

Earth and Life Science Quarter 1 – Module 6: The Earth's Internal Heat



Earth and Life Science – Senior High School Alternative Delivery Mode Quarter 1 – Module 6: The Earth's Internal Heat First Edition, 2021

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Earth and Life Science Quarter 1 – Module 6: The Earth's Internal Heat



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-bystep 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 master the nature of Earth and Life Science. 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. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module covers:

• Lesson 1 – The Earth's Internal Heat

After going through this module, you are expected to:

- 1. Describe the parts and function of Earth's interior.
- 2. Describe where the Earth's internal heat comes from.
- 3. Identify the sources of Earth's internal heat; namely, radiogenic heat and primordial heat.
- 4. Describe the processes of heat transfer in Earth's mantle.



What I Know

Read each question and choose the correct answer. Write your answer on a separate sheet of paper.

- 1. Why does radioactive decay play a very important role in earth's internal heat?
 - A. Spontaneous nuclear disintegration of radioactive elements produced thermal energy.
 - B. Radioactive element can be found anywhere in the planet.
 - C. When radioactive element decays, it produces heat.
 - D. All of the above
- 2. How does the conduction in the surface of the earth affect the temperature of our atmosphere?
 - A. Air molecules do not come in contact with the warmer surface of the land and ocean resulting to the increase of its thermal energy.
 - B. Air molecules do not come in contact with the cooler surface of the land and ocean resulting to the increase of its thermal energy.
 - C. Air molecules come in contact with the warmer surface of the land and ocean resulting to the increase of its thermal energy.
 - D. Air molecules come in contact with the cooler surface of the land and ocean resulting to the decrease of its thermal energy.
- 3. How convection in Earth's mantle does affect the formation of landmass like volcano and mountain?
 - A. When warm material in the mantle rises up to the surface (ground), it will cool and sinks, these cooled materials will eventually be turned into landmass.
 - B. Collision and separation of tectonic plates happens due to the slow motion of convection cells.
 - C. Heat tries to escape in the interior of the earth.
 - D. All of the above
- 4. What is produced by the radioactive decay of isotopes in the mantle and crust?
 - A. heat from the sun
 - B. primordial heat
 - C. radiogenic heat
 - D. superheating
- 5. This refers to the heat left over from the formation of the Earth?
 - A. heat from the sun
 - B. primordial heat
 - C. radiogenic heat
 - D. superheating
- 6. How much is the approximate terawatts in the flow of heat in Earth's interior to its surface?
 - A. 41 terawatts
 - B. 43 terawatts
 - C. 47 terawatts
 - D. 49 terawatts

- 7. Which of the following is the outermost layer of the Earth?
 - A. crust
 - B. core
 - C. discontinuity
 - D. mantle
- 8. Which of the following stores magma and located in a region just beneath the crust all the way to the core?
 - A. crust
 - B. inner core
 - C. mantle
 - D. outer core
- 9. What heat transfer of fluid in the Earth's interior results to the movement of rocky mantle up to the surface?
 - A. conduction
 - B. convection current
 - C. insolation
 - D. radiation
- 10. Which of the following are boundaries between the three major layers of the Earth?
 - A. arches
 - B. discontinuities
 - C. plates
 - D. poles
- 11. What refers to the shaking of the surface of the Earth resulting from a sudden release of energy caused by a convection current?
 - A. earthquake
 - B. hurricane
 - C. storm surge
 - D. volcanic eruption
- 12. How does the mantle behave as a viscous fluid on a geological time scale?
 - A. existence of high temperature
 - B. presence of high radiation
 - C. absence of high pressure
 - D. decrease in altitude
- 13. What kind of heat transfer occurs mostly on the Earth's surface?
 - A. conduction
 - B. convection
 - C. insolation
 - D. radiation
- 14. What kind of process by which heat energy is transmitted through collisions between neighboring atoms or molecules?
 - A. conduction B. convection
 - C. insolation

- D. radiation
- 15. What are the two factors that affect conduction on the Earth's surface?
 - A. Radioactive decay and nuclear disintegration of elements.
 - B. Movement of plates and radiation from the Earth's core.
 - C. Heat from the Earth's core and radiation from the Sun.
 - D. Stored magma and volcanic eruption.

Lesson

The Earth's Internal Heat

Heat energy plays a vital role in our planet. It is one of the extreme factors in what makes the world liveable. If you think of a volcano, you know Earth must be hot inside. Our planet's internal heat shifts continents, creates mountains, and produces earthquakes, but where does all this heat inside the earth originate?

Before we proceed to the sources of heat, let's have a short review of layers of the earth. Basically, Planet Earth has 3 main layers, these are Crust, Mantle and Core. The **Crust** of the earth is a very thin layer when compared to the 3 other layers. The **Mantle** is the largest layer of the earth with estimated 1800 miles thick. The mantle is composed of very hot dense rock called magma, because of the high temperatures with the Mantle, the rock is kept in a semi-liquefied state. The **Outer Core** is composed of liquefied metals such as nickel and iron. It is kept in it liquefied state because of the immense heat in this layer. The **Inner Core** is also composed of metals however they are not kept in a liquefied state. It is believed that the temperature and pressure at depth is so great that the metals are squeezed tightly together restricting movement, so much that the particles have to vibrated in place almost like a solid structure.

Sources of heat in our planet can be identified as Primordial and Radiogenic heat. During the early formation of the Earth, the internal heat energy that gradually gathered together by means of dispersion in the planet during its few million years of evolution is called *Primordial heat*. The major contribution of this internal heat is the **accretional energy** – the energy deposited during the early formation of a planet. The core is a storage of primordial heat that originates from times of accretion when kinetic energy of colliding particles was transformed into thermal energy. This heat is constantly lost to the outer silicate layers of the mantle and crust of the earth through convection and conduction. In addition, the heat of the core takes tens of thousands of years to reach the surface of the earth. Today, the surface of the earth is made of a cold rigid rock since 4.5 billion years ago, the earth's surface cools from the outside but the core is still made of extremely hot material.

On the other hand, the thermal energy released as a result of spontaneous nuclear disintegration is called *Radiogenic Heat*. It involves the disintegration of natural radioactive elements inside the earth – like Uranium, Thorium and Potassium. Uranium is a special kind of element because when it decays, heat (radiogenic) is produced. Estimated at 47 terawatts (TW), the flow of heat from Earth's interior to the surface and it comes from two main sources in equal amounts: the radiogenic heat produced by the radioactive decay of isotopes in the mantle and crust, and the primordial heat left over from the formation of the Earth. Radioactive elements exist everywhere on earth in a fairly significant concentration. Without the process of radioactive decay, there would be fewer volcanoes and earthquakes – and less formation of earth's vast mountain ranges.



What's In

Activity 1: Earth's Layers

Label the diagram below with the names of each layer. Include a brief description of each of the Earth's layers.



THE STRUCTURE OF THE EARTH

Activity 2: Which of which?

Identify the sources of internal heat by writing **RH** for radiogenic heat and **PH** for primordial heat. Write your answer on a separate sheet of paper.

- ____1. Presence of different isotopes of heat producing element in the mantle and crust.
- _____2. Internal heat accumulated by dissipation of planet.
- ____3. Release of accretional energy.
- _____4. Processes involved in mantle convection.
- 5. Release of thermal energy as a result of spontaneous nuclear disintegration.





What's New

Activity 3: Find Me

Find and encircle the given 10 words in the grid. Then, create 1 sentence for each word you found. Words may appear straight across, back-word straight across, up, and down.

MANTLE CURRENT EARTH TECTONIC RADIATION CONVECTION PRIMODIAL RADIOGENIC HEAT CONDUCTION

S	М	V	Х	R	S	В	J	E	R	Х	С	Η	Κ	Ν
0	Y	U	D	Η	W	L	Т	L	Y	Q	S	L	S	Z
Q	N	Z	E	С	Ι	Ν	E	G	0	Ι	D	А	R	Ν
Y	В	А	D	W	0	Р	Q	В	Q	Х	V	Q	С	V
С	Т	М	Η	В	R	Y	D	J	K	R	U	S	D	Е
D	0	U	F	С	0	Ν	V	E	С	Т	Ι	0	Ν	А
Т	F	N	L	А	Ι	D	0	М	Ι	R	Р	U	В	R
L	N	K	D	E	С	Z	K	Ι	Х	U	J	F	D	Т
S	Х	E	Z	U	L	Ι	Η	С	Т	E	S	Ι	S	Η
Р	D	K	R	E	С	Т	N	Е	K	А	Κ	G	Y	D
0	Ι	S	Η	R	А	Т	N	0	V	W	Ι	А	V	Z
М	N	D	С	D	U	Η	Ι	А	Т	0	Т	D	Ι	Κ
Q	V	Y	Z	W	S	С	L	0	М	С	G	0	А	Р
R	S	Ν	E	Р	Х	0	М	Q	N	F	E	В	J	R
Ν	А	K	Z	F	A	Q	U	J	С	Х	S	Т	K	Q



What is It

Sources of Heat and Heat Transfer

Both sources of heat whether primordial or radiogenic undergo heat transfer and it plays an important role to the continuous changes and development of our planet. In connection, another part of this module describes the heat transfer in the Earth. Three processes can transfer heat: conduction, convection, and radiation.

Conduction processes happen in the earth's surface and it directs the thermal settings in almost entire solid portions of the Earth and plays a very important role in the lithosphere. One of the three main ways of heat transfer is conduction. Technically, it can be defined as the process by which heat energy is transmitted through collisions between neighboring atoms or molecules. Conduction carries heat from the Earth's core and radiation from the Sun to the Earth's surface. When the atmosphere in normal temperature contacts with the warm surfaces of the land, it transfer thermal energy, then it will heats up the rest of the air through convection.

Convection is the transfer of heat by the movement of mass, and it is a more effective mode of heat transport in the Earth than pure conduction. Convection dominates the thermal conditions in zones with significant amounts of fluids (molten rocks) and thus governs the heat transport in the fluid outer core and the mantle. In geological time scale, due to the tremendous temperature, the mantle acts like a viscous fluid. In convection current, the mantle of the earth moves slowly because of transfer of heat from the interior of the earth up to the surface. This results to the movement of tectonic plates. Hot materials are added at the edges of a plate and then it cools. At those edges, it becomes dense by its exposure from the heat and sinks into the earth at an ocean trench. This starts the formation of volcanoes.

Radiation is the least important mode of heat transport in the Earth. The process of heat exchange between the Sun and the Earth, through radiation, controls the temperatures at the Earth's surface. Inside the Earth, radiation is significant only in the hottest parts of the core and the lower mantle. When the land and water become warm in summer, it emits long – wavelength infrared radiation that is readily absorbed by the atmosphere. This continues during night time too. Convection in the air then spreads out the thermal energy throughout the atmosphere.

Activity 4: My Notepad

In your own words, how do the three (3) major processes of heat transfer affect the temperature of the Earth? Write your answer on the space provided.

CRITERIA	10 points	5 points	3 points
Knowledge	Concepts are	Concepts are	The paper
Integration	integrated into	integrated into	demonstrates
	student's own	student's own	that the author,
	insight. Student	insight. But some	to a certain
	provides remarks	of the	extent,
	that show	conclusions are	understands and
	analysis and	not supported in	has applied
	synthesis of	the body of the	concepts learned
	ideas.	paper.	in the course.
Content	The content is	Sufficiently	Limited content
	focusing clearly	developed content	with inadequate
	enough for the	with adequate	elaboration and
	scope of the	elaboration or	explanation.
	lesson.	explanation	
Style	Precise,	Generic use of a	Limited word
	illustrative use of	variety of words	choice and
	variety of words	and sentence	control of
	and sentence	structures that	sentence
	structure to	may describe the	structure that
	describe the topic	topic	may or may not
	appropriately.	appropriately.	describe the topic appropriately.

Activity 5: Fill me up!

Use the word bank to fill in the gaps in the passage below. Write your answers on a separate sheet of paper.

Convection Convection current Crust	Earth's plates Earthquakes Plate tectonics	Plates Volcanoes
---	--	---------------------

The surface layer of the earth is called the	This layer is
broken up into pieces called These	"float" on
the mantle. Heat rising and falling inside the mantle creates	current called
The current move the	·
This movement is known as The movement of the movement	he earth's plate
causes earthquakes and	



What's More





Figure B. Conduction

Figure A shows a convection cell, warm material rises (up to the surface of the earth) and cool material sinks. These cooled materials will eventually turn to land formation. In mantle convection, the heat source is the core. The core of the earth is very hot. It is nearly as hot as the surface of the sun – about 6000°C. Convection current is relevant to the movement of tectonic plate because the heat builds up pressure underneath the crust (tectonic plates). As they become unstable, they push against each other (subduction) and rise upwards or one goes under the other.

Figure B shows the process of conduction on how air molecules come in contact with the warmer surface of the land or ocean, resulting to the increase of its thermal energy through conduction. The thermal energy of the core is transferred to the surface of the earth and the lower levels of ocean by conduction.

Activity 6: Picture Analysis

Read and analyze figures A in page 9 and figure B in page 10. Answer the questions stated below.

Figure A shows the process of convection in the earth's mantle. How does it affect the formation of mountains and the temperature in the surface (ground)?
How the convection current affects the movement of tectonic plates?
How convection in earth's interior and conduction in the surface affect the temperature in our atmosphere?
How subduction cause the formation of land mass like mountains and volcanoes?
Why does earthquake occur in subduction zone? (The area where subduction occur)
s: Based from figure A and B, how convection and conduction is inter-

Values Integration: How can pressure and stress be an agent to achieve success in life?

Activity 7: Crossword Puzzle

Complete the crossword by filling in the word that describes each clue.



Across:

- 2. air molecules come in contact with warmer molecules
- 3. crust are made up of puzzle like landmass called ____
- 4. rising and falling movement of material in the mantle
- 5. when tectonic plates push with each other

7. it is the result of movement of earth's plate

Down:

- 1. elements that play a vital role in Earth's internal heat
- 6. least important mode of heat transport
- 8. warm material rise; cool material _____
- 9. heats build up underneath the crust

___.

_.



What I Have Learned

Read each question and fill in the blanks with the correct term to complete the statement. Write your answer on a separate sheet of paper.

- 1. ______ in the interior of the earth can be classified as primordial and radiogenic heat.
- 2. The thermal energy released as a result of spontaneous ______ is called Radiogenic Heat while the internal heat energy accumulated by ______ in a planet during its few million years of evolution is called Primordial heat.
- 3. There are three processes can transfer heat: _____, ____, and radiation.
- 4. _____ governs the thermal conditions in almost entire solid portions of the Earth and plays a very important role in the lithosphere.
- 5. _____ involves transfer of heat by the movement of mass, which is a more efficient means of heat transport in the Earth compared to pure conduction.
- 6. _______ is the least important mode of heat transport in the Earth.
- 8. The ______ of the core is transferred to the surface of the earth and the lower levels of ocean by conduction.
- 9. Air molecules come in contact with the warmer surface of the land or ocean, resulting to the increase of its _____.

10. The area where subduction occur is called ______.



What I Can Do

Activity 6: Illustrate and Explain

Illustrate the example indicated in the given scenario in the box where conduction and convection are applied. Then, relate it to the processes occurring in the Earth's internal heat.

CONDUCTION

Chocolate candy in your hand will eventually melt as the heat from your body is released and makes it melted.



Explanation:

CONVECTION

A heater in the hot air balloon heats the air. The air inside is trapped causing the balloon to rise.



Explanation:



Read each question and choose the correct answer. Write your answers on separate sheet of paper

- 1. What process by which heat is directly transmitted through a substance when there is a difference of temperature or between adjoining regions, without movement of the material?
 - A. conduction
 - B. convection
 - C. insolation
 - D. radiation
- 2. Why radioactive decay plays a significant role in Earth's internal heat?
 - A. Spontaneous nuclear disintegration of radioactive elements produced thermal energy.
 - B. Radioactive element can be found anywhere in the planet.
 - C. When radioactive element decays, it produces heat.
 - D. All of the above
- 3. Which of the following is described as the process of heat exchange between the Sun and the Earth that controls the temperatures of the latter?
 - A. conduction
 - B. convection
 - C. insolation
 - D. radiation
- 4. What is produced by the radioactive decay of isotopes in the mantle and crust?
 - A. heat from the sun
 - B. primordial heat
 - C. radiogenic heat
 - D. superheating
- 5. How the conduction in the surface of the earth affect the temperature of our atmosphere?
 - A. Air molecules do not come in contact with the warmer surface of the land and ocean resulting to the increase of its thermal energy.
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 - C. Air molecules come in contact with the warmer surface of the land and ocean resulting to the increase of its thermal energy.
 - D. Air molecules come in contact with the cooler surface of the land and ocean resulting to the decrease of its thermal energy.
- 6. What are the two factors that affect conduction on the Earth's surface?
 - A. radioactive decay and nuclear disintegration of elements
 - B. movement of plates and radiation from the Earth's core
 - C. heat from the Earth's core and radiation from the Sun
 - D. stored magma and volcanic eruption
- 7. What kind of process by which heat energy is transmitted through collisions between neighboring atoms or molecules?
 - A. conduction
 - C. insolation

- B. convection
- D. radiation

- 8. What kind of heat transfer occurs mostly on the Earth's surface?
 - A. conduction
 - B. convection
 - C. insolation
 - D. radiation
- 9. How does the mantle behave as a viscous fluid on a geological time scale?
 - A. altitude
 - B. pressure
 - C. radiation
 - D. temperature
- 10. What refers to the shaking of the surface of the Earth resulting from a sudden release of energy caused by a convection current?
 - A. earthquake
 - B. hurricane
 - C. storm surge
 - D. volcanic eruption
- 11. Which of the following are boundaries between the three major layers of the earth?
 - A. arches
 - B. discontinuities
 - C. plates
 - D. poles
- 12. What heat transfer of fluid in the earth's interior results to the movement of rocky mantle up to the surface of the earth?
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 - B. convection current
 - C. insolation
 - D. radiation
- 13. Which of the following stores magma and located in a region just beneath the crust all the way to the core?
 - A. crust
 - B. inner core
 - C. mantle
 - D. outer core
- 14. Which of the following is the outermost layer of the Earth?
 - A. core
 - B. crust
 - C. discontinuity
 - D. mantle
- 15. How much is the approximate terawatts in the flow of heat in Earth's interior to its surface?
 - A. 41 terawatts
 - B. 43 terawatts
 - C. 47 terawatts
 - D. 49 terawatts



Additional Activities

Directions. Using your smartphones, take a picture of five (5) common activities/scenarios on which heat transfer is applied. It may be material, event or situation. Classify each whether it is conduction, convection or radiation. Provide brief explanation to support your answer. Post the picture and your answer on a separate sheet of paper.

PICTURE	KIND OF HEAT TRANSFER	BRIEF EXPLANATION

CRITERIA	10 points	5 points	3 points
Interpretation	Draws connections. Clearly describes the scenario/subject in full detail.	Draws connections. Clearly describes the scenario/ subject in detail.	Give the basic description but Does not draw connection.
Effort	Demonstrates above board effort in accomplishing the assignment going the extra distance in research and time spent to get the assignment done and on time.	Demonstrates a good effort in accomplishing the assignment in research and time spent to get the assignment carried out.	Demonstrates limited effort in accomplishing the assignment.
Creativity	The student demonstrates superior creativity and originality in the selection of the visual components.	The student demonstrates good use of creativity and originality in the selection of the visual components.	The student shows little evidence of creativity or originality in the selection of the visual components.



.5 Hd Hd .2 RН .ι Activity 2 COTE Core – Outer and Inner ·ɔ Lower mantle Mantle – Upper and ٠q Continental crust Crust – Oceanic and ٠e Activity 1 ni s'tshW 12[.] C 14. A 13. A 12. A A.11 10[.] B .6 В .8 С

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В

С ·4

D .5 .2

С

D **won** I јай

.5 RН **.**4 RН Volcanoes .8 ٠Ž Earthquakes 6. Plate tectonics Convection .5 Convection current .4 3. Plates Earth's Plates .2 teurd ٠ī Activity 4 Jusmssssa ٠L A С •9 JI s'JgAW

to student's perception

Activity 3

wəN s'jghw

Answer may vary according



Answer Key

12' C

14' B

13. C

12. B 11. B

10. A D .6 .8 .8 A

A

С •9

С .5

С .4

D .5

D

Activity 5

Ућаť's Моте

to student's perception

Answer may vary according

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