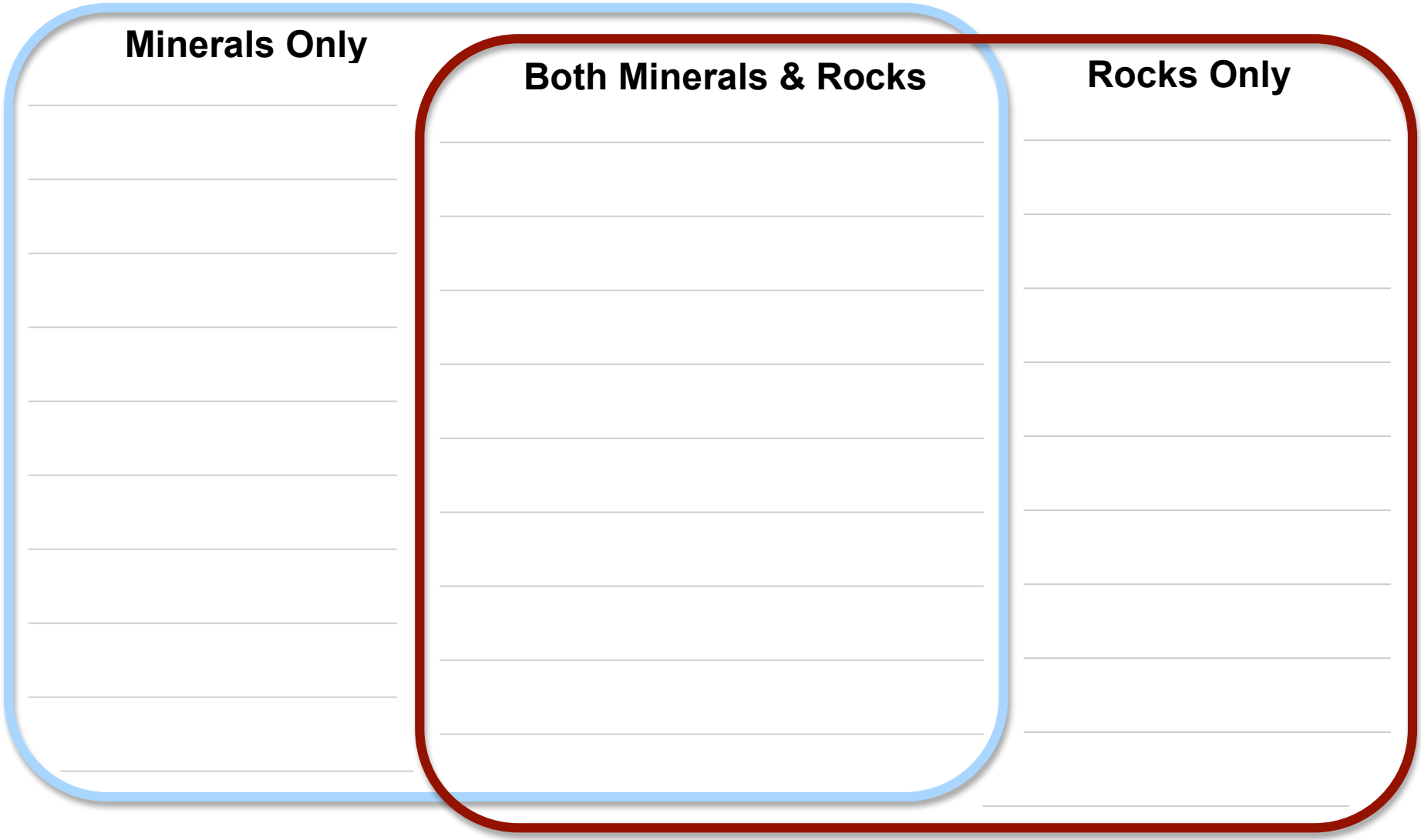
Granite is a natural solid that forms deep beneath Earth's surface, when molten rock cools and hardens. It is made mostly of quartz and feldspar, with varying amounts of other minerals like mica. Granite crystals are often large, smooth, and shiny.

color: usually light pink or gray
common uses: building materials; countertops; monuments
density: varies slightly
type: igneous

Compare Rocks & Minerals 10

	Diamond	Coal	Calcite	Limestone	Quartz	Granite
What is it? (rock or mineral)						
Is it naturally formed? (i.e., not man-made)						
Is it organic? (i.e., comes from living things)						
What is its state? (solid, liquid, or gas)						
What kind of structure does it have? (crystalline or amorphous)						
What kind of substance is it? (element, compound, or mixture)						
Does it have a predictable density?						

Compare Rocks & Minerals



The 21st Century Center for Research & Development in Cognition & Science Instruction

Trilobite Hunter

Imagine your class is on a field trip to a local quarry. The teacher asks everybody to find the coolest rock you can and bring it back to her. You and your friend go to opposite sides of the quarry.

Your friend brings back a rock that hardly weighs anything and is full of tiny holes. You bring back a gray rock marked with what looks like a picture of a bug.

Your teacher says, “That’s a trilobite fossil. You can sell that rock on the internet for a lot of money.”

Your friend says, “Where can I find a trilobite fossil?”

The teacher answers, “if you want to find fossils, you have to know about how rocks form and where rocks that contain fossils are likely to be found.”

Throughout this chapter, see if you can figure out the answers to these questions:

- What kinds of rocks are likely to contain fossils?
- Where should you look for trilobite fossils?

Granite

Igneous

Granite forms when molten rock cools and hardens. This happens when magma is trapped underground. The temperature there is very warm, so the magma hardens slowly. This slow cooling results in the formation of large crystals that are easily visible without a hand lens.

Granite makes up a large portion of Earth's crust and mountain ranges. It is very hard and long-lasting, so it is often used for headstones and other monuments. Granite does not contain fossils.

Pumice

Igneous

Pumice forms when molten rock cools and hardens. This happens when a volcano erupts and lava explodes into the air. The temperature there is very cool, so the lava hardens quickly. This fast cooling results in the formation of tiny pieces of volcanic glass.

Pumice also contains tiny holes that were once gas bubbles in foamy lava. The holes make it so light that some can even float in water. The volcanic glass makes pumice useful as an abrasive in skin soaps and household cleaners. Pumice does not contain fossils.

Igneous – Granite & Pumice

Question	Same	Different
How does the rock form?		Granite – Pumice –
What features result from this process?		Granite – Pumice –

Sandstone

Sedimentary

Sandstone forms when grains of sand get compacted and cemented together. When a river carrying sand slows, the sand settles and piles up. Over time, new layers form on top of old layers, squeezing and compacting the sand in the bottom layers. A chemical called a cementing agent that holds the grains of sand together.

Because the remains of plants and animals often settle along with grains of sand, sandstone often contains fossils. Its color depends on what it is made of. A lot of sand is mostly quartz, which is clear or white. But some sand is sand is black or gray because it contains a lot of volcanic rock crystals.

Limestone

Sedimentary

Limestone forms when the remains of sea creatures get compacted and cemented together. When these organisms die, their shells settle and pile up. Over time, new layers form on top of old layers, squeezing and compacting the pieces in the bottom layers. Shells are made of calcium carbonate, which acts as a cementing agent that holds the pieces together.

Because it is made from shell pieces, limestone often contains fossils. Its color depends on what it is made of. Calcium carbonate is white, but limestone usually contains sand and mud as well, so it is often tan.

Sedimentary – Sandstone & Limestone

Question	Same	Different
How does the rock form?		Sandstone – Limestone –
What features result from this process?		Sandstone – Limestone –

Slate

Metamorphic

Slate forms when shale, a sedimentary rock, changes due to heat and pressure. This process happens deep beneath Earth's surface.

Shale is a smooth, hard rock with very fine grains arranged in layers. Slate is also smooth with very fine grains, but it is harder and more compact. Shale often contains fossils, but slate rarely does. The biggest change is that slate can be easily split into sheets of different thicknesses. For this reason, it is often used to make roofing tiles and paving stones.

Schist

Metamorphic

Schist forms when slate, a metamorphic rock, changes due to extreme heat. This process happens deep beneath Earth's surface.

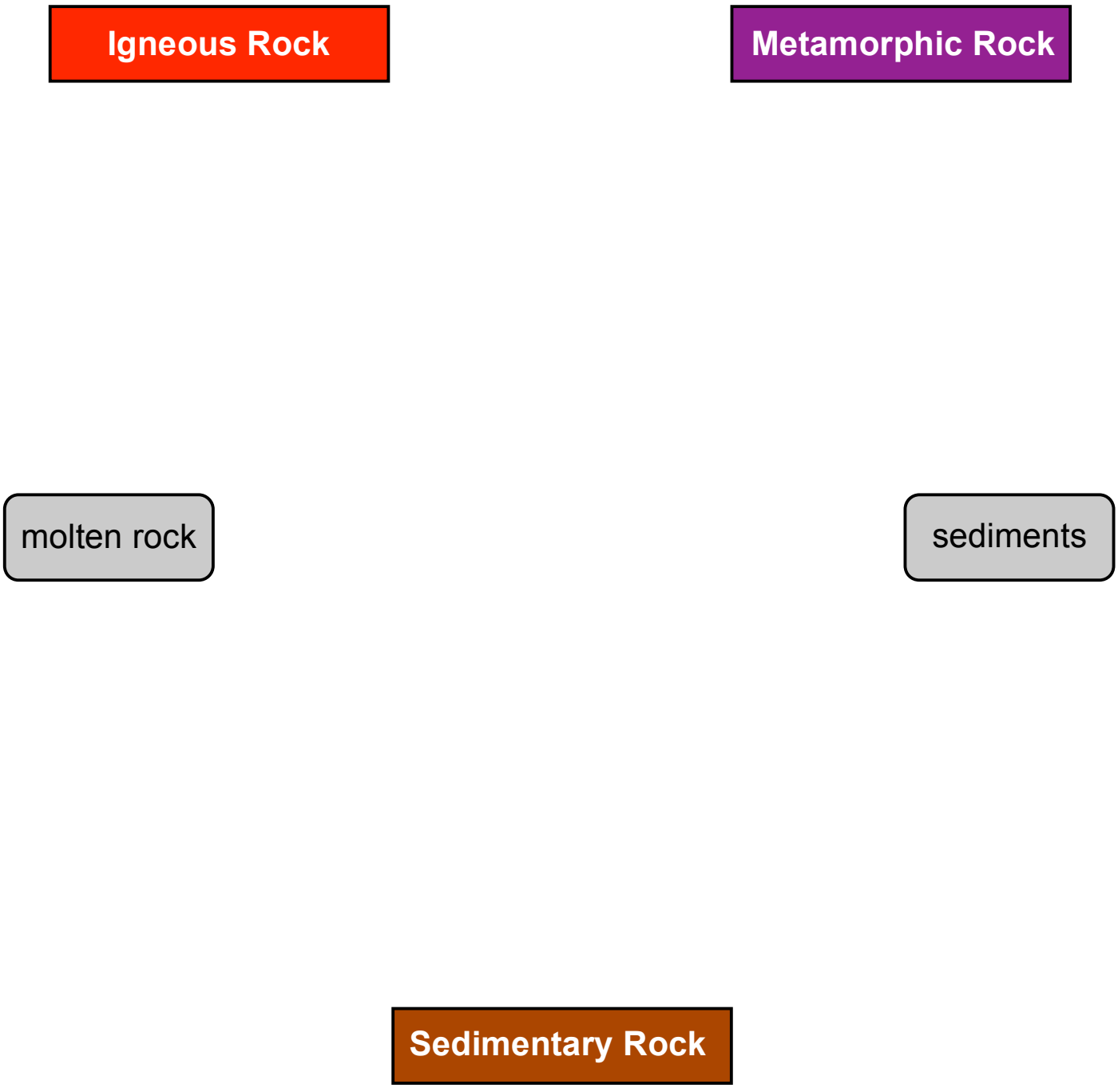
Slate is smooth, fairly shiny, and hard. Schist is rough and shiny, and small pieces tend to flake off easily. The biggest change is in grain size. Slate has very fine grains. Schist has medium to coarse crystals that are flat and arranged in layers. Fossils are rarely found in slate or schist.

Compare Properties

Properties of SHALE (original)	
Properties of SLATE that are the same	
Properties of SLATE that are different	
Properties of SLATE (original)	
Properties of SCHIST that are the same	
Properties of SCHIST that are different	

Metamorphic – Slate & Schist

Question	Same	Different
How does the rock form?		Slate – Schist –
What features result from this process?		Slate – Schist –



changes due to heat &/or pressure

cools & hardens

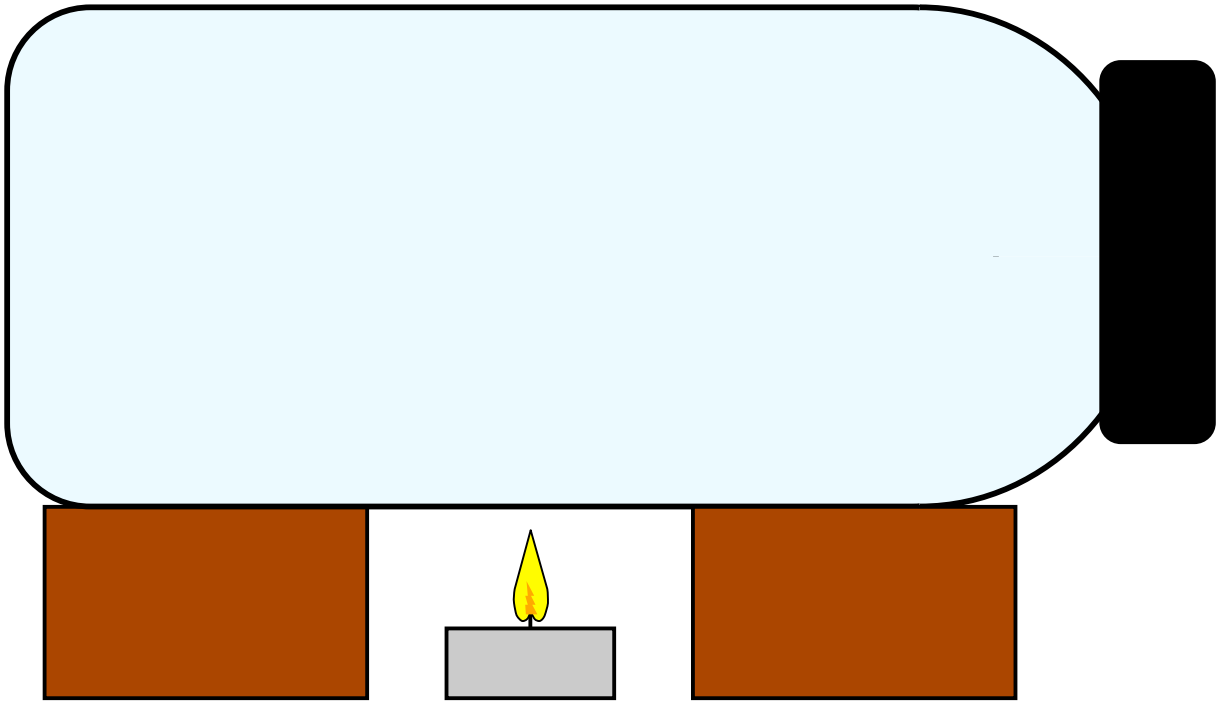
get compacted & cemented together

melts due to extreme heat

weathers, erodes, moves & settles

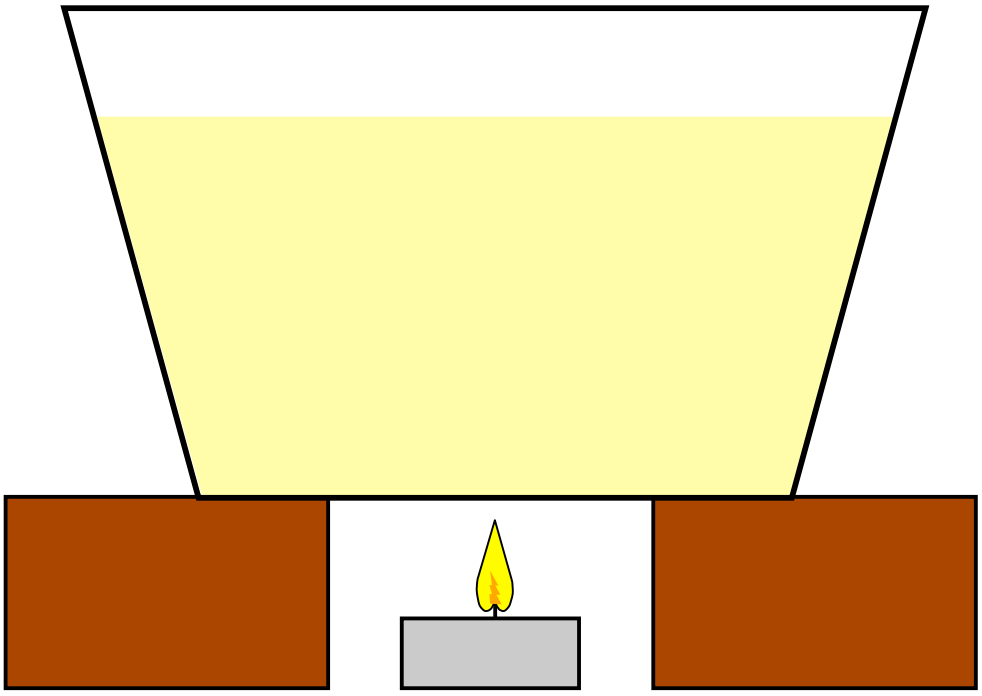
Rheoscopic Fluid

Use drawings and/or words to show what happens to the fluid after the candle is lit.

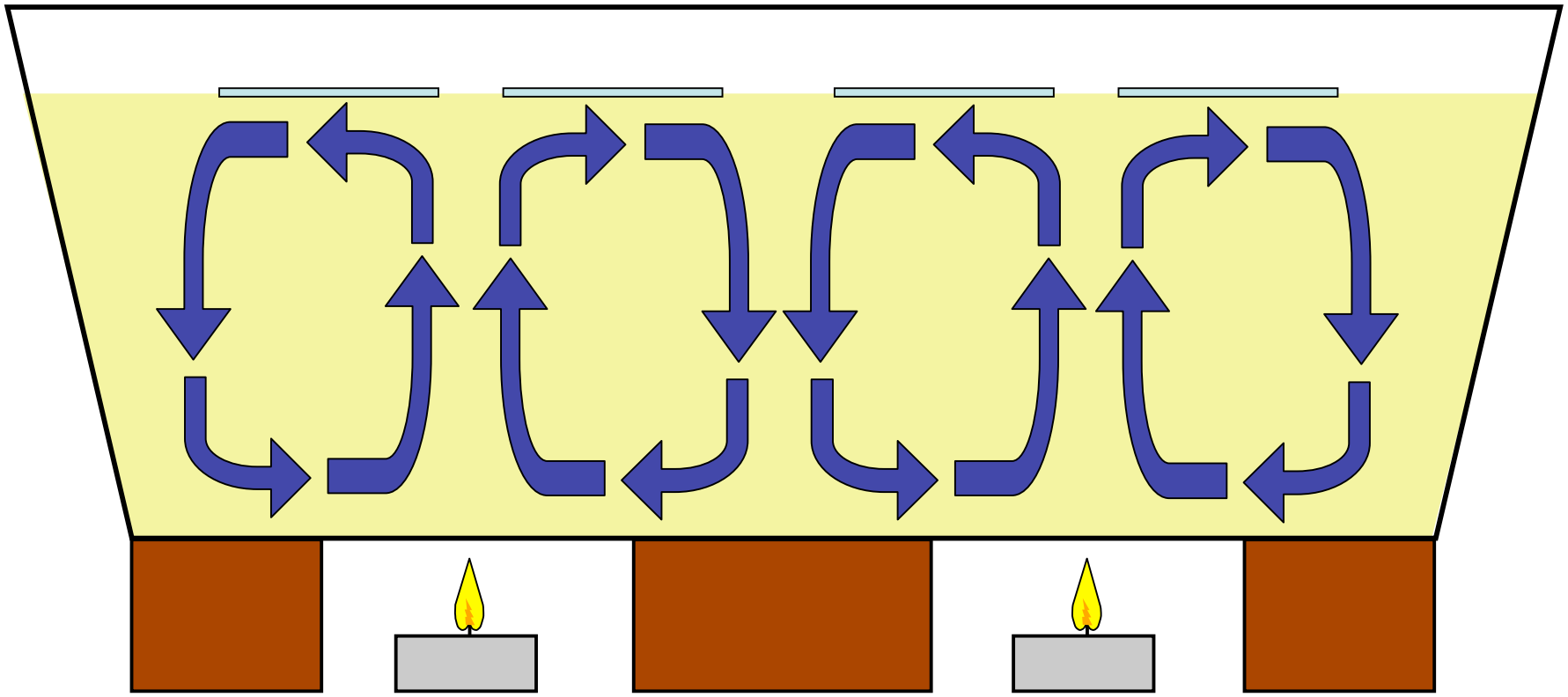


Vegetable Oil

Use drawings and/or words to show what happens to the fluid after the candle is lit.



Convection Diagram 1 – Extra-Wide Beaker



Convection Diagram 2 – Cut-Away Globe

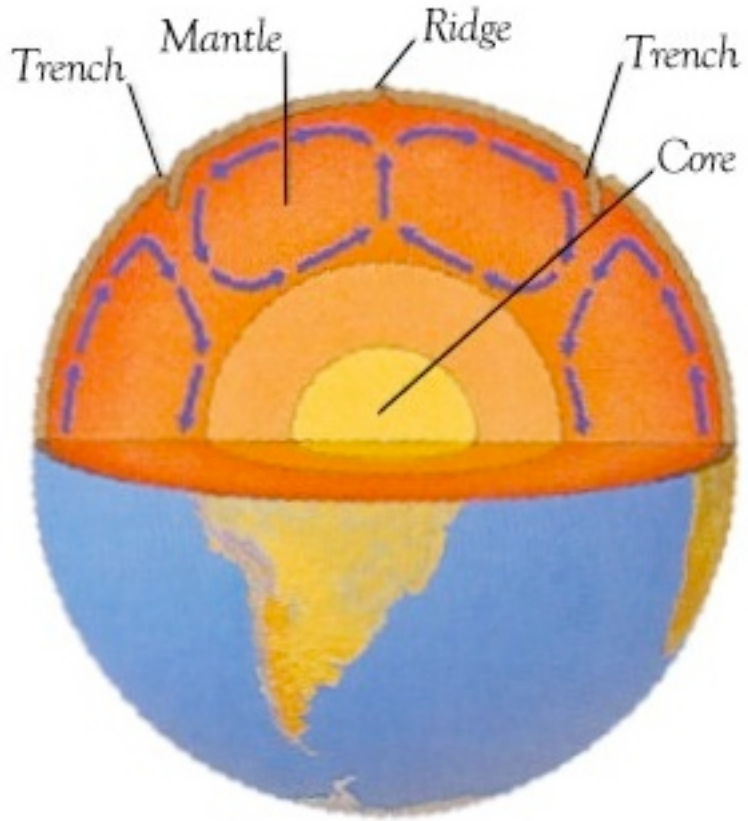


Plate Diagram 1 – Cut-Away Globe Section

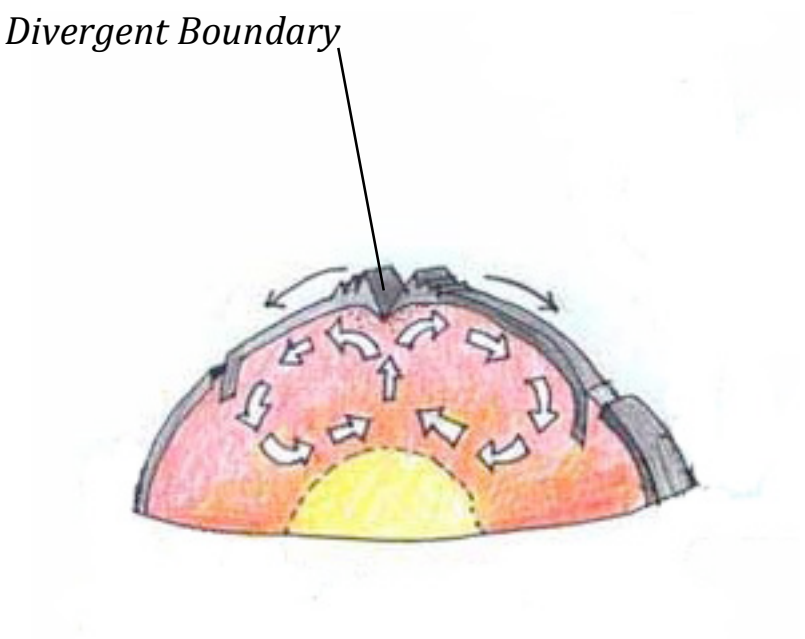
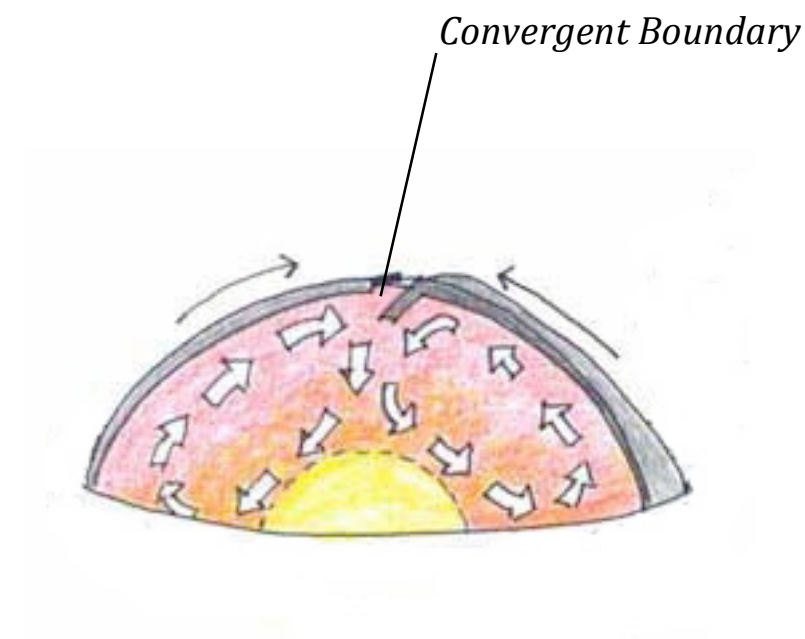
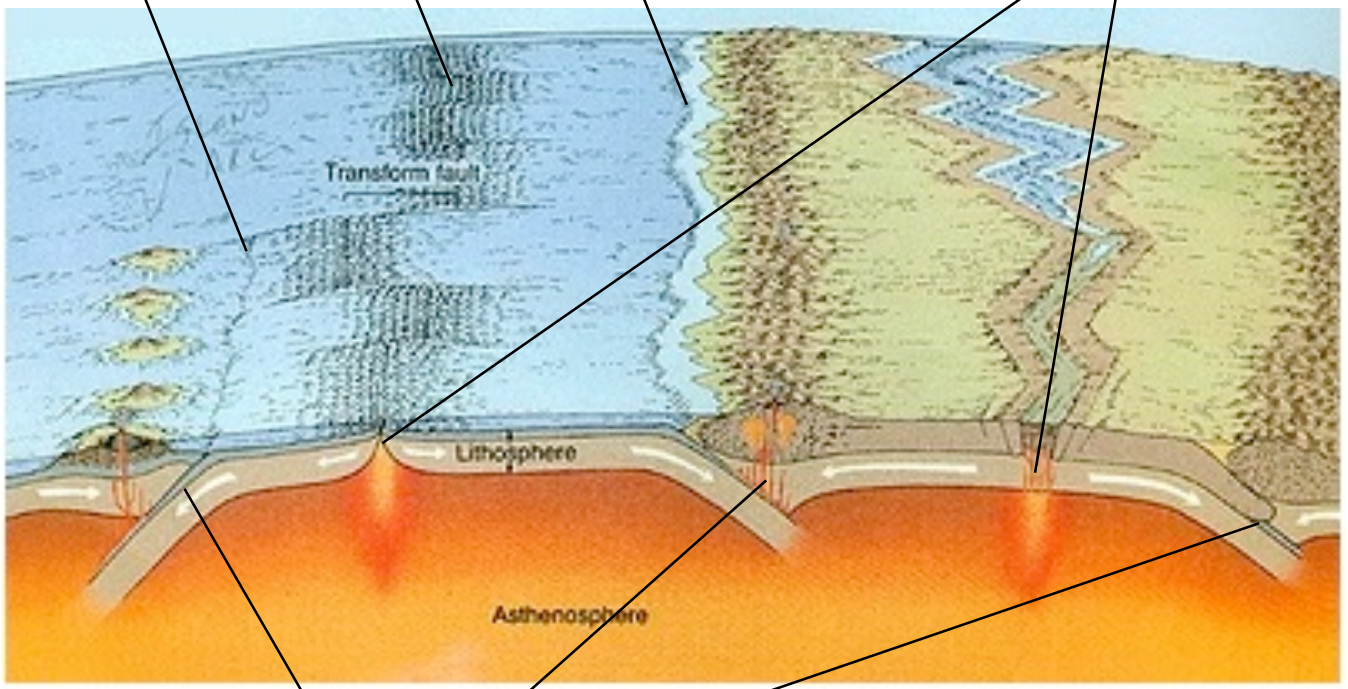
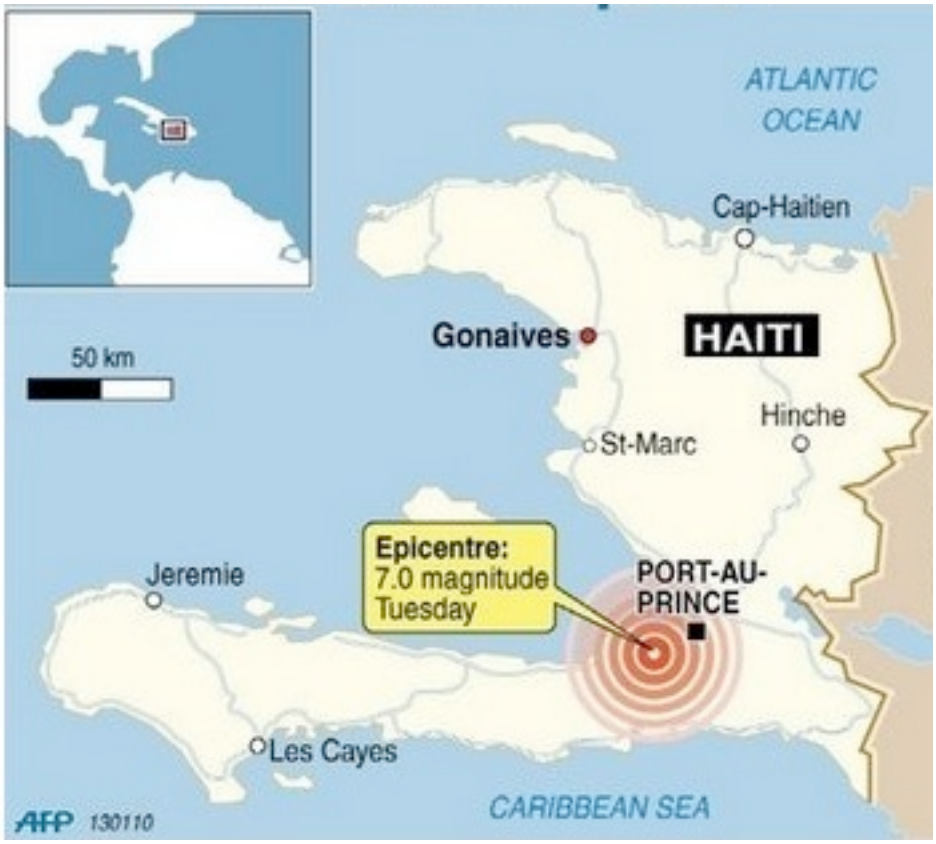
	
When part of the mantle is warmer than its surroundings, it rises. When it reaches the plates, it spreads out. If there is a plate boundary above that area, the plates move apart, or **diverge**.	When part of the mantle is cooler than its surroundings, it sinks. If there is a plate boundary above that area, the plates move toward each other, or **converge**.

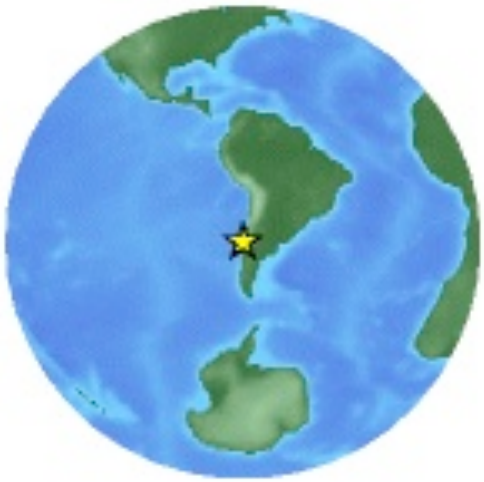
Plate Diagram 2 – Globe Surface





On Tuesday, January 12, 2010, a 7.0-magnitude earthquake struck Haiti. It only lasted for about 35 seconds, but more than 200,000 people were killed and at least 500,000 homes were damaged or destroyed. Government buildings, offices, hotels, schools, and stores collapsed during and after the earthquake, burying people beneath rubble. The earthquake also caused widespread power outages, destroyed roads and hospitals, and damaged communication systems, which hindered rescue and aid efforts. By January 24, at least 52 aftershocks measuring 4.5 or greater had been recorded.

The earthquake was caused by the movements of two tectonic plates: the North American and the Caribbean. Haiti is part of a large island that lies on the boundary between these two plates. At that boundary, both plates have mostly oceanic crust. These two plates are not moving toward or away from each other. Instead, the two plates are moving side-by-side, with the North American plate heading west and the Caribbean plate heading east.



On Saturday, February 27, 2010, an 8.8-magnitude earthquake occurred off the coast of Chile. It lasted 90 seconds and triggered a tsunami that devastated several towns along the coast and caused minor damage in San Diego, California. The earthquake generated a blackout that affected 93% of the country and lasted several days in some locations. Although it was much stronger than the earthquake that struck Haiti, fewer than 1000 people died, perhaps because of Chile's strict laws requiring earthquake-resistant buildings.

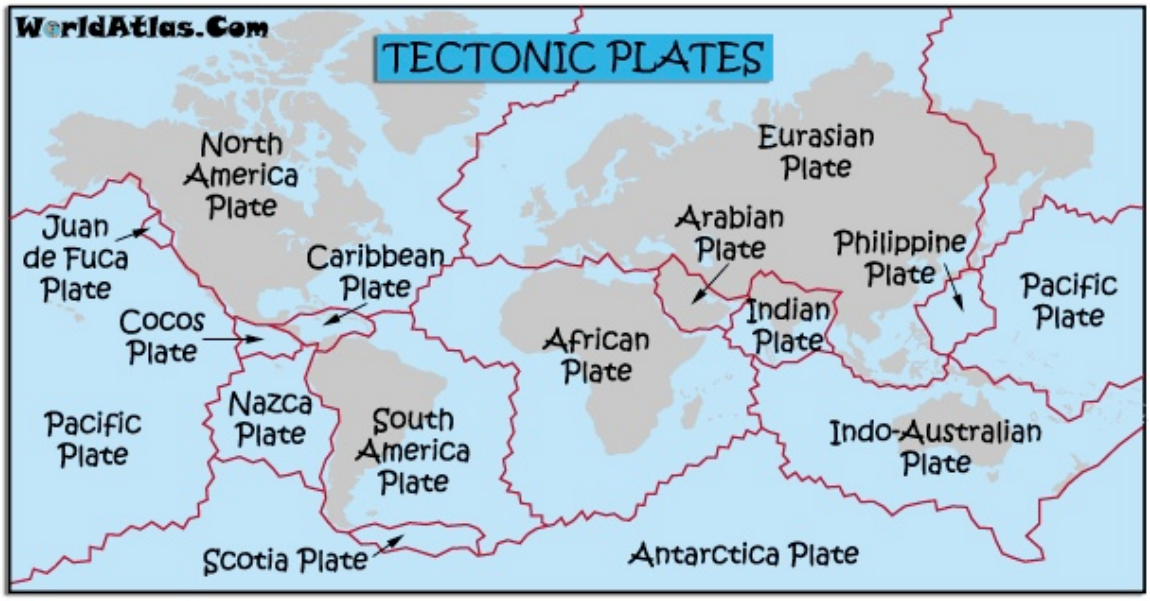
The earthquake was caused by the movements of two tectonic plates: the Nazca and the South American. The Nazca plate has oceanic crust and, at that boundary, the South American plate has continental crust. As these plates move toward each other, the Nazca plate is sinking and moving under the South American plate.

Mount St. Helens, in the state of Washington, is one of the most beautiful mountains of the Cascade Range. But on May 18, 1980, it erupted with a force that blew off the mountain's top and sent ash and debris more than 12 miles into the sky. Sixty two people were killed, and thousands of acres of prime forest were destroyed.

The formation of the Cascade Range and the eruption of Mount St. Helens were caused by the movements of three tectonic plates: the Pacific, the North American, and a tiny plate called Juan de Fuca, which lies between the other two. The Pacific and the Juan de Fuca plates have oceanic crust, and they are moving away from each other. The Juan de Fuca and North American plates are moving toward each other. At that border, the North American plate has continental crust, so the Juan de Fuca plate is sinking and moving under the North American plate. As the plate sinks, magma forms and then rises to the surface. Volcanoes that form this way typically erupt with explosive force, because trapped gases expand as the magma rises, creating tremendous pressure. This pent-up pressure is suddenly released in a violent eruption.

This is an aerial photograph of Amero, a town in Columbia that was destroyed when the Nevado del Ruiz volcano erupted on November 13, 1985. It ejected only about 3 percent of the magma that erupted at Mount St. Helens, yet this tiny eruption triggered mudflows that killed more than 23,000 people. The hot volcanic material melted the snow and ice that covered the mountain, creating floods of water that swept downward. As these floods descended, they picked up soil and loose debris forming hot mudflows. Two and a half hours after the start of the eruption, one of the mudflows reached Amero, 45 miles from the volcano. Within a few short minutes, most of the town was buried or swept away.

Nevado del Ruiz is in the Andes Volcanic Chain of western South America. The formation of the chain and the eruption of Nevado del Ruiz were caused by the movements of two plates: the Nazca, which has oceanic crust, and the South American, which has continental crust at that boundary. As these plates move toward each other, the Nazca plate is sinking and moving under the South American plate.



Haiti Earthquake

name of plate		
type of crust		
type of boundary		

Chile Earthquake

name of plate		
type of crust		
type of boundary		

Mount St. Helens Eruption

name of plate		Juan de Fuca	
type of crust			
type of boundary			

Nevado del Ruiz Eruption

name of plate		
type of crust		
type of boundary		