

# Science

## Quarter 1 – Module 4: Earth’s Mechanism



**Science – Grade 10**  
**Alternative Delivery Mode**  
**Quarter 1 – Module 4: Earth’s Mechanism**  
**First Edition, 2020**

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**Science**  
**Quarter 1 – Module 4:**  
**Earth’s Mechanism**

## **Introductory Message**

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or have any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.



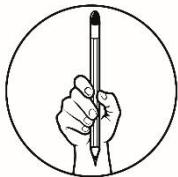
## **What I Need to Know**

The Earth's whole lithosphere is broken into several rigid sections called plates that move constantly. Do lithospheric plates move quickly or slowly? What must be the reason behind the motion of the massive lithospheric plates?

This module contains different activities that will help you understand the driving force behind plate tectonics.

After going through this module, you should be able to:

1. describe the possible causes of plate movement (S10ES-Ia-j-36.5); and
2. recognize the process of convection current in the mantle.



## **What I Know**

Choose the letter of the best answer. Write your letter of choice on a separate sheet of paper.

1. A convection current is caused by differences in temperature resulting to variation in \_\_\_\_\_.
  - A. air pressure
  - B. color
  - C. density
  - D. mass
2. It is a measure of how much mass there is in a volume of a substance.
  - A. volume
  - B. temperature
  - C. density
  - D. mass
3. Hot molten materials in a convection cell rises near the \_\_\_\_\_.
  - A. outer core
  - B. crust
  - C. inner core
  - D. mantle
4. Which of the following theory explains how the heavy plates move along the different types of plate boundaries.
  - A. Continental Drift Theory
  - B. Plate tectonic Theory

### C. Seafloor Spreading Theory

5. The motion of gas or liquid caused by differences in temperature is a \_\_\_\_\_.
  - A. tectonic movement
  - B. plate tectonic
  - C. convection current
  - D. magma chamber
6. A driving force for plate motion at mid-ocean ridges as a result of the rigid lithosphere sliding down \_\_\_\_\_.
  - A. slab pull
  - B. ridge push
  - C. convection current
  - D. seafloor spreading
7. Lithospheric plates are flowing in this area .
  - A. inner core
  - B. asthenosphere
  - C. outer core
  - D. lithosphere
8. Which of the following is NOT a method of heat transfer?
  - A. condensation
  - B. convection
  - C. conduction
  - D. radiation
9. Which of the following is NOT a driving force of tectonic plates?
  - A. ridge push
  - B. slab push
  - C. drag force
  - D. mantle convection
10. What is the source of heat in a mantle convection current?
  - A. the Sun
  - B. the crust
  - C. the core
  - D. the moon

# Lesson 1

## Mantle Convection

Earth's mechanism deals with the forces acting on lithospheric plates to move in a particular direction. The motion is a result of thermal convection in the mantle due to the convection current formed. The mantle convection process will be further explained as you go along the module.



### What's In

From the previous lesson, you have learned about Theory of Continental Drift in which Wegener thought that the seven continents we know today had been once a part of a supercontinent called Pangaea. It broke apart like pieces of a puzzle and moved to their present location, becoming today's continent. Can you still remember the evidence of the Continental Drift Theory? Can you figure out these evidence that supported this theory? How about the evidence of the Seafloor Spreading Theory? What could be the reasons why scientists rejected Wegener's idea of Continental Drift?

In this lesson, you will learn about mantle convection and forces as a mechanism to the motion of the massive plates of the lithosphere and the development of the Theory of Plate Tectonic.



### What's New

#### Convection in the Mantle Vocabulary

##### Let's use these materials:

paper, ball pen

##### Let's do it this way:

1. Arrange the scrambled letters below to form the word defined in each number.
2. Answer on a separate sheet of paper.

**Assessment:**

1. tmnael \_\_\_\_\_

A layer beneath where the less dense hot molten material rises, and sinks

2. thprehaeosens \_\_\_\_\_

A soft, weak and plastic-like layer, the upper part of the mantle where lithospheric plates float and move.

3. mmgaa \_\_\_\_\_

Hot molten rocks formed beneath the Earth's surface.

4. noitcevnoc ctunrre \_\_\_\_\_

Facilitates the movement of the lithospheric plates.

5. orce \_\_\_\_\_

The innermost layer of the Earth, which generates heat to the mantle.

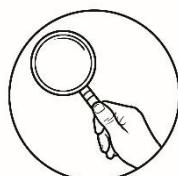
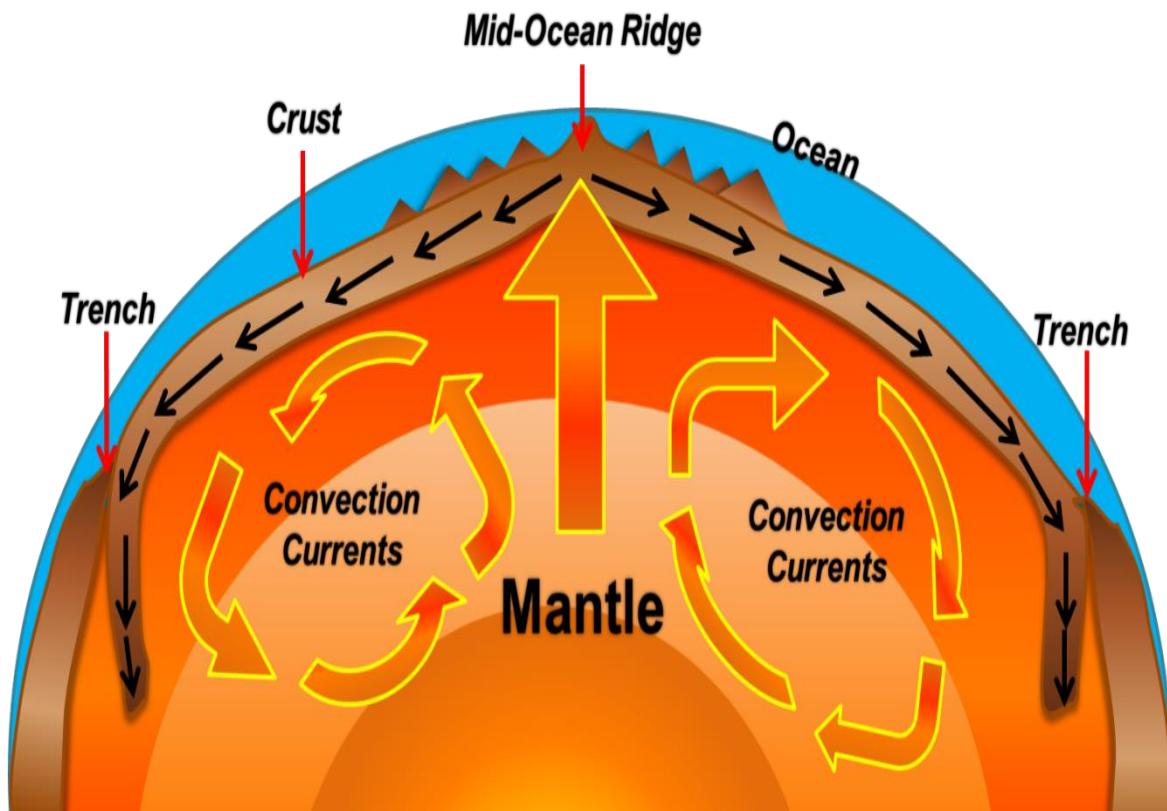
**What is It****Plate Tectonic Theory**

Plate Tectonic Theory was developed in 1960s, stating that the Earth's lithosphere-the crust and the upper mantle- is broken up into several pieces called plates that move slowly. It explains how the massive plates move along the different types of plate tectonic boundaries (convergent, divergent, and transform fault) where they interact, and the geologic events (earthquakes and subduction) and geologic features (formation of mountains, volcanoes, and trenches) that occur at their boundaries.

## What Makes Lithospheric Plates Move?

A convection current is a heat transfer process that involves the movement of energy from one place to another. The convection currents tend to move a fluid, gas particles, or molten rock. These are due to the differences in the densities and the temperature of a specific gas or a fluid. Due to this temperature difference, the hot fluid tends to rise as it expands, whereas cold fluid tends to sink because it contracts. Convection is one of the kinds of heat transfer; the other two are radiation and conduction.



Illustrator: Marianne D. Soriano

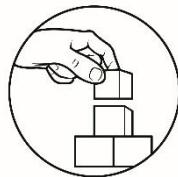
Convection current also happens in the mantle. The mantle is the second inner layer of Earth, made up of mostly hot rocks and magma. It is a very hot layer because of the heat generated by the core. The source of heat from the core is due to the decay or breakdown of radioactive elements. Mantle convection is a process by which thermal convection occurs in the inner layer of the earth. The differences in the temperature at the Earth's interior and surface cause convection currents to occur within the mantle.

Lithospheric plates are the parts of the uppermost layer of the Earth, and they are flowing in an area called the asthenosphere. The asthenosphere is a soft, less rigid upper part of the mantle where the lithospheric plates float and move around. Plates move slowly and continuously when the hot less dense material rises. The rising hot material cools down in a certain area. Hence, it becomes denser than the cool, dense material sinks that creates convection cell, with hot rising currents and cool sinking currents are regularly repeated and become a cycle. The movement of

the lithospheric plate is attributed to mantle convection and considered as one of the driving mechanisms for plate motion. The lithosphere at the divergent boundary will uplift and tear apart due to the rising of hot magma. The sinking of magma pulls down the tectonic plate at a convergent boundary. Aside from mantle convection, ridge push, sliding, and slab pull are other forces that move the lithospheric plates.

In the process of slab pull, the presence of a heavier subducting plate pulls down the trailing slab into the subduction zone.

In a ridge push or gravitational sliding process, the old oceanic crust becomes heavier than the new oceanic crust and sinks because of the weight of the raised ridge, which pushes down the older oceanic crust towards the trench at the subduction zone.



## **What's More**

You have learned from the previous activity about what is happening during convection.

Convection is a kind of heat transfer. Heat transfer in convection is caused by differences in temperature and density within a fluid or gas particle.

To further understand this process, answer the first enrichment activity of this module.

### **Activity 1: Rise and Fall**

#### **Let's use these materials:**

paper, ball pen, pictures of the heat transfer process

#### **Let's do it this way:**

- A. On the space provided, put a checkmark (✓) on the items that describe or present a convection process. Place a cross mark (X) on the items that do not show a convection process.
- B. Write five examples of a situation or object that uses convection current
- C. Answer in a separate sheet of paper

**Assessment 1:**

1. \_\_\_\_\_



boiling of water

*Illustrator: Richard C. Paragas*

2. \_\_\_\_\_



Warming of spoon

*Illustrator: Richard C. Paragas*

3. \_\_\_\_\_



rising of hot air balloon

*Illustrator: Richard C. Paragas*

4. \_\_\_\_\_



Burning of wood

*Illustrator: Richard C. Paragas*

5. \_\_\_\_\_



melting of ice

*Illustrator: Richard C. Paragas*

B. Example of situation or object that uses convection current

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

Good job! Can you now explain convection as a kind of heat transfer?

Plates move by bumping, in the opposite direction, and sliding past each other resulting in making areas of volcanic activities, earthquake, and mountain formation. According to scientists, the motion is driven by a convection current mechanism within the earth.

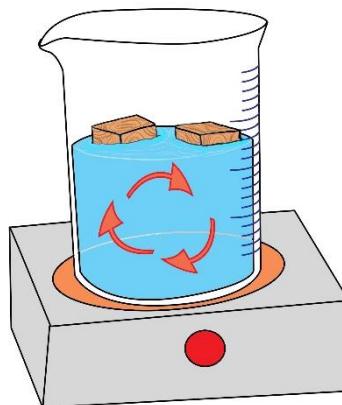
This time, connect your understanding of the convection process from the previous enrichment activity.

You may now continue onto the next activity.

### **Activity 2: Lithospheric Float**

#### **Let's use these materials:**

paper, ball pen, a picture showing convection process.



*Illustrator: Richard C. Paragas*

#### **Let's do it this way:**

1. Refer to the picture to answer the questions that follow.
2. Answer in a separate sheet of paper

#### **Assessment 2:**

Based on the picture,

1. What represents the plates?
2. What represents the mantle?
3. Where is the heat source?
4. Why are the blocks of wood floating?
5. Which part of the water has a greater density? Lesser density?
6. Explain convection current

Continue doing good!

After learning how plates move due to convection current, you are now ready to do the next enrichment activity. You will get acquainted and be familiarized with some geological features and events deep within the Earth.

### **Activity 3: Get to the Right Track!**

#### **Let's use these materials:**

1. paper, ball pen

#### **Let's do it this way:**

1. Read and understand the statements.
2. Answer in a separate sheet of paper.

#### **Assessment 3:**

Arrange the following events in the mantle convection process. Use numbers 1-5.

- a. Lithospheric plates move in the asthenosphere due to the rising and sinking of materials.
- b. The decomposition of radioactive elements causes heat in the interior part of the Earth.
- c. Heat slowly rises to the mantle and creates convection current.
- d. Heat moves to the core.
- e. The process repeats as a cycle.



### **What I Have Learned**

Let's summarize your lesson and activities!

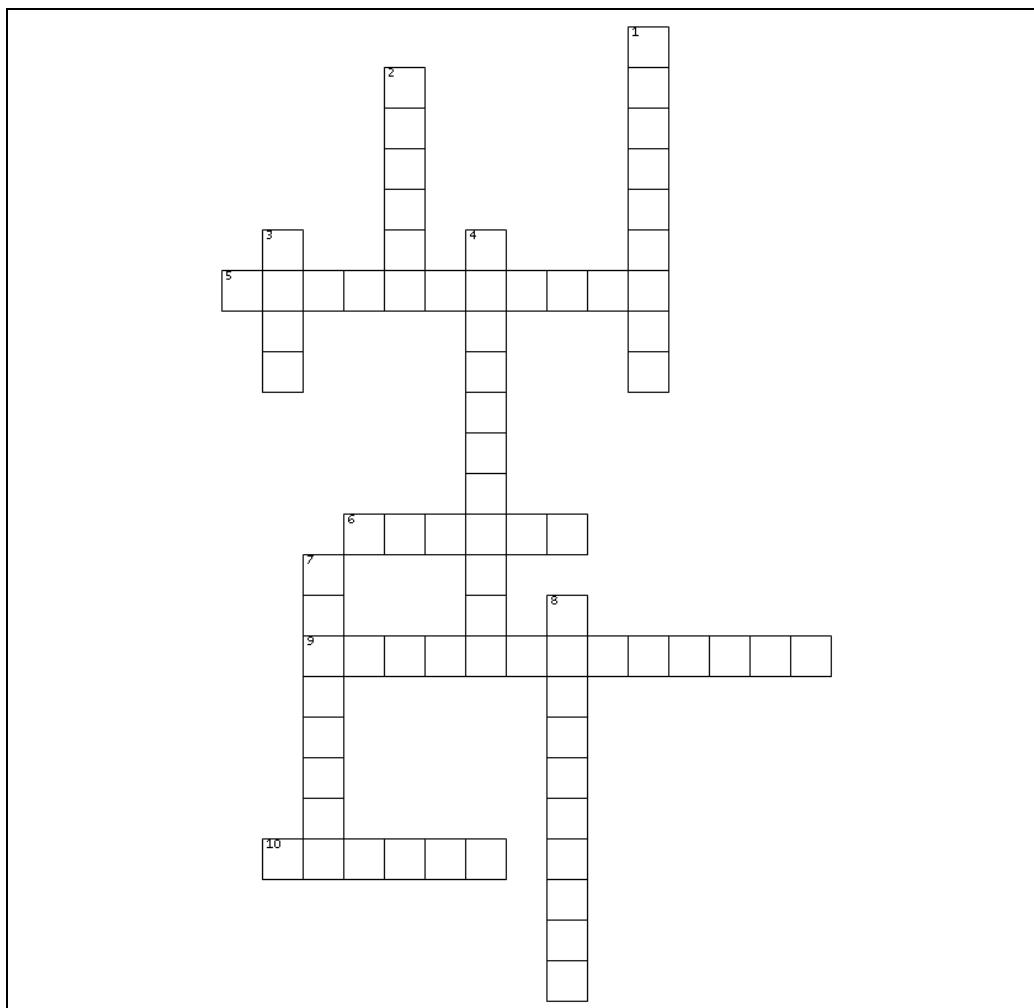
#### **Sum Up Challenge.**

#### **Let's use these materials:**

1. ball pen

**Let's do it this way:**

Complete the paragraph by choosing the correct answer from the box.

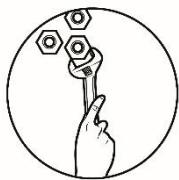


**ACROSS**

5. Heat transfer in convection is cause by differences in \_\_\_\_ and density in a fluid or gas particle.
6. Magma is made of \_\_\_\_\_ rock formed beneath the Earth's surface
9. This is where lithospheric plates flow.
10. In the asthenosphere, there are lithospheric \_\_\_\_\_

**DOWN**

1. The lithosphere at the \_\_\_\_\_ boundary will uplift and tear apart due to hot magma
2. Convection currents also happen in the \_\_\_\_\_.
3. A convection current is a \_\_\_\_\_ transfer process
4. The source of heat from the core is due to the decay of \_\_\_\_\_ elements.
7. The presence of a heavier subducting plate pulls down the trailing slab to the subduction zone
8. A \_\_\_\_\_ current tends to move a fluid, gas particles, or molten rock.



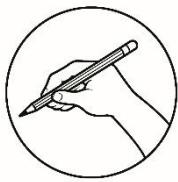
## **What I Can Do**

### **HOW DO WE COOK BY CONVECTION?**

**Palitaw** is a kind of sweet, chewy, and flattened rice cake. This Filipino rice cake is prepared by soaking glutinous rice grains in water overnight and then processed as a dough. The dough is flattened into small pieces and cooked in boiling water until they float; this is the reason it was called palitaw. Based on your knowledge about convection current, make a sketch that can explain why palitaw floats in boiling water. In a separate sheet, sketch the convection current occurring in making the said rice cake.

The scoring rubric below will be used by your teacher in assessing your output.

<b>Category</b>	<b>Excellent (5pts)</b>	<b>Good (4pts)</b>	<b>Satisfactory (3pts)</b>	<b>Needs improvement (1pt)</b>	<b>Score</b>
Accuracy	The sketch is excellently accurate and can explain the information asked.	The sketch is accurate and is able to explain some of the information asked.	The sketch is slightly accurate and cannot fully explain the information needed.	The sketch is not accurate.	
Sketch	The sketch is neat, and necessary markings are found on the paper. It shows a clear and legible concept.	The sketch is legible. The concept is clear and legible but can be neater.	The sketch is somewhat okay but is not exactly neat and legible.	The sketch is not legible or clear at all.	
Understanding of the topic	The learner understood the lesson and is able to apply it to the activity.	The learner has a sufficient comprehension of the lesson and can apply it to the activity.	The learner has a sufficient understanding of the lesson but is not applied in the activity.	The learner has not understood most of the lesson and cannot apply it to the activity.	
<b>TOTAL (15pts):</b>					

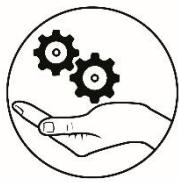


## Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following **DOES NOT** describe a convection process?
  - A. the handle of a metal pot is hot while cooking
  - B. boiling of macaroni pasta
  - C. a sea breeze
  - D. ocean water in the surface is warmer
2. Which of the following has a faster movement of molecules?
  - A. hot materials
  - B. warm materials
  - C. cold materials
  - D. room temperature materials
3. Which of the following has a lesser density in a convection cell?
  - A. warm fluid materials
  - B. cold fluid materials
  - C. room temperature fluid materials
  - D. hot fluid materials
4. In a convection current, hot materials move \_\_\_\_\_.
  - A. any direction
  - B. sideward
  - C. upward
  - D. downward
5. The motion of gas or liquid caused by differences in temperature is a \_\_\_\_\_.
  - A. tectonic movement
  - B. plate tectonic
  - C. convection current
  - D. magma chamber
6. Which is not a geologic feature that occurs in the plate boundaries?
  - A. mountains
  - B. volcanoes
  - C. trenches
  - D. subduction
7. In which part of the innermost layer of the earth does convection current occur?
  - A. inner core
  - B. outer core
  - C. mantle
  - D. asthenosphere

8. Lithosphere at \_\_\_\_\_ boundary will uplift and tear apart due to rising hot magma.
- A. convergent
  - B. divergent
  - C. transform-fault
  - D. mantle
9. Older oceanic crust pushes down towards the \_\_\_\_\_ at the subduction zone.
- A. ridge
  - B. trench
  - C. fault
  - D. crack
10. What is the source of heat generated by the core to the mantle?
- A. gases
  - B. decayed radioactive elements
  - C. molten rocks
  - D. molten metals.



## ***Additional Activities***

### **Mantle Convection Infographic**

#### **Let's use these materials:**

- For non-digital infographic: any size paper, Earth Science book, ruler, scissors, glue stick or paste, pencil, and colored pencils or markers
- For digital infographic: any electronic device with internet

#### **Let's do it this way:**

1. Make a Mantle Convection Infographic. An infographic is a visual image that is designed to represent information and knowledge in a quick and clear manner.
2. The orientation of the infographic must be portrait. You may create the infographic with traditional materials like a pen, colored paper, and coloring materials; or you may create the infographic digitally using platforms such as Canva.
3. The infographic must include the following focus questions:
  - a. What causes convection currents?
  - b. What causes convection currents in Earth's mantle?

Your output in this activity will be rated by your teacher according to the following criteria.

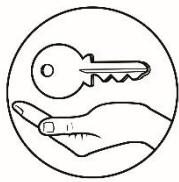
<b>Category</b>	<b>Excellent (5pts)</b>	<b>Good (4pts)</b>	<b>Satisfactory (3pts)</b>	<b>Needs improvement (1pt)</b>	<b>Score</b>
Infographic	The infographic is very informative. The focus question was answered by the information in the pamphlet.	The infographic contains sufficient information on the topic. Can use more elaboration.	The infographic holds enough information, too vague.	The infographic does not bear information that subjects to the topic.	
Content	The information is well-organized, with references properly cited. No confusion	The information is organized, with references cited. It is	The information needs more organization ,and references are not	The information is confusing and plagiarized.	

	on the set of content.	good enough to understand.	cited properly.		
Design	The design of the infographic is eye-catching and creative. The color scheme and diagrams are uniform and neat.	The design of the infographic is well-made but needs a more uniform theme.	The design of the infographic is dull and needs more elements.	No design at all.	
TOTAL (15pts):					

Copy and accomplish this self-rating table adapted from Valdoz (2017) before returning the module to your teacher.

### ***How I Rate My Self...***

<b>How much did this module help you</b>	<b>Fair (5 points)</b>	<b>Good (8 points)</b>	<b>Excellent (10 points)</b>
Understand the process of convection			
Explain the convection current in the mantle that drives the lithospheric plates to move			



## Answer Key

1. A
2. A
3. D
4. C
5. C
6. D
7. C
8. B
9. B
10. B

## Assessment

- Learned
1. Wood blocks
  2. Water
  3. Heat from a hot plate
  4. Because of convection currents
  5. Temperature
  6. Molten asthenosphere
  7. Plates
  8. Asthenosphere
  9. Convective currents
  10. Density

What I have

## Activity 3

Activity 2

temperature differences in their sinking of cold water due to their density. It is the rising of warm water and the surface lesser density. greater density, near the surface. The sinking of cold water due to their density. It is the rising of warm water and the surface lesser density. greater density, near the surface. The sinking of cold water due to their density.

### What I Know

- 10. C
- 9. C
- 8. A
- 7. B
- 6. B
- 5. C
- 4. B
- 3. D
- 2. A
- 1. A

### What Is It?

### Activity 1

#### What's more

- 5. ▲
- 4. X
- 3. ▲
- 2. X
- 1. ▲

- 5. core
- 4. Convection
- 3. Asthenosphere
- 2. Mantle
- 1. Magma

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