Chemistry

Unit 2: Heat and Energy in the Earth's Systems

Workbook 3

Name: _____ Period: _____

Guiding Question:

Do Now:

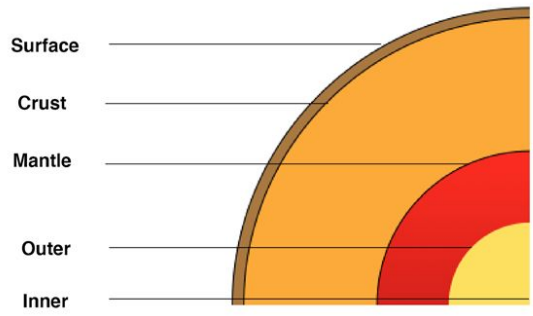
Important Definitions and Equations:

Notes:

Density

- Objects will layer themselves based off of density
- Things with a higher density have particles _____ and will _____ while objects with a lower density have particles _____ and will _____

Earth's layers are sorted by density:



Temperature also contributes to the density of an object

- Objects with a _____ temperature have particles moving more _____ and makes the particles spread out more – _____ the density
- Objects with a _____ temperature have particles moving more _____ and this makes the particles move closer together – _____ the density

Pressure, however, will change the density as well.

- If there is _____ pressure, particles are being _____ _____ – density _____
- If there is less pressure, particles are _____ – density _____

The layers of the earth are arranged as they are because of density, temperature, and pressure (from all the layers above being stacked on them)

Response:

Workbook Date:

8 Caution, Contents Under Pressure

Using Data and Density to Investigate Earth's Layers

Purpose

Investigate the interior of the Earth using principles of density and develop a model of the interior of the Earth.

Background

Scientists who study the Earth's layers are called geologists. Since they cannot see the inside of the Earth, they use geographical clues to help them. These clues are gathered from activities such as volcanoes and earthquakes. From these clues, geologists make inferences about what the inside of the earth actually looks like.

Geologists believe the Earth is made up of different layers known as the crust, mantle, and inner/outer core. These layers vary in depth, pressure, and temperature. Since pressure and temperature affect density, each layer has a different density as well. The density of each layer determines its position in the Earth.

Materials

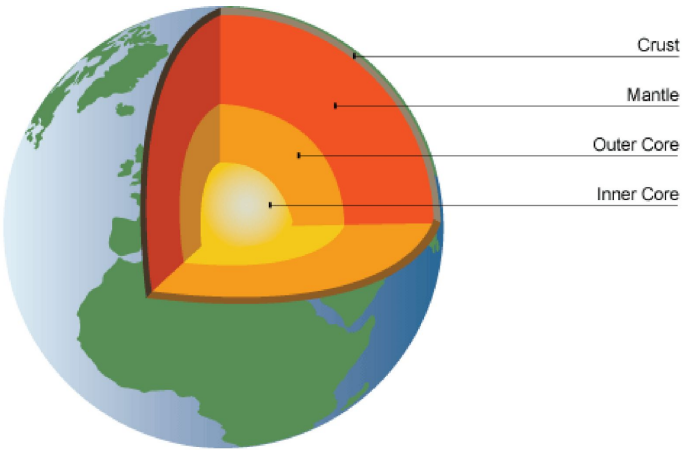
- Graduated Cylinder
- Colored Water
- Dish Soap
- Vegetable oil
- Honey
- Masking Tape

Pre-Lab

Data Table 1

Earth Layer	Density
Crust	2.6 g/mL
Mantle	4.0 g/mL
Outer Core	10.2 g/mL
Inner Core	13.1 g/mL

Figure 1



1. Which layer is the least dense?

2. Which layer is the most dense?

3. What is the relationship between the density and the position of each Earth layer? Support your answer using evidence from Data Table 1 and Figure 1 above.

Workbook Date:

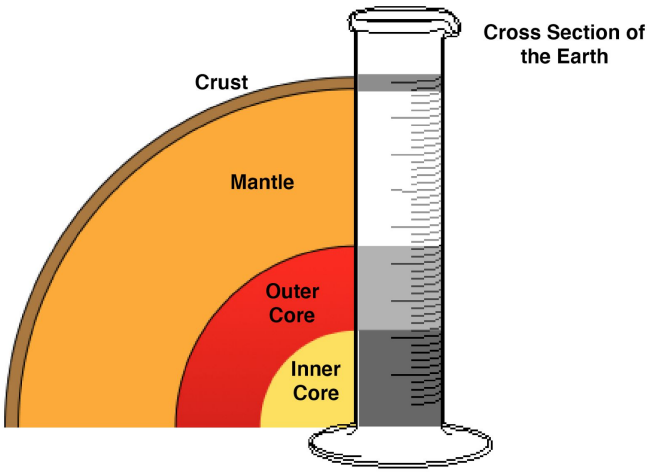
Procedure: Part 1 - Densities of Earth's Layers

1. Using Data Table 2 and the cross section of the Earth below, create a density column that represents the layers of the earth.
2. It is very important to pour the liquids carefully into the center of the cylinder. Make sure they do not touch the sides of the cylinder while you are pouring. It is important to let each layer settle before adding the next one. ***Take your time and pour slowly and carefully.***
3. Make sure that the thickness of the layers in the cross section of the earth below match up with the thickness of the liquids in your density column.
4. Using masking tape, label each layer.
5. Have your teacher sign off on your density column when you are finished.
6. After you have your density column checked off, pour all liquids into the sink and clean your lab station (including the graduated cylinder) with plenty of soap and water.
7. When you have finished, start **Part 2**.

Data Table 2

Liquid	Density (g/mL)	Volume (mL)
Vegetable Oil	0.92	
Honey	1.42	
Dish Soap	1.06	
Water	1.00	

Figure 2



Workbook Date:

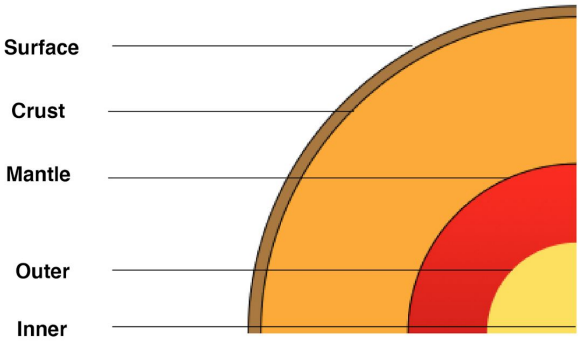
Procedure: Part 2 - Temperatures of Earth's Layers

1. Using Data Table 3 and Figure 3, create a Temperature vs. Depth Graph (remember the rules from before for independent and dependent variables). Label your axes and give your graph a title.
2. After you have completed the graph, have your teacher check your work. Then move on to the analysis questions.

Data Table 3

Earth Layer	Temperature (°C)	Depth (km)
Surface	0	0
Crust	870	30
Mantle	3700	2700
Outer Core	4300	5100
Inner Core	7200	6300

Figure 3



Cross Section of the Earth

Analysis

1. As depth increases, what happens to the temperature?

2. If an object is more dense, will it sink or float in something that is less dense? Explain your answer.

3. The inner core is comprised of iron. Explain what makes this layer solid.

4. Explain the difference in density between the upper mantle (part closest to the crust) and lower mantle (part closest to the core).

5. Why do you think there is a difference in the densities of the upper and lower mantle? Use evidence from this lab (density and temperature pressure graph) to justify your answer.

6. **Search it Out:** Looking at the layers of the Earth, use *research methods* to determine the state of matter (solid, liquid, gas) of each layer.

7. **Model It:** Increases to temperature causes particles to spread out, yet increases to pressure cause particles to become more compact. Create a particle model of each layer taking into account the temperature, pressure, and density of each layer (Data Table 1 and 3).

8. Using your models above, explain why each layer of the Earth is organized in the way it is. Justify your answer by referring to the model in 7, density column in part 1, and graph in part 2.

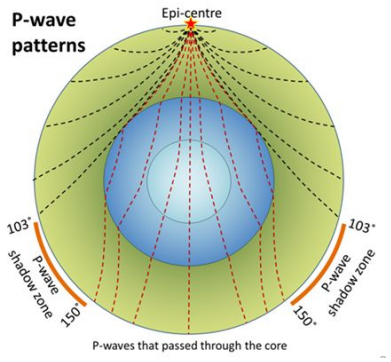
Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

Seismologists can use data from earthquakes occurring all over the world to determine the physical state of each layer of the earth

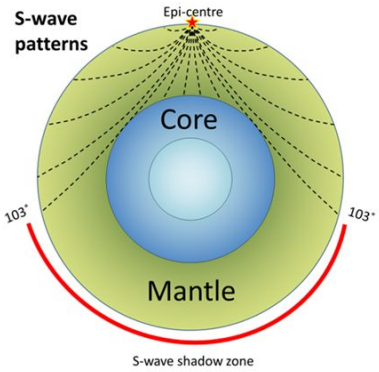


P Waves

- A _____ Wave
- Cause the ground to move up and down
- Pass through _____
- _____

S Waves

- _____ Waves
- Cause the ground to move left to right
- Travel through _____ _____
- _____
- Create a _____



Both P and S waves are refracted as they pass through the different densities and layers in the earth

Notice the shadow zone where no S waves get through

By comparing the differences in the waves, seismograph stations in different places can calculate the size of the earth's core and verify that it is a liquid.

Response:

9 Shake Like an Earthquake

Using P and S Wave Data to Determine the Composition of Earth's Layers

Purpose

Generate an understanding of P and S waves and apply them to movement of waves through matter, specifically Earth's interior.

Materials

- Slinky - DO NOT OVER STRETCH THE SLINKY!
- Meter stick
- Masking Tape

Procedure: Part 1 - P Waves (Push and Pull)

1. Mark and measure out 3 meters using the meter stick and masking tape
2. Select roles:
    a. Timer
    b. Stationary (non-moving) holder
    c. Moving holder
    d. Recorder (this can be done by the timer if in a group of 3)
3. Stretch the slinky to 3 meters and one person hold one end securely on the ground. The other will also be on ground level, but responsible for moving the slinky.
4. Test run: moving holder will pull the slinky slightly towards them and release. ***Record what you notice below***. You should see it move between the two holders 4 times (or 2 cycles, 12 meters total, towards stationary and back 2 times).

5. Now pull back slightly again and when timer says "release" let it go. Timer will time how long it takes to travel 12 meters (between two holders 4 times - there, back, there, back). Record the time in the data table below.
6. Repeat 2 more times (3 trials total). Make sure to pull the same way each time.
7. Sketch the movement of the slinky in the box next to the data table.
8. Determine the speed of each trial using the equation below. (remember distance is 12m)

$$\text{speed} = \text{distance}/\text{time}$$

9. Determine the average speed of the P waves using the equation below.

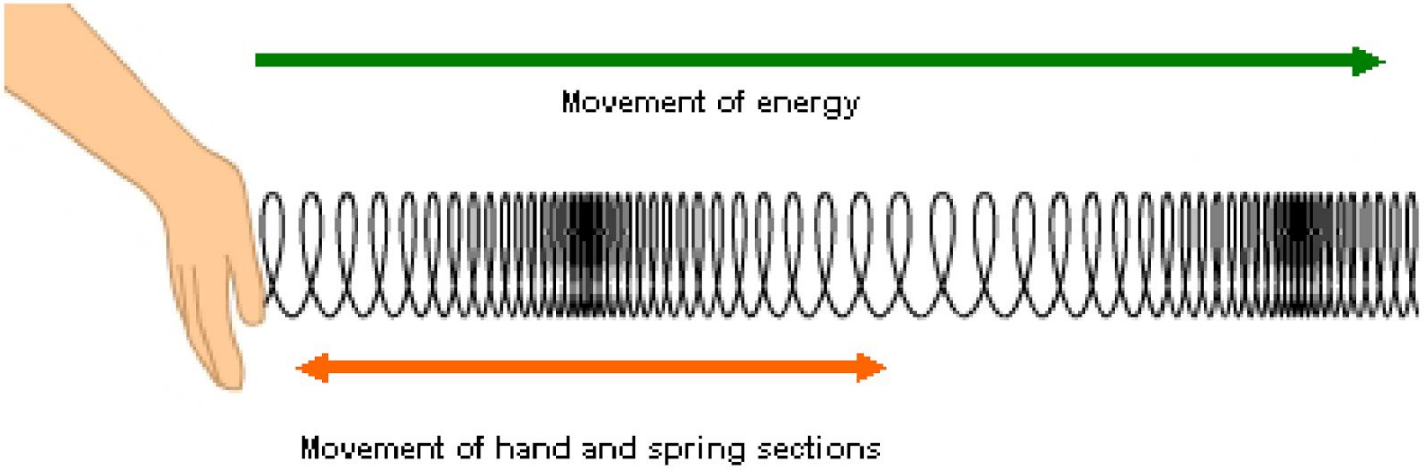
$$\text{Average speed} = (\text{Speed 1} + \text{Speed 2} + \text{Speed 3}) / 3$$

Workbook Date:

Data

Trial	Time (seconds)	Speed (m/s)
1		
2		
3		
Average Speed		

Movement of Slinky



Workbook Date:

Procedure: Part 2 - S Waves (Side-to-Side)

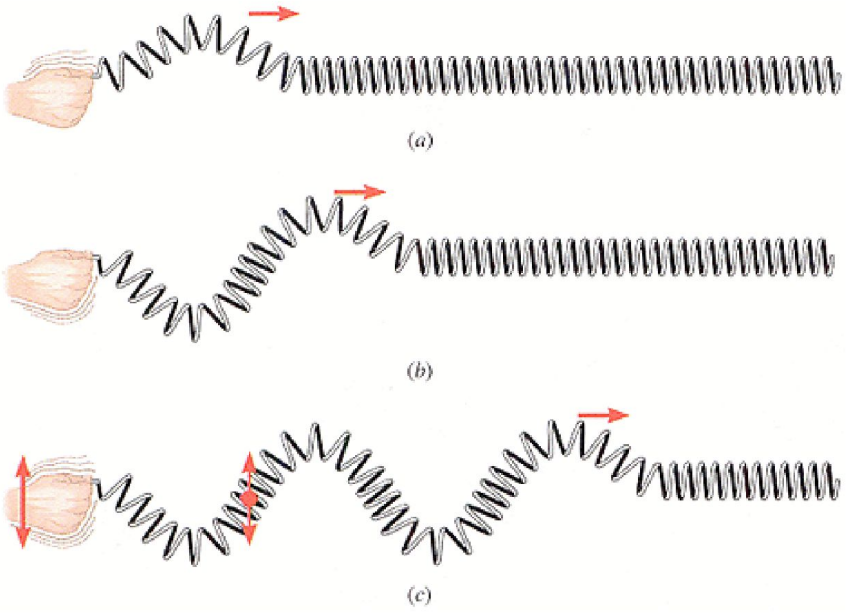
1. Shake one end of the slinky from side to side. What do you notice? How does the slinky move compared to the wave that is travelling? Record below.

2. Stretch the slinky to the 3 meter marks again.
3. Timer will be timing 2 complete trips (there and back and there and back) again.
4. When timer says, shake the slinky.. Timer will time how long it takes to travel 12 meters (between two holders 4 times - there, back, there, back). Record the time in the data table below.
5. Repeat 2 more times (3 trials total). Make sure to shake the same way each time.
6. Sketch the movement of the slinky in the box next to the data table.
7. Determine the speed of each trial.
8. Determine the average speed of the S waves.

Data

Trial	Time (seconds)	Speed (m/s)
1		
2		
3		
Average Speed		

Movement of Slinky



Analysis

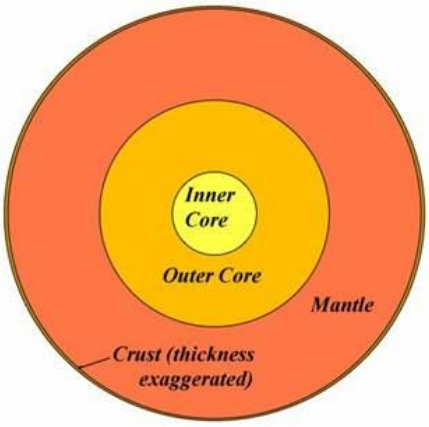
1. Which type of waves travelled the fastest in your experiment? Explain why you think this is the case (think of the movement pattern of each type of wave).

2. Because of the type of movement of each wave and the speed of the wave, they will travel through Earth's interior differently. What types of materials can P waves travel through (may need to do some research) and what types of materials can S waves travel through?

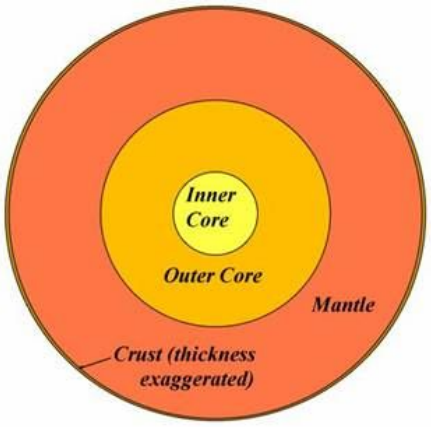
3. With the previous response in mind and the material make-up of Earth's interior determined and discussed in the previous lab, predict what types of waves will travel through each of Earth's layers.

4. Predict the patterns of each wave movement using the diagrams below.

P Wave



S Wave

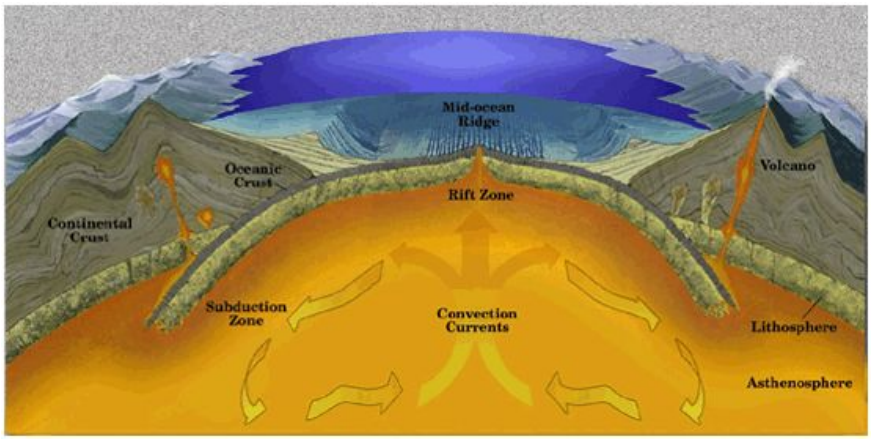


Guiding Question:

Do Now:

Important Definitions and Equations:

Notes: (Label the image with numbers as we go through notes)



1. _____ are caused by the _____ pressure and temperature at Earth's Core and the relatively _____ temperature and pressure at Earth's surface.
   The material at Earth's core _____ and becomes _____ than the material surrounding it. This causes it to _____.
2. However as the material rises towards Earth's surface it _____ and the particles become _____. This makes them _____.
3. Eventually this material will then again _____ (not necessarily all of it) and descend back towards _____.
4. This creates a _____ within Earth's interior through the core, mantle, and just under the crust.
   - This cyclic pattern results in the phenomenon of _____ that we will investigate later.

Response:

10 Move, Hot Stuff

Convection Currents and Movement of Matter in Earth's Interior

Purpose

To develop a model of how matter can cycle through Earth's interior because of temperature and density.

Materials

- Hot plate
- Beaker with Water
- Glass Stir rod
- Hole punched paper circles

Procedure

1. You are going to put hole punches into water and see what happens. Write a prediction as to what you may see. This prediction should include something about convection.

2. Add 250-300 mL to beaker.
3. Place dots into water. Use a glass stir rod to help them sink if they float.
4. Observe the beaker of water. Sketch your observation below. Label all parts (beaker, water, dots, energy and any movement)
5. Place the beaker on the hot plate and set to high setting.
6. Observe the water heating for 10 minutes.
7. Sketch your observations below. Label all parts.
8. When finished, pour water into strainer on front table and clean out any excess dots into trash. Reset lab station for next period.

Data and Observations

Observation 1: No Heat

Observation 2: With Heat

Analysis

1. Explain the differences between your observations in diagrams 1 and 2. How does it apply to your prediction?

2. What did the path of the paper dots in diagram 2 represent? Explain your answer.

3. Convection currents also occur within the Earth's interior. What do you think powers it? Explain (you may do additional research, verify with your teacher).

4. Where do you think most of the convection currents occur within Earth's interior? How do you think this might affect or contribute to the cycling of matter from Earth's core to the surface?

5. Remember back to the density lab about Earth's interior. The core of the planet is extremely hot. Explain what would happen to the flow of matter in Earth's interior if the planet's core eventually cools down.

Guiding Question:

Do Now:

Important Definitions and Equations:

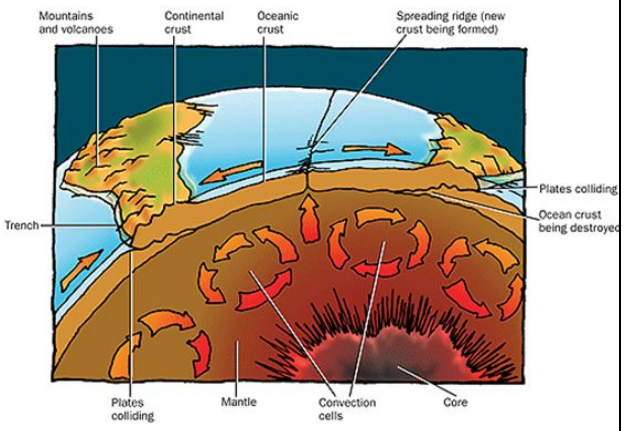
Notes:

Earth started off as a single continent, Pangea, and over time has become what we know today. This theory of plate tectonics was first introduced by Wegner.

- Plates would ideally slide past each other gently and easily.
- However, due to friction, they tend to grind against each other causing earthquakes and other phenomena
- Because of the non-ideal behavior of Earth's plates, we get many observable features (draw arrows)

Examples:

-
-
-
-



Response:

Workbook Date:

11 Fits Like a Puzzle
Plate Tectonics

Directions

For the vocabulary below, find the definition and then create a visual representation (draw a picture) to help you remember the definition. You need to use color in your visuals. Your teacher has provided some.

Term	Definition	Visual
Plate Tectonics		
Continental Drift		
Pangaea		

Term	Definition	Visual
Mid-Atlantic Ridge		
Divergent Boundaries		
Seafloor Spreading		

Workbook Date:

1. At the beginning part of the 20th century, German researcher, geophysicist and meteorologist, Alfred Wegener, suggested that Earth's continents were once connected together and have since moved apart through Continental Drift. He described this "All Earth" as Pangaea. Describe three pieces of evidence that Wegener used to support his theory.

2. Explain how sea floor topography shows evidence for plate tectonics.

3. The process of plate tectonics is occurring today in the same way as in the past. Project future positions of the continents by looking a a map of their present positions and the position of the Mid-Atlantic Ridge using the map below. What oceans are growing and which are shrinking? Explain your answer.

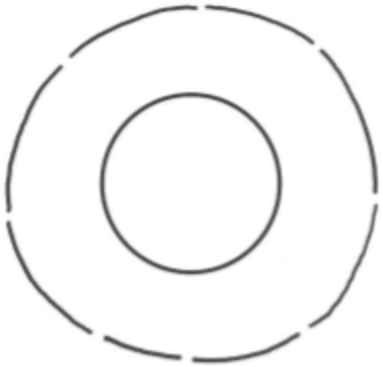
Guiding Question:

Do Now:

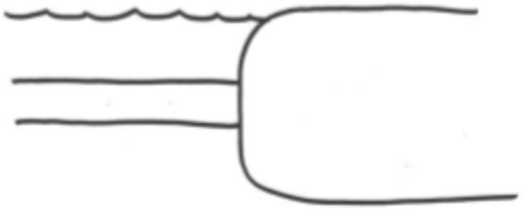
Important Definitions and Equations:

Notes:

LITHOSPHERIC PLATES

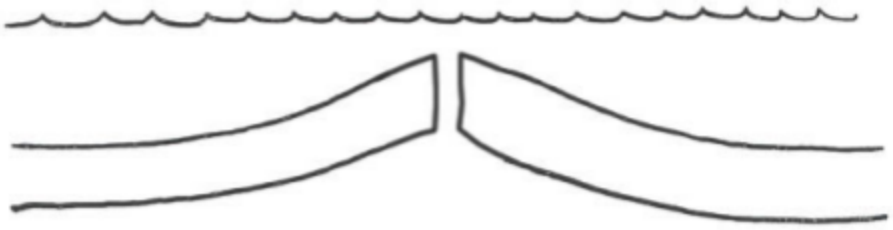


TWO TYPES OF CRUST



DIVERGENT BOUNDARY – OCEANIC

EXAMPLE:



EFFECTS:

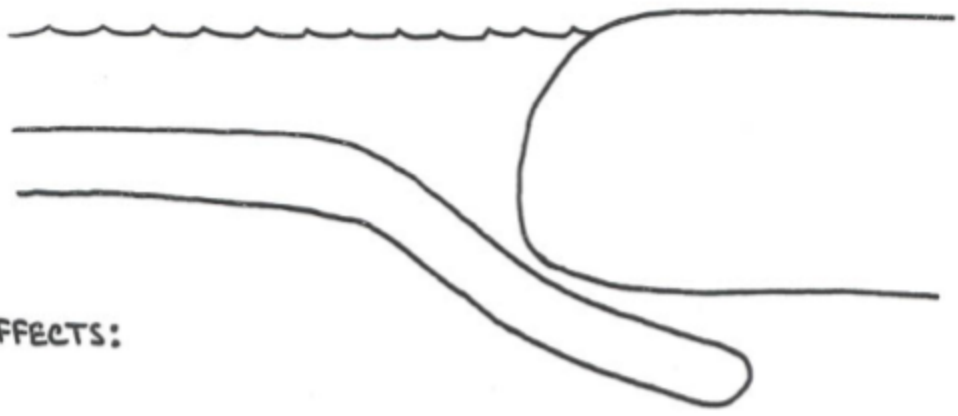
DIVERGENT BOUNDARY – CONTINENTAL

EXAMPLE:

EFFECTS:

CONVERGENT BOUNDARY – OCEANIC / CONTINENTAL

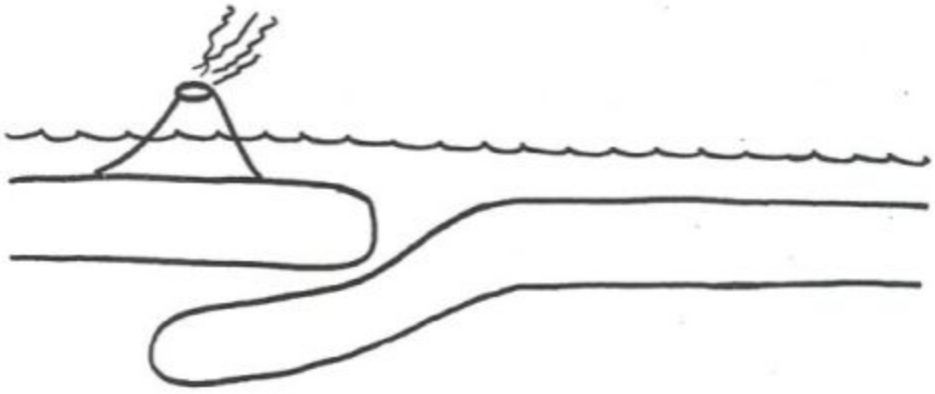
EXAMPLE:



EFFECTS:

CONVERGENT BOUNDARY - OCEANIC | OCEANIC

EXAMPLE:

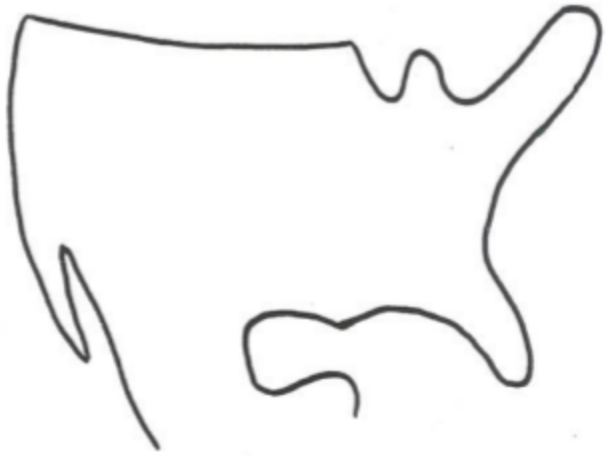


EFFECTS:

CONVERGENT BOUNDARY - CONTINENT | CONTINENT

EXAMPLE:

EFFECTS:

	TRANSFORM BOUNDARY – CONTINENTAL EXAMPLE:  EFFECTS:
Response:	

12 Make it Move
Plate Tectonics

Purpose

Investigate the phenomenon of various plate tectonic movements and relate it to movement of matter within the earth's interior.

Materials

- Graham crackers, broken into sections
- Cup of Frosting
- Cup of water
- Paper plate
- Plastic Knife or Spoon

Part 1: Investigate Plate Movement

1. Obtain materials from your teacher, you will be working at your desks
2. Smear a thick layer of frosting on the plate
3. Place two cracker next to each other with a little space between them.
4. Gently pushing down on the crackers, move them apart.
5. Draw what you see below. Label the diagram.

6. What tectonic process is modeled here? Explain using observations.

7. Based on our previous notes, what are the limitations of this model? (What can be illustrated and what cannot be illustrated)

8. Remove the crackers (eat if you wish) and smooth the frosting again.
9. Place two dry crackers next to each other on the frosting.
10. Gently slide them past each other.

11. Draw what you see below. Label the diagram.

12. What tectonic process is modeled here? Explain using observations.

13. Based on our previous notes, what are the limitations of this model?

14. Remove the crackers (eat if you wish) and smooth the frosting again.
15. Wet the end of one section of cracker with water
16. Place the wet cracker and a dry cracker on the frosting with space between (at least the width of your pinky)
17. Push the two crackers together.
18. Draw what you see below. Label the diagram.

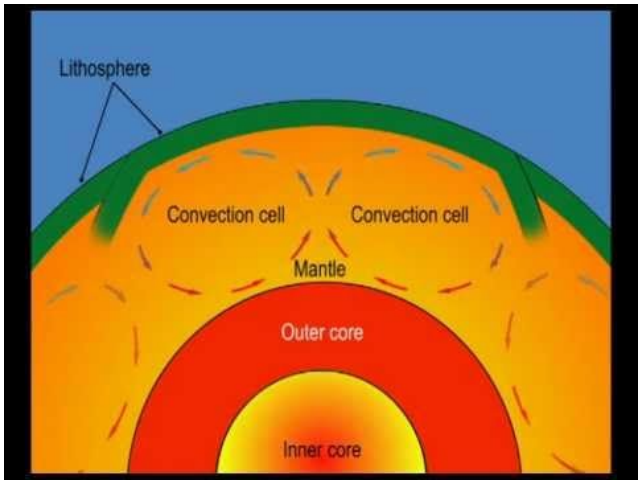
19. What tectonic process is modeled here? Explain using observations.

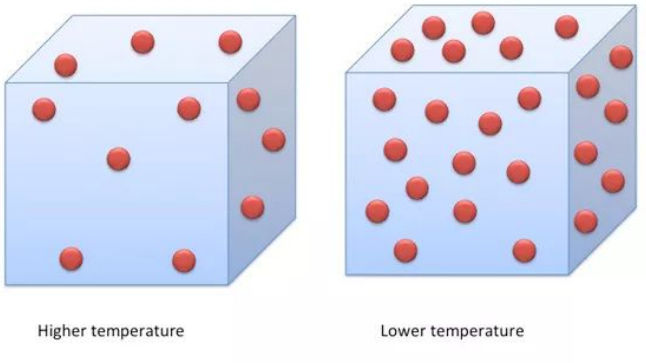
20. Based on our previous notes, what are the limitations of this model?

21. Clean up: Eat what you wish of the crackers and frosting. Place the remaining supplies into the trash. Wipe down your desks with a disinfecting wipe or cleaning solution.

Part 2: Applying it

1. Using the graphics below, explain how ***density***, ***convection***, and ***plate tectonics*** are related. Hint: Tell a story of how convection of heat can change density which causes the phenomena associated with plate tectonics.





2. Convection currents within the Earth's interior cause cycling of matter from Earth's interior to Earth's surface. Explain how this occurs.

3. Using the observations from the lab above and (maybe) a little research, explain how they result in the following phenomena:
    a. Divergent Boundary, Mid-Atlantic Ridge, Seafloor spreading

    b. Convergent Boundary, Oceanic Trenches (Monterey Bay, Monterey Canyon)

    c. Transverse Boundary, San Andreas Fault