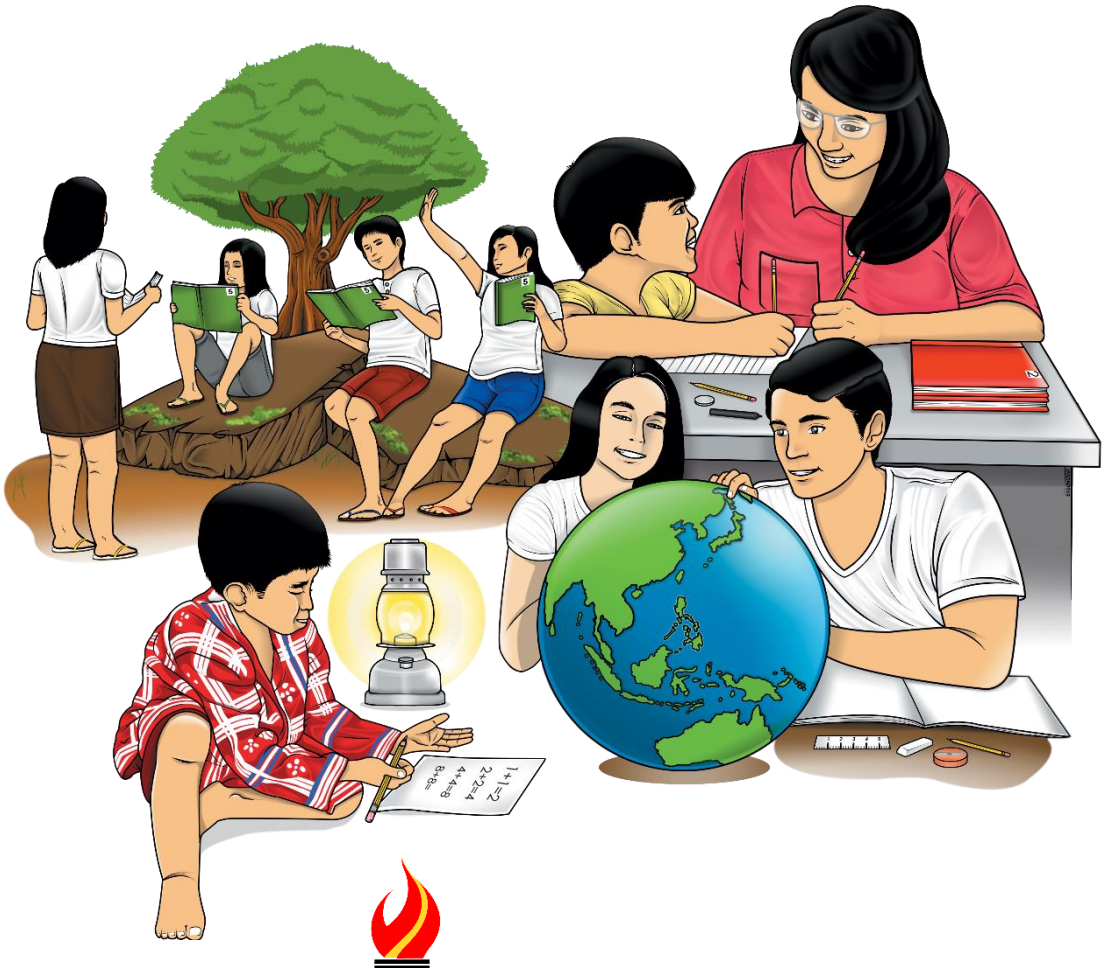
Senior High School

DepED
DEPARTMENT OF EDUCATION

Earth and Life Science

Quarter 1 – Module 8: Changes in Mineral Components and Texture of Rocks (Metamorphism)



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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

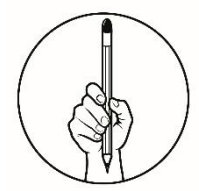
This module was designed and written with you in mind. It is here to help you master the Nature of Earth and Life Science. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged 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 – Changes in Mineral Components and Texture of Rocks (Metamorphism)

After going through this module, you are expected to:

1. describe the changes in mineral components and texture of rocks due to changes in pressure and temperature (metamorphism);
2. identify rock samples based on the effects of changes on temperature and pressure; and
3. analyze through a diagram on how temperature and pressure affect the mineral components and texture of rocks.



What I Know

Read and analyze each statement and choose the letter which corresponds to the correct answer by writing it on your answer sheet/notebook.

1. Which of the following statements best describe metamorphosis?
   A. change in rock formation
   B. process of rock formation
   C. process which involves changes
   D. change that takes place within body of rock once expose to different conditions

2. Which of the following metamorphism is affected by heat and reactive fluid?
   A. contact only
   B. regional only
   C. both contact and regional
   D. neither contact nor regional

3. Which of the following is an example of rock produced by a contact metamorphism?
   A. gneiss
   B. hornfels
   C. marble
   D. slate

4. Which of the following led to the formation of deformed rocks with foliation?
   A. volume of air entering the rocks
   B. temperature and rising of magma
   C. temperature and volume of minerals
   D. pressure and recrystallization of minerals

5. What is the effect of heat and pressure in rocks as there is an increase in depth?
   A. foliation surfaces shine
   B. low-grade metamorphism
   C. grain size becomes coarse
   D. increase in mineral alignment

6. Which of the following is the main factor in the process of regional metamorphism?
   A. air
   B. pressure
   C. temperature
   D. water

7. Which of the following rock samples is less influenced by the heat?
   A. gneiss
   B. phyllite
   C. schist
   D. slate

8. How do you describe the grain size texture of hornfels?
    A. fine texture
    B. coarse texture
    C. coarse to fine texture
    D. medium coarse texture

9. Which of the following is not a non-foliated metamorphic rock?
    A. hornfels
    B. marble
    C. phyllite
    D. metaconglomerate

10. What happened to the temperature and pressure if the rocks are buried down deep?
    A. It increases
    B. It decreases
    C. It remains constant
    D. It is intermittently degrading

11. Which of the following is NOT true about metamorphism?
    A. Slate and Gneiss are examples of foliated rock.
    B. Contact Metamorphism creates non-foliated rocks.
    C. Pressure is the main factor of contact metamorphism.
    D. Magma will bake the surrounding rocks due to different in temperature.

12. Which of the following is an example of non-foliated rock?
    A. gneiss
    B. marble
    C. phyllite
    D. schist

13. Which of the following is the main factor of regional metamorphism?
    A. air
    B. fire
    C. pressure
    D. temperature

14. Which type of metamorphism is caused by high temperature and high pressure enacted over a large volume of crust?
    A. burial
    B. contact
    C. regional
    D. pyroclastic

15. Which of the following is a distinct projecting textural feature of regional metamorphic rocks?
    A. ripples
    B. bedding
    C. foliation
    D. non-foliation

Lesson 1 Changes in Mineral Components and Texture of Rocks (Metamorphism)

This part of the module contains topics about metamorphism. Students must describe changes in mineral component and texture of rocks due to changes in pressure and temperature by doing the different activities included in this part of the module. Likewise, concept about the metamorphism is available for the students' reference in doing each activity incorporated in the procedure.

What's In

Metamorphism is the change that takes place within a body of rock as a result of it being subjected to conditions that are different from those in which it is formed. It is from the Greek word "meta" means change and "*morphe*" means form.

Notes to the Teacher

General Notes:

- **Extend.** Provide the materials to the students.
- **Explore.** Allow the students to explore and check the given materials.
- **Explain.** Describe each part of the instructional material or the module.
- **Enable.** Let the students perform or accomplish the module.
- **Evaluate.** Assess learners' output and get back to them.

Specific Note:

Remind the students with the major task.

Major Task. Take note of the number of correct responses you will be making in every activity (What I know, What's new, What is it, What's More A and B, What I have learned, and What I can do). Then, look for the corresponding letter of each number of responses and think of the words which are associated in metamorphism. Accomplish it in the "Additional Activity" part.

Example:

A. What I Know	:	6 - F	=	fluid
B. What's New	:	4 - D	=	deep rock
C. What is It	:	7 - G	=	gneiss
D. What's More A and B	:	9 - I	=	intrusive
E. What I Have Learned	:	8 - H	=	heat
F. What I Can Do	:	5 - E	=	energy

What's New

The box on the left side contains important words which may or may not be associated to metamorphic process. Identify words which are related to the said process by choosing and writing the words on the opposite box.

Example: HEAT (It causes changes in rocks. Hence, it is related to metamorphic process.)

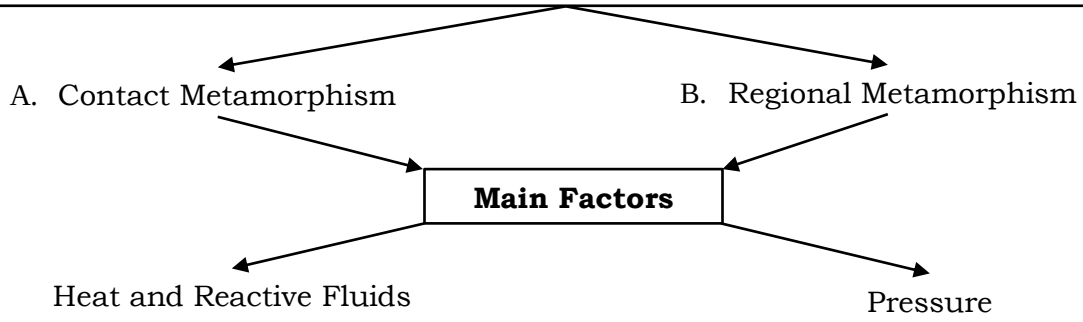
HEAT VOLCANIC ROCK PRESSURE FLUID MANTLE TEMPERATURE WEATHERING CEMENTATION	HEAT

Score:

What is It

Activity: Heat, Pressure, and Metamorphism

METAMORPHIC ROCK is formed at the surface of the Earth through the process of metamorphism with recrystallization of minerals in rocks due to changes in pressure and temperature conditions.



The table below shows the scheme of metamorphic rock identification. It includes key points on how to classify rocks depending on its type, texture, and grain size. Specific rock samples are also presented with their map symbol. Likewise, compositions of metamorphic rock are also situated parallel to the type of metamorphism.

Table 1. Scheme of Metamorphic Rock Identification

TEXTURE		GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED	MINERAL ALIGNMENT	FINE	MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET, PYROXENE	Regional	Low-grade metamorphism of shale	Slate	
		FINE TO MEDIUM		(Heat and Pressure increase with depth)	Foliation surfaces shiny from microscopic mica crystals	Phyllite	
					Platy mica crystals visible from methamorphism of clay or feldspars	Schist	
	BANDING	MEDIUM TO COARSE			High-grade metamorphism; some mica changed to feldspar, segregated by mineral type into bands	Gneiss	
NONFOLIATED		FINE	Variable	Contac Heat	Various rocks changed by heat from nearby magma/lava	Hornfels	
		FINE TO COARSE	Quartz	Regional or Contact	Metamorphism of rocks sandstone	Quartzite	
			Calcite and/or dolomite		Metamorphism of limestone or dolostone	Marble	
		COARE	Various Minerals in particles and matrix		Pebbles may be distorted or stretched	Metaconglomerate	

The three main factors/agents of metamorphism include heat, pressure, and chemically active fluids. The heat perhaps is the most important factors because it provides the energy to drive the chemical changes which results in the recrystallization of minerals. The heat increases as the depth increases. Pressure just like heat, also increases with depth, and the buried rocks are subjected to the force or stress. Heat and pressure cause physical changes to buried rocks. Chemically active fluids enhanced the metamorphic process. Usually, the common fluid which helps the chemical activity is water containing ions in solution. As the rocks buried deeply, the water is forced out of the rock and becomes available to aid in chemical reactions.

Let's do it!

Answer the question below by putting a check in the box .

Question: How do temperature and pressure affect the metamorphic rock formation? (5 points)

- ☐ If the rocks are buried deep, temperature, and pressure will get increased.
- ☐ Contact metamorphism creates no-foliated metamorphic rocks.
- ☐ Magma will bake the surrounding rocks due to difference in temperature.
- ☐ Deformed rocks with foliation/lineation are brought by pressure and recrystallization of minerals.
- ☐ Pressure is the main factor of contact metamorphism
- ☐ Slate and gneiss are examples of foliated rocks.

Score:

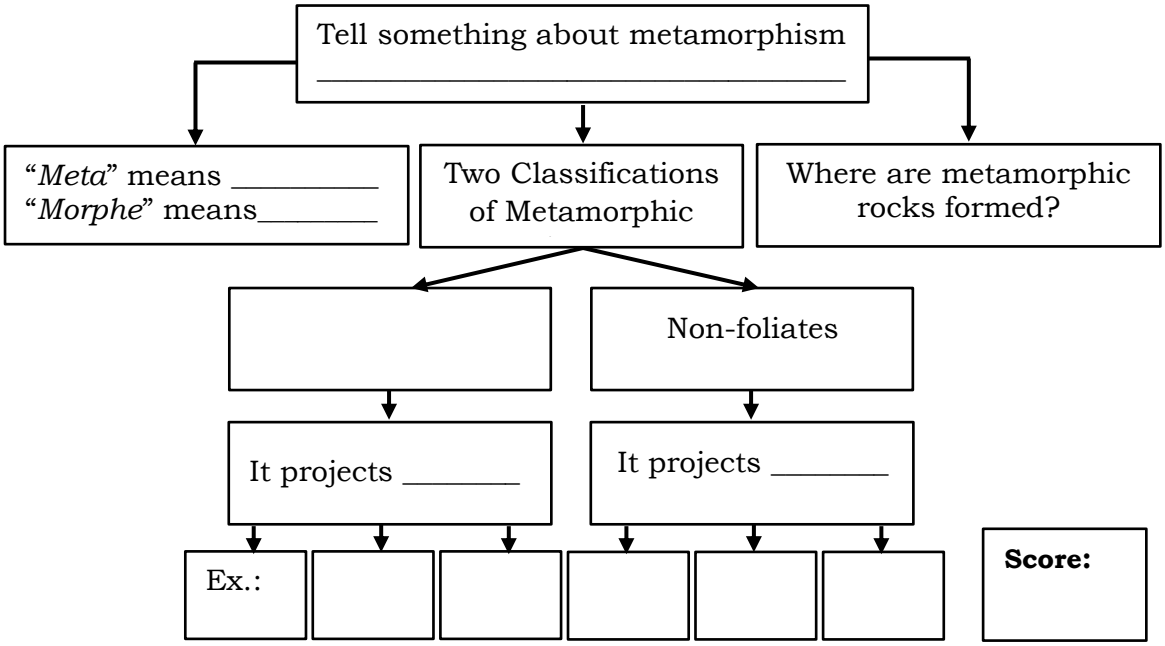
What's More

Activity A. Metamorphism Map

Complete the concept map about metamorphism by supplying the missing words and phrases which can be chosen from the box below.

Key Terms:

form volcano	non-Foliated	magma
lineation/foliation	fine grain	pressure
schist	hornfels	heat
gneiss	marble	quartzite
	slate	



Activity B. The Hidden Word

Arrange the jumbled letters by putting the correct sequence on the shaded boxes to form a word (names of rocks) based on the given description. Use the numbered boxes to discover the hidden word.

Example: It is formed when limestone is exposed to high temperature and pressure.

L	E	B	A	R	M
M	A	R	B	L	E

1. It has low-grade metamorphism of shale.

T	E	L	A	S
	2			

2. Plays mica crystals visible from metamorphism of clay or feldspar.

T	S	S	I	C	H
4					

3. Metamorphism of bituminous coal.

A	N	I	T	H	R	A	C	T	E
3									

4. High –grade metamorphism.

S	S	I	N	E	G

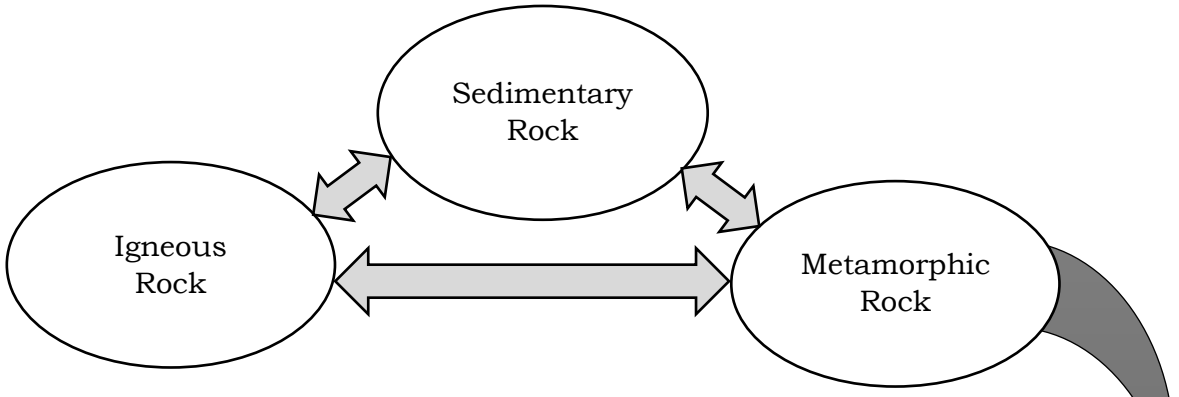
5. Foliation surface is shiny from microscopic mica crystals.

E	T	P	Y	H	L	L	I
				1			

The hidden word is _____.

Activity C: Rock You

Read and analyze the diagram below. It will provide you better understanding about the lesson.



The third family of rock is the metamorphic rock formed from either igneous rock or sedimentary rocks that have been changed due to tremendous heat and pressure.

Metamorphism does not actually melt the rocks but transforms them into denser, more compact rocks. Mineral may also be rearranged due to chemical reactions involving fluids that enter rocks

Metamorphic Rocks are used for variety of purposes.

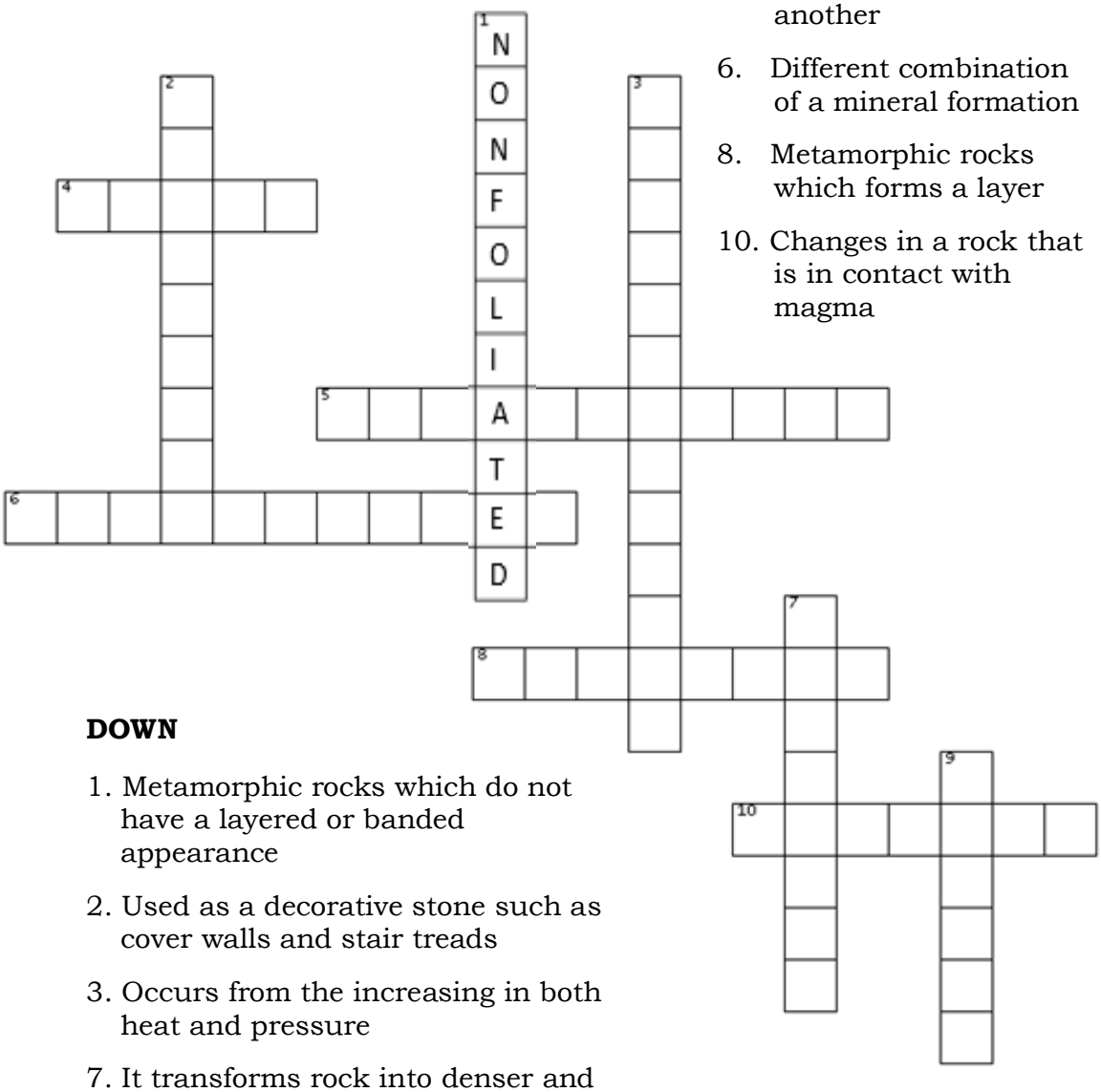
Slate is used commercially for your classroom blackboards and for pool tabletops.

Marble is used in the construction of building floors, bathroom walls, and counter parts (Pavico and Faraon, 2007, 224-225).

Extreme heat and pressure change the original state of an existing rock. They also change chemical composition and physical structure of existing rocks. Combinations of minerals in rocks are stable only over specific ranges of pressure and temperature. At pressure and temperature not within the ranges, the minerals form different combinations call mineral assemblages (Kasten 2012, 290-291).

Activity D: My Metamorphic Puzzle

Complete the crossword puzzle by filling in a word which corresponds to the description written in the across and down clues.



ACROSS

4. Used commercially classroom blackboards
5. Rock formed by heat and pressure changing one type of rock into another
6. Different combination of a mineral formation
8. Metamorphic rocks which forms a layer
10. Changes in a rock that is in contact with magma

DOWN

1. Metamorphic rocks which do not have a layered or banded appearance
2. Used as a decorative stone such as cover walls and stair treads
3. Occurs from the increasing in both heat and pressure
7. It transforms rock into denser and more compact rock
9. Used in construction of building floors

What I Have Learned

Match the statements in column A with the indicated terms in column B. Write the letter of the correct answer on the blank before each number.

Column A	**Column B**
____ 1. It is a Greek word which means "change"	A. quartzite
____ 2. It is one of the factors affecting metamorphic rock which creates lineation	B. metamorphism
____ 3. Hornfels, marble and _____	*C. meta*
____ 4. It is the main factor of contact metamorphism	D. regional metamorphism
____ 5. It is a process of changing rock formation	E. heat
____ 6. It has a foliation surface shiny from microscopic mica crystal	F. pressure
____ 7. A rock sample which maybe distorted or stretched	G. phyllite
____ 8. A rock sample with carbon composition	H. metaconglomerate
____ 9. It is formed by great heat and pressure deep within the earth	I. anthracite
____ 10. It takes place when magma introduces great amount of heat into an existing rock resulting in the recrystallization and mineral reaction in the rock	J. metamorphic rock
	K. contact metamorphism

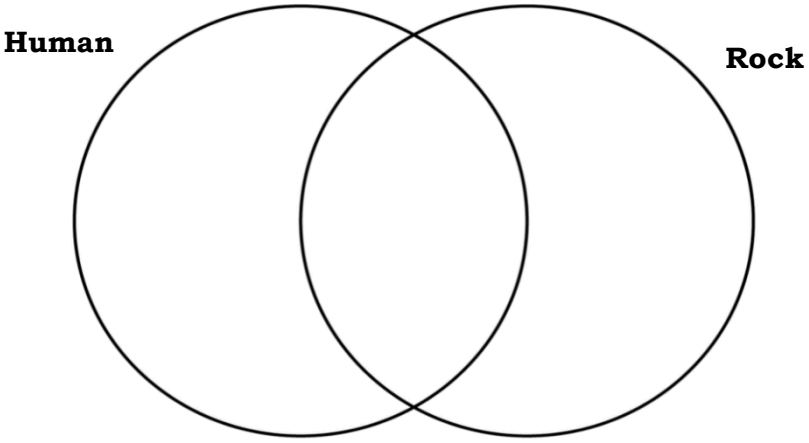
Score:

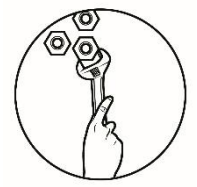
Additional Task

For your own reflection and understanding, answer the posted question below. You may use the available diagram in answering the question.

> *"Humans are different from each other, also men, and women are far way different from each other. On the other hand, they possess characteristics and functions which are both important and needed for the world progression and development. Like rocks, which display different texture and colors but despite of these differences they both possess beauty and brilliance."*

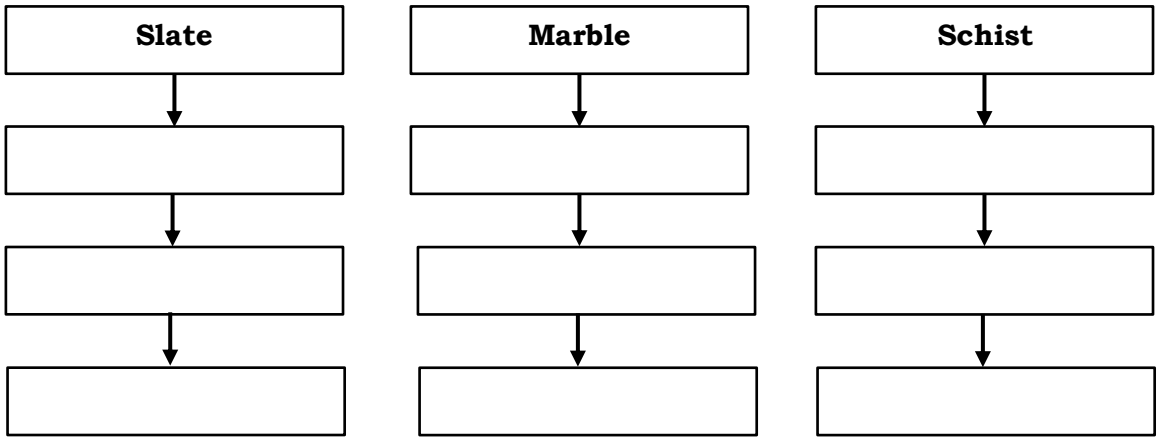
Based on the quotation above, how do you see the similarities and differences of human and rocks?





What I Can Do

A. Give the uses of the following metamorphic rock samples. Write your answer in the box provided under each rock samples.



B. Read the following tips on how you can make rock useful at home. Look for rocks with different textures as the highlight of your task. Choose one from the three suggestions and once you do it, take a picture of it and attach it in the space below. In case, you do not have ways to print it, just illustrate your project on the space provided.

1. Rock can be displayed in crystal or transparent vase/jar.
2. Make a good arrangement of rocks in a jar. You can make it with same color, same textures, or sizes.
3. Aside from the rock in jar. You can also use them in a garden by putting it together with plants. Arrange it according to your taste.

Assessment

Multiple Choice. Read and analyze each statement and choose the letter which corresponds to the correct answer by writing it on your answer sheet/notebook.

1. Which of the following words is NOT associated with metamorphism?
   A. heat
   B. mantle
   C. pressure
   D. weathering
2. What is the effect of heat and pressure in rocks as there is an increase in depth?
   A. foliation surfaces shine
   B. low-grade metamorphism
   C. grain size becomes coarse
   D. increase in mineral alignment
3. What is the main factor that affects regional metamorphism?
   A. heat
   B. fluid
   C. water
   D. pressure

4. Which of the following rock sample contains fine texture?
    A. gneiss
    B. hornfels
    C. quartzite
    D. metaconglomerate

5. What rock is the result of the metamorphism of sandstones?
    A. slate
    B. schist
    C. marble
    D. phyllite

6. What are the main factors for contact metamorphism to occur?
    A. air and water
    B. heat and reactive fluid
    C. temperature and water
    D. pressure and temperature

7. How do you describe the grain size texture of Hornfels?
    A. It has fine texture
    B. It has coarse texture
    C. It has coarse to fine texture
    D. It has medium coarse texture

8. Which of the following rock samples is less influenced by the heat?
    A. phyllite
    B. gneiss
    C. schist
    D. slate

9. Which of the following is NOT true about metamorphism?
    A. Slate and gneiss are examples of foliated rock.
    B. Contact metamorphism creates non-foliated rocks.
    C. Pressure is the main factor of contact metamorphism.
    D. Magma will bake the surrounding rocks due to different in temperature.

10. What happens to the grain size of the minerals in rocks when the heat is increased?
    A. It increases
    B. It decreases
    C. It remains constant
    D. It degrades intermittently

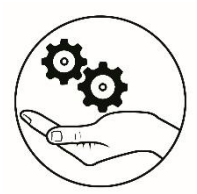
11. Which of the following DOESN'T belong to the group?
    A. dolomite
    B. feldspar
    C. mica
    D. quartz

12. Foliation or lineation happens among deformed rocks due to
    A. pressure and recrystallization of rocks
    B. eruption of magma from the mantle to the crust
    C. increase in temperature in the surrounding area
    D. increase in volume of water as the rocks' depth increases

13. Which of the following relationships is INCORRECT?
    A. fine grain: slate
    B. banding: gneiss
    C. non-foliated: phyllite
    D. contact heat: hornfels

14. How do temperature and pressure affect metamorphism?
    A. Pressure and temperature increase as you go up to the crust.
    B. The deeper the rock depth, the higher the pressure and temperature.
    C. Foliation happens as there is an increase in the pressure and temperature.
    D. Magma cannot bake the surrounding rocks due to the difference in temperature.

15. Samer is walking down the river when she sees an unknown metamorphic rock. Which of the following characteristic can BEST help her to immediately identify the type of metamorphism that the rock underwent using a magnifying glass?
    A. foliation
    B. grain size
    C. name of the rock
    D. kind of mineral present in the rock

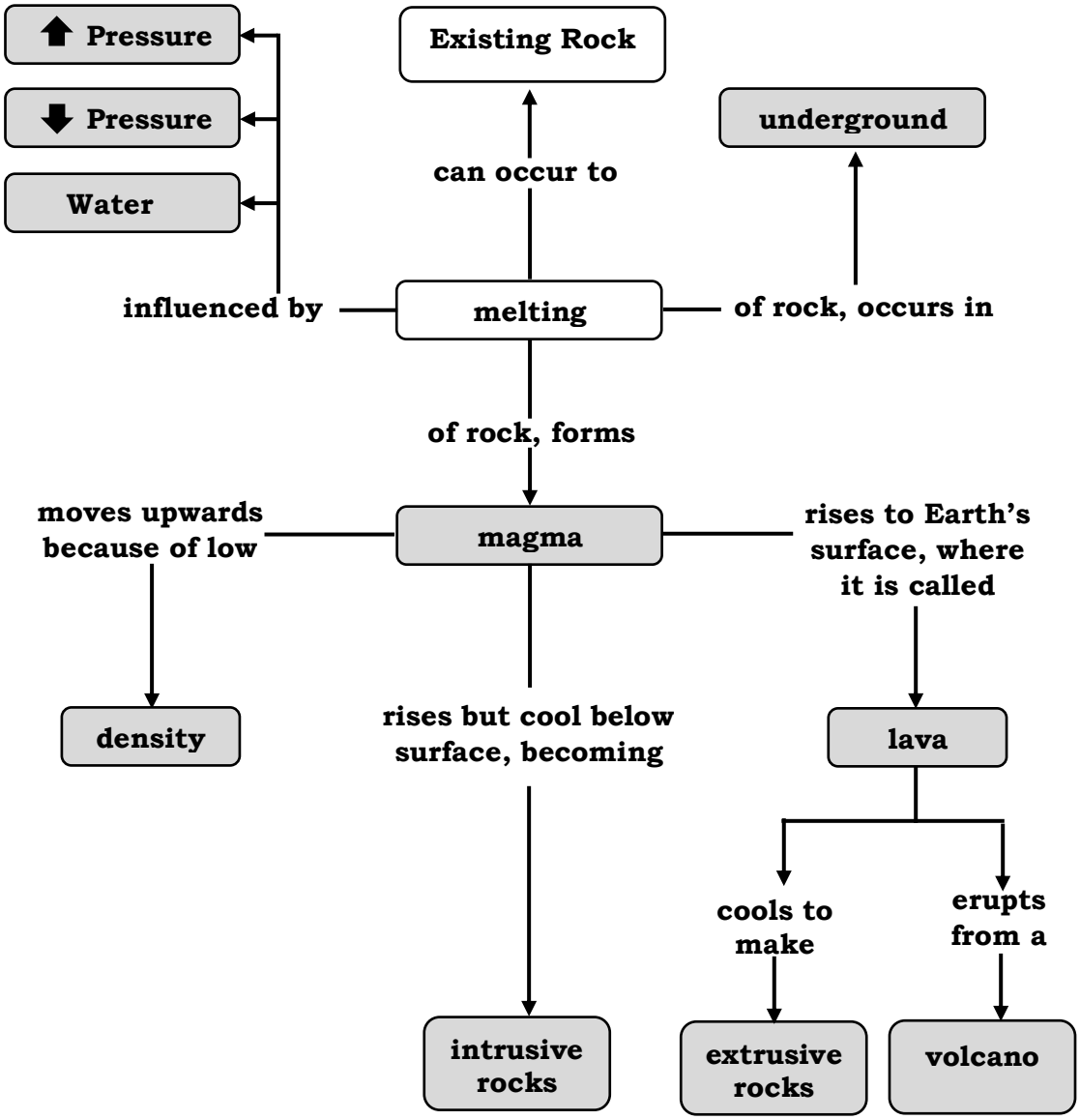


Additional Activities

A. Indicate the scores you obtained from the previous activities. Please refer to the major task in case you forget the directions. Write your answer on the space provided in the box below.

Activity	Score	Formed Words
What I Know		
What's New		
What is it		
What's More (A+B)		
What I have Learned		
What I can Do		
Assessment		

B. For additional information, take time to read and observe the concept map.



The concept map above presents the processes between igneous and metamorphic rocks. It shows how metamorphism takes place from any existing rocks such as igneous rock.

Answer Key

What's More

A.

B.

1. Slate
2. Schist
3. Anthracite
4. Gneiss
5. Phyllite

D.

1. Nonfoliate	6. Assemblages
2. Quartzite	7. Regional
3. Metamorphosis	8. Foliates
4. Slate	9. Marble
5. Metamorphic	10. Contact

What I Know

1. D
2. B
3. B
4. D
5. C
6. B
7. D
8. A
9. D
10. A
11. C
12. B
13. C
14. D
15. D

What's New

Heat
Pressure
Fluid
Mantle
Temperature
Volcanic Rock

What I Can Do

Slate:

1. Good roofing material
2. Decorative gardening stones
3. Base for snooker tables
4. And it was used as a writing board (or writing slate)

Marble:

1. Use for building or sculpture material
2. Can be ground down and use as cleaning and soap material

Schist:

1. Use for building, sculpture. Paving and grade decoration

What is It

- If the rocks buried deep, temperature and pressure in get increase
- Contact metamorphism creates no-foliated metamorphic rocks
- Magma will bake the surrounding rocks due to difference in temperature
- Deformed rocks with foliation/lineation are brought by pressure and recrystallization of minerals
- Slate and gneiss are examples of foliated rocks

Assessment

1. D
2. C
3. C
4. B
5. C
6. B
7. A
8. D
9. C
10. A
11. A
12. A
13. C
14. B
15. B

What I Have Learned?

1. C	6. G
2. F	7. H
3. A	8. I
4. E	9. J
5. B	10. K

Additional

Task (Answer may Vary)

Example

1. Human shows characteristics and attitudes which are unique to humans as a rational being.
2. Rocks display characteristic, beauty, appearance which are different from other types of rocks
3. In spite of differences, both are the same when it comes to the ability of showing how unique and wonderful they are.

References

A. Books

Acosta Herma D. et al. Science Learners Material Grade 10, 2015.

Commission on Higher Education. Earth and Life Science for Senior High School. C.P. Garcia Ave., Diliman, Quezon City Philippines. Commission on Higher Education, 2016

Kasten Lileth P. Integrated Science: Secondary Education Curriculum, 2012.

Pavico-Ferriols Josefina and Faraon-Darvin Genevieve, Exploring Life Through Science:Integrated Science, 2007.

Vengco Lilia G. and Religioso Teresita F. You and the Natural World: Integrated Science, 3rd Edition 2008.

B. Electronic References

Steven Earle, Gabriola Island, 2015 retrieved from

https://opentextbc.ca/geology/chapter/chapter-7-metamorphism-and metamorphic-rocks/

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