Senior High School

DepED
DEPARTMENT OF EDUCATION

# Earth Science for STEM

## Quarter 2 – Module 2:
## Earth's Internal Heat Sources

ALTERNATIVE DELIVERY MODE
ADM

**Earth Science for STEM**
**Alternative Delivery Mode**
**Quarter 2 – Module 2: Earth's Internal Heat Source**
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# 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 any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

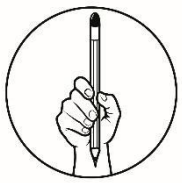
# *What I Need to Know*

This module was designed and written with you in mind. It is here to help you understand the concepts on Earth's internal heat sources. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course.

The module explains the essential details on the different internal heat sources of Earth. It contains activities that you need to complete to grasp the essential details of the lesson.

After going through this module, you are expected to:

1. identify the sources of the internal heat of the Earth; and
2. explain the process of the production of internal heat of Earth.



# *What I Know*

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

1. The heat _____ from the crust down to the inner core due to several reasons. Which of the following words will best complete the thought of the given statement?
    a. Decreases
    b. Equals
    c. Increases
    d. Proportional

2. Each layer of the earth has its own distinct features, composition, properties and characteristics. Which among the layers of the earth has the highest temperature?
    a. The core which has decaying isotopes.
    b. The crust which is the most exposed to ultraviolet rays.
    c. The lithosphere which is the solid part of the earth.
    d. The mantle which is the mostly solid bulk layer of the earth.

3. Different elements with varying properties comprises the layers of the earth. Which layer of the earth has the highest amount of molten state iron?
    a. The core which is the hot and dense inner most layer of the earth.
    b. The crust which is the lightest and thinnest layer of the earth.
    c. The lithosphere which is known as the solid outermost part of the earth.
    d. The mantle which is the most massive layer of the earth.

4. Why do you think Earth is considered as a thermal engine?
    a. As a natural satellite the moon gives thermal energy to earth.
    b. Decay of isotopes contributes to the internal heat of the earth.
    c. The energy coming from the sun gives tremendous heat on the surface.
    d. Too much pressure on the crust causes materials to be molted which gives large amount of heat.

5. What do you think will happened to the amount of heat from the outermost layer of the earth down to its core?
    a. As you move from the surface of the earth to the inner core the amount of heat lower.
    b. As you move from the surface of the earth to the inner core the amount of heat becomes higher.
    c. The amount of heat in the surface of the earth is equal to its interior.
    d. The amount of heat is indirectly proportional to the location of the earth.

6. Which of the following pertains to the process by which gasses and dust of cloud were attracted by gravitational energy 4.6 billion years ago?
    a. Accretion
    b. Gravitational pull
    c. Solidification
    d. Planetesimal

7. Direct observation is not possible to know all the details about the interior of the earth due to its changing nature of internal composition and tremendous heat that come from its inner most layer. Which of the following will best describe the given sentence?
    a. The statement conveys correct information.
    b. The statement conveys incorrect information.
    c. The statement is dependent on the inner or outer core.
    d. The thought of the statement cannot be determined due to the nature of Earth.

8. Which among the layers of the earth has the greatest pressure which contributes to the production of the tremendous internal heat?
    a. Crust has the greatest pressure due to movement of rocks.
    b. Inner core has the greatest pressure among the layers of the earth.
    c. Mantle contains most volume of the earth causing it to have high pressure.
    d. Outer core has greater pressure than the inner core.

9. There are several sources that contribute to the internal heat of the earth. Which of the following is NOT a major process that contributed to Earth's internal heat?
    a. As radioactive isotopes decay, it releases heat which contributes to the earth's internal heat.
    b. Heat released by colliding particles during the formation of the planet
    c. Primordial heat from the formation of the planet contributes to its internal heat.
    d. When iron is crystallized heat is released causing the inner core to be the hottest layer.

10. How did the Earth generate heat on its early stage of formation?
    a. Due gravitational pressure at the center of the planet.
    b. Due to radioactive decay of some isotopes.
    c. Due to the collision of huge amount of gas and dust particles.
    d. Through absorption of energy from planetisimals.

11. What process exist as heat is transferred from one plate to another along plate boundaries?
    a. Conduction
    b. Convection
    c. Radiation
    d. Thermal transfer

12. How do radioactive isotopes emit heat energy and contribute to Earth's internal heat?
    a. Due to preservation of primordial heat from the earliest stage of the earth.
    b. Due to spontaneous radioactive decay of isotopes.
    c. Through gravitational pressure between particles.
    d. Through pressure freezing of the particles.

13. How do naturally occurring isotopes play a vital role in the production of earth's internal heat?
    a. Due to chemical stability.
    b. Due to its abundance and emission of heat when it decays.
    c. Due to its high energy capacity.
    d. Due to the heat it releases as it is subjected to low temperature.

14. What happened to the pressure inside the Earth as you go deeper?
    a. The pressure decreases as you descend to the interior of the earth.
    b. The pressure increases as you descend to the interior of the earth.
    c. The pressure is the same all throughout.
    d. The pressure is unstable and is affected by gravity.

15. Why does Earth's internal heat builds up due to gravitational pressure?
    a. Because the escape of heat from Earth's surface is greater than the heat generated.
    b. Heat cannot escape from the interior of the earth since it is a closed system.
    c. The amount of heat that can be generated on the earth's interior is tremendous while lesser amount can escape on the surface.
    d. The amount of heat that can be released on the surface is greater.

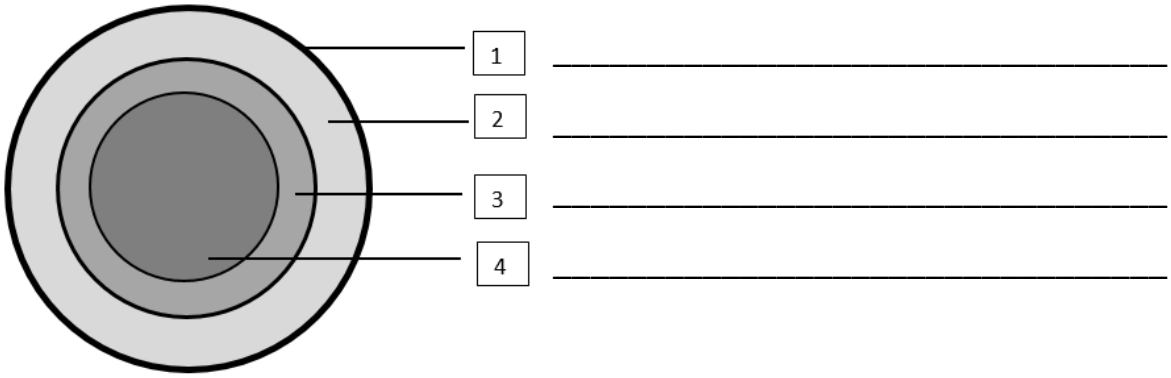
**Lesson 2**

# Earth's Internal Heat Sources

Heat is needed in order for organisms to survive. This heat may come from internal and external sources. The Earth's internal heat provides the heat and energy which supplies the force for natural phenomena such as earthquakes and volcanic eruptions. It also provides energy for the movement of the plates. However, despite the large amount of heat that the Earth possesses, its internal energy is greater during its early stages.

## *What's In*

Based on the illustration given, identify and give the description of each layers of the earth.




***Notes to the Teacher***

This module is a self-assisted module however your help is necessary in monitoring and evaluating students work. Make sure that the students completely accomplish all the activities to ensure high quality transfer of learning in this module.

# *What's New*

Read the situation below and answer the following guide questions.

Taal volcano was considered as the world's smallest volcano. After being inactive for a long time, it began to have a phreatomagmatic eruption from its main crater last January 12, 2021. It does not only affect the municipalities of Batangas but also the provinces of Cavity and Laguna. Due to this geologic phenomena, people had evacuated, numerous families were affected and caused damages to agricultural areas and infrastructures. Like any other volcano, its magma originates in the lower part of the Earth's crust and in the upper portion of the mantle. One way on which magma is formed is through heat transfer in which liquid rock intrudes into Earth's crust. As it solidifies, it loses and transfer heat to its surrounding rocks causing to melt which then formed into magma. Another way in which magma can be formed is through decompression melting which involves the upward movement of mantle. When the hot material rises to an area of lower concentration it reduces the overlying pressure that enables the mantle rock to melt and form magma.

Taal Volcano during its eruption on January 12, 2020. Photos are taken from one of the evacuees Mr. Apolonio Enriquez at Brgy. Bilibinwang, Agoncillo, Batangas

**Guide Questions:**

1. Where does the magma come from?
2. How does internal structure of Earth produce magma?
3. What can you infer on the Earth's internal temperature?

## *What is It*

### Earth's Internal Heat Source

Earth was formed about 4.6 billion years ago and continue to serve as habitat to diverse organisms. Its biotic components remain alive due to proper regulation of internal heat. It has massive amount of heat that varies from its layer. The heat increases from the crust down to the inner core due to several reasons. This internal heat comes from the following sources.

**1. Primordial heat of the planet remains from its early stage.**

The Earth was formed from the process of accretion wherein gasses and dust of cloud was attracted by gravitational energy. When these masses compacted it formed planetisimals. In the process, due to the collision of these masses, heat was generated. This process formed the earliest stage of planet Earth which is molten in state and heat is trapped in the core of the planet. Eventually, the accrued heat did not vanish. It took a long time for heat to move from the internal part of the planet going to its surface. There had been the convective transport of heat within the core to the mantle of the earth. While conductive transport of heat occurs through different plate boundary layers. This resulted in the preservation of some amount the primordial heat in the interior earth.

**2. Heat from the decay of radioactive elements.**

Earth is considered as thermal engine since its main source of internal heat come from the produced decay of some naturally occurring isotopes from its interior. This process is known as radioactive decay by which the spontaneous breakdown of an atomic nucleus causes the release of energy and matter from the nucleus. Some of the isotopes are potassium – 40, Uranium - 235, Uranium - 238 and Thorium - 232. There are other radioactive isotopes that are also present in the Earth however they play a minor role in the production of heat due to its small abundance and low heat capacity. This process of radioactive decay which emits heat energy as one of the products prevents the Earth from completely cooling off.

**3. Gravitational pressure**

The more a person descend into Earth's interior, the amount of pressure increases due to the force pressing on an area caused by the weight of an overlying rocks. The pressure near the center is considered to be 3 to 4 million times the pressure of atmosphere at sea level. Again, because rocks are good insulators, the escape of heat from Earth's surface is less than the heat generated from internal gravitational attraction or squeezing of rock, so heat builds up within. At high temperature, the material beneath will melt towards the central part of the earth. This molten material under tremendous pressure conditions acquires the property of a solid and is probably in a plastic state.

**4. Dense core material in the center of the planet.**

Due to increase in pressure and presence of heavier materials towards the earth's center, the density of earth's layers also increases. Obviously, the materials of the innermost part of the earth are very dense. The inner core as the inner most layer is composed primarily of iron and nickel which contributes to the density in the core that ranges between 12,600-13,000 kg/m3. This suggests that there must be other heavy elements such as gold, platinum, palladium, silver and tungsten that are present in the core. Like in the descent of the dense iron-rich material that makes up the core of the planet to the center that produce heating in about 2,000 kelvins. The inner core's intense pressure prevents the iron and other minimal amount of some elements from melting. The pressure and density are simply too great for the iron atoms to move into a liquid state. Thus, this contributes to the intense heat in the interior of the planet.

## *What's More*

**A.** Analyze the given set of statements. Choose what best describes the statements from the given choices.

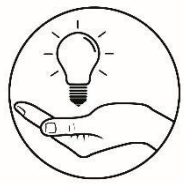
A. The given statements convey correct information.
B. The first statement is correct while the second is incorrect.
C. The first statement is incorrect while the second is correct.
D. Both statements convey incorrect information.

1. The Earth's interior has tremendous amount of heat. The amount of heat increases from the crust of the earth down to its core.
2. Accretion is the process wherein gasses and dust cloud were attracted by gravitational energy. Some of the gasses from the earliest formation of the earth remains which contributes to the heat on earth.
3. Frictional heating also contributes to the heat inside the earth. This is caused by less dense core material sinking to the planet's interior.
4. All isotopes of naturally occurring elements are present inside the core of the earth. Radioactive decay of isotopes and radioactive elements results to release of energy in a form of heat which contributes to internal heat.
5. The internal heat of the earth serves as source for some geologic activities. It is also the major source of heat in the crust and atmosphere.
6. Pressure increases from the interior of the earth up to its crust. Thus, at low temperature, the material beneath the crust will melt towards the central part of the earth.
7. Energy in a form of heat is transported all throughout the earth. This is transported in the process of conduction or convection.

**B.** Choose from the word bank the most appropriate word to complete the statements below. Write your answers in a separate sheet of paper.

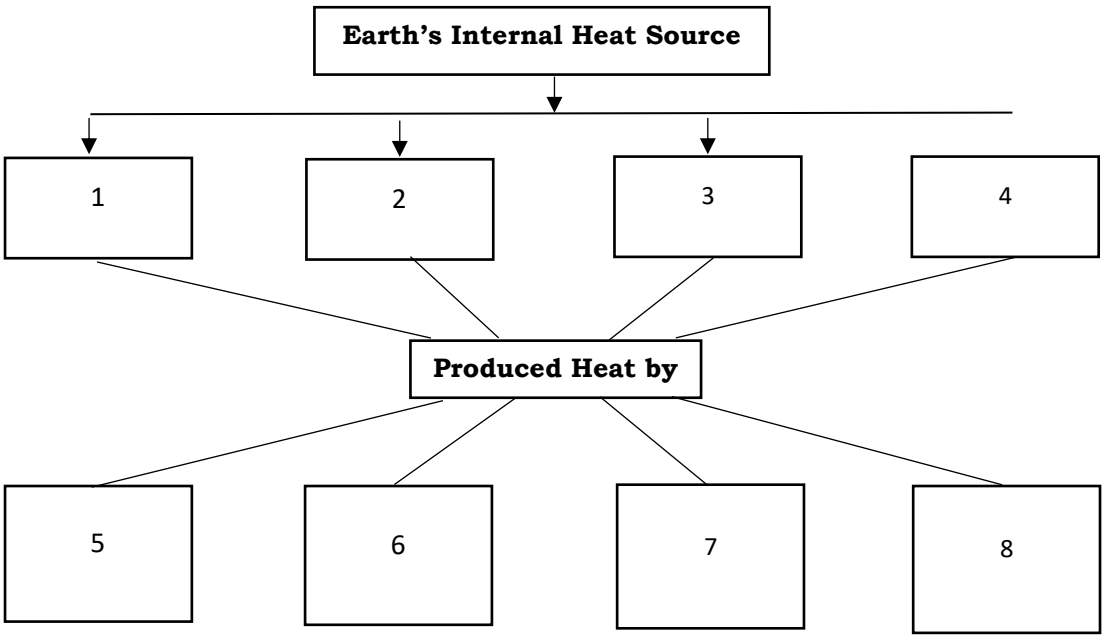
| | | | |
|---|---|---|---|
| thermal engine | heat energy | molten material | pressure |
| gravitational attraction | heat | metling | plastic state |
| convection transport | inner core | liquid state | radiation |

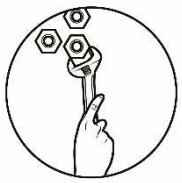
8. It took a long time for _____ to move from the internal part of the Earth going to its surface.
9. There had been _____ of heat within the core to the mantle of the earth.
10. Earth is considered as _____ since its main source of internal heat come from the produced decay of some naturally occurring isotopes from its interior.
11. Radioactive decay emits _____ that prevents the Earth from completely cooling off.
12. The escape of heat from Earth's surface is less than the heat generated from internal _____, so heat builds up with.
13. _____ under tremendous pressure conditions acquires the property of a solid and is probably in a _____.
14. The _____ intense pressure prevents the iron and other minimal amount of some elements from _____.
15. The _____ and density are simply too great for the iron atoms to move into a _____.



## *What I Have Learned*

Complete the concept map below. Write your answers in a separate sheet of paper.





# *What I Can Do*

Read and analyze the scenario below. Write your answers in a separate sheet of paper. Refer to the rubrics below as your guide in answering the questions.

In school, students tend to do a lot of activities, research, and assignments in all subjects. Once the deadline is near, they tend to work UNDER PRESSURE. They get easily mad and complain about everything.

Why do you think this thing happen? How will you relate this scenario in the earth's interior that is also under pressure?

_____

_____

_____

_____

**Rubrics**

| Category | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|
| Content | It shows an understanding of the topic's concepts and principles and uses appropriate terminology and notations, There is no misconceptions or errors evident. The relation between the topic and real life situation was clearly and precisely stated. | It has some mistakes in terminology or shows a few misunderstandings of concepts. Few misconceptions are evident. However, the relation between the topic and real life situation was clearly and precisely stated. | It has many mistakes in terminology and shows a lack of understanding of many concepts. Some misconceptions are evident. The relation between the topic and real life situation was valid but not precise. | It has many mistakes in terminology and shows a lack of understanding of many concepts. Some misconceptions are evident. The relation between the topic and real life situation was vague. | It does not show understanding of the topic's concepts and principles. It has many misconception. It does not show any relation between the topic and real – life situation. |
| Organization of ideas | The ideas and concepts are precisely organized in a logical format and easy to follow. | Some ideas and concepts are vague but in a logical format but easy to follow. | Few ideas and concepts are vague and unorganized but not misleading. | Few ideas and concepts are incoherent and misleading. | All ideas and concepts are incoherent and misleading |

| | | | | | |
|---|---|---|---|---|---|
| Focus and details | There is one clear, well focused topic and content. Main ideas are clear and are well supported by detailed and accurate information. | There is one clear, well focused topic and content. Main ideas are clear but are not well supported by detailed information. | There is one topic and content. Main ideas are somewhat clear. | There is more than one focus of topic and content. Main ideas are vague and not detailed. | The topic and main ideas are not clear. |
| | | | Total Score: | | |

## *Assessment*

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

1. What happens to the temperature as you move from the surface of Earth to its inner most layer?
    a. The temperature decreases as the amount of heat increases.
    b. The temperature fluctuates from the crust done to the core.
    c. The temperature increases from the crust down to the core.
    d. The temperature stays the same in all the layers.

2. As you move from the surface of Earth to the inner core, what happens to the density of the materials of each layer?
    a. Density of materials decreases due to its composition.
    b. Density of materials may increase but will decrease from time to time.
    c. Density of materials remains the same in all the layers.
    d. Density of the materials increases from the crust to the core.

3. What prevents the iron and other minimal amount of some elements in the core from melting?
    a. Density
    b. Pressure
    c. Temperature
    d. Vapor

4. How do naturally occurring isotopes play a vital role in the production of earth's internal heat?
    a. Due to chemical stability
    b. Due to its abundance and emission of heat when it decays.
    c. Due to its high energy capacity
    d. Due to the heat it releases as it is subjected to low temperature.

5. Heat flows from the different layers to the earth. What type of heat transport occurs between the mantle and the core?
    a. Conduction
    b. Convection
    c. Radiation
    d. Sublimation

6. Which of the following is an isotope that is present in the core of the earth which contributes to immense heat in its interior?
    a. Uranium – 235
    b. Uranium – 253
    c. Uranium – 523
    d. Uranium – 325

7. Which of the following terms pertains to the spontaneous breakdown of an atomic nucleus which results to the release of energy and matter from the nucleus?
    a. Convection
    b. Gravitational pressure
    c. Radiation
    d. Radioactive decay

8. What happens to the amount of pressure as you move from the outermost layer of Earth to its inner most layer?
    a. The amount of pressure decreases from the outermost layer to the innermost layer.
    b. The amount of pressure increases from the crust down to the core.
    c. The amount of pressure remains the same.
    d. The pressure will increase then decrease from each layer.

9. Why do you think Earth is considered as a thermal engine?
    a. As a natural satellite the moon gives thermal energy to earth.
    b. Decay of isotopes contributes to the internal heat of the earth.
    c. The energy coming from the sun gives heat tremendous heat on the surface.
    d. Too much pressure on the crust causes materials to be molted which gives large amount of heat.

10. Why does Earth's internal heat builds up due to gravitational pressure?
    a. Because the escape of heat from Earth's surface is greater than the heat generated.
    b. Heat cannot escape from the interior of the earth since it is a closed system.
    c. The amount of heat that can be generated on the earth's interior is tremendous while lesser amount can escape on the surface.
    d. The amount of heat that can be released on the surface is greater.

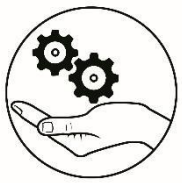
11. How did the Earth generate heat on its early stage of formation?
    a. Due gravitational pressure at the center of the planet.
    b. Due to radioactive decay of some isotopes.
    c. Due to the collision of huge amount of gas and dust particles.
    d. Through absorption of energy from planetisimals.

12. Which of the following sentences about the internal heat of the earth is **INCORRECT**?
    a. As someone goes down the center of the earth, the density of the materials increases, thus, the temperature increases.
    b. As someone goes down the center of the earth, the pressure increases, thus, the temperature increases.
    c. Due to radioactive decay in the center of the Earth, the planet is cooling off.
    d. There are remains of primordial heat of the Earth.

13. The heat that flows from the inner most layer makes materials move in the different layers of the Earth. Which of the following best describe the given sentence?
    a. It cannot be determined due to the composition of Earth.
    b. The given statement conveys correct information.
    c. The given statement conveys incorrect information.
    d. The information is dependent on the given layer of the Earth.

14. How do radioactive isotopes emit heat energy and contribute to Earth's internal heat?
    a. As gravitational pressure is applied to isotopes, it condenses then emits heat.
    b. High amount of pressure freezes the isotopes.
    c. Isotopes preserves the primordial heat of the earth.
    d. Radioactive isotopes releases heat upon undergoing spontaneous radioactive decay.

15. Which of the following is the main source of Earth's internal heat?
    a. Decay of radioactive elements in the core of the earth.
    b. Dense materials in the core of the Earth.
    c. Gravitational pressure acting on the materials of the internal layers.
    d. Primordial heat from the beginning of the earth.



# *Additional Activities*

Write an essay on how humans harness the internal heat of the earth in producing electricity. Refer to the rubric below as your guide in writing your essay.

**Rubrics**

| Category | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|
| Content | It shows an understanding of the topic's concepts and principles and uses appropriate terminology and notations, There is no misconceptions or errors evident. | It has some mistakes in terminology or shows a few misunderstandings of concepts. Few misconceptions are evident. | It has many mistakes in terminology and shows a lack of understanding of many concepts. Some misconceptions are evident. | It has many mistakes in terminology and shows a lack of understanding of many concepts. Some misconceptions are evident. | It does not show understanding of the topic's concepts and principles. It has many misconceptions |
| Organization of ideas | The ideas and concepts are precisely organized in a logical format and easy to follow. | Some ideas and concepts are vague but in a logical format but easy to follow. | Few ideas and concepts are vague and unorganized but not misleading. | Few ideas and concepts are incoherent and misleading. | All ideas and concepts are incoherent and misleading |
| Focus and details | There is one clear, well focused topic and content. Main ideas are clear and are well supported by detailed and accurate information. | There is one clear, well focused topic and content. Main ideas are clear but are not well supported by detailed information. | There is one topic and content. Main ideas are somewhat clear. | There is more than one focus of topic and content. Main ideas are vague and not detailed. | The topic and main ideas are not clear. |
| | | | Total Score: | | |

# *Answer Key*

**What's New**

1. Magma originates in the lower part of the Earth's crust and in the upper portion of the mantle.
2. Magma is form from heat transfer and decompression melting.
3. From the surface of the Earth going to its internal layers, the amount of heat increases.

**What's More**

1. A
2. A
3. B
4. C
5. B
6. D
7. A
8. heat
9. convection transport
10. thermal engine
11. heat energy
12. gravitational attraction
13. molten materials – plastic state
14. inner core – melting
15. pressure – liquid state

**Assessment**

1. c
2. d
3. b
4. b
5. b
6. a
7. d
8. b
9. b
10. c
11. c
12. c
13. b
14. d
15. a

**What I Know**

1. c
2. a
3. a
4. b
5. b
6. a
7. a
8. b
9. d
10. c
11. d
12. b
13. b
14. b
15. c

**What's In**

1. Crust
2. Mantle
3. Outer Core
4. Inner Core

The description may vary depending upon the description of the learners.

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