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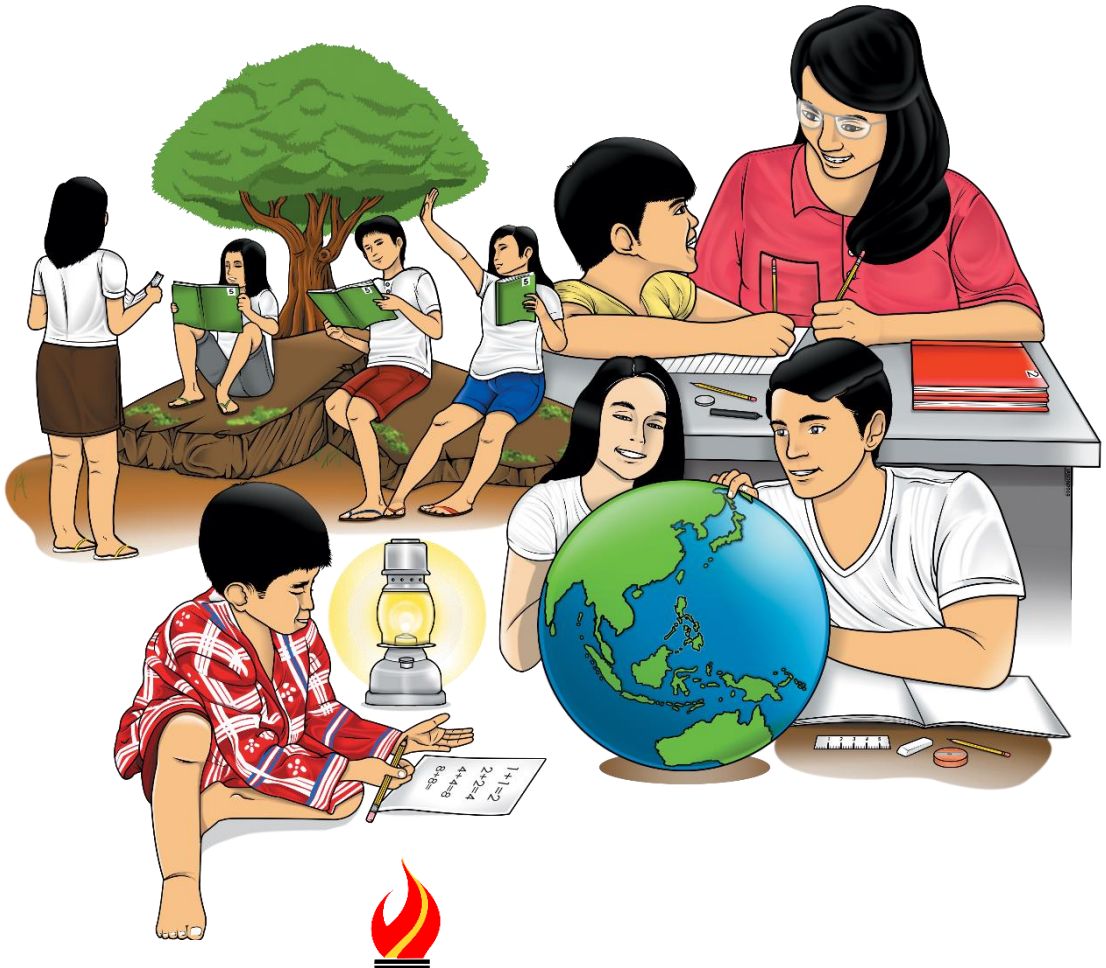
Science

Quarter 1 – Module 3:
Processes and Landforms Along Plate Boundaries



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Science

Quarter 1 – Module 3: Processes and Landforms Along Plate Boundaries

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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 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

This learning material includes discussions on the different processes that take place as different plate boundaries are created. The landforms are also mentioned since they are formed at the same time as processes or events happen.

In Lesson 1, we will identify the geological processes, how and why they take place in the different types of convergent plate boundaries which happen between:

- two oceanic plates
- oceanic-continental plates
- two continental plates

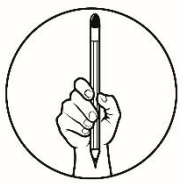
In Lesson 2, the different processes taking place at a divergent plate boundary, where and why they take place, and their effects will be discussed.

In Lesson 3, we shall discuss the transform fault boundary, also known as strike-slip boundary.

There are activities included in this module. Please perform them with patience, and you will be fascinated with what you will observe and learn.

After going through the activities and discussions in this module, you are expected to be able to:

1. explain the different processes that occur along the plate boundaries; and (S10ES-Ia-j-36.3), and
2. name the landforms produced in each type of plate boundary.



What I Know

Before you start in this module, kindly assess your understanding of the lesson by answering the Pre-test.

Pre-test

Directions: Choose the letter corresponding to the correct answer. Write your answers on a separate sheet.

1. When magma in the earth's mantle develops a great pressure, the ground above it is pushed upward. If this happens in the middle of an ocean, what landform is produced?
   A. mountain B. volcanic island C. volcano D. continent

2. The tall landform created when two continental plates converge is called_____.
   A. mountain range B. volcanic arc C. rift valley D. Oceanic ridge

3. It is a plate that dives down under a less dense plate during subduction.
   A. subducting plate B. continental plate C. mantle D. overriding plate

4. Materials in the mantle flow up and down. Which of the following best describes the mantle?
   A. a solid layer B. partially liquid C. a metallic layer D. very hot layer

5. Which of the following happens when plates diverge or move away from each other?
   A. The crust is destroyed.
   B. New crust is produced because magma rises, then cools off and turns into solid.
   C. Earth's size changes because mountains are added on the earth's surface.
   D. The mantle rises.

6. A rift valley is formed simultaneously with which of the following type of plate boundary?
   A. Convergent C. Transform fault
   B. Divergent D. Both convergent and divergent

7. How do the plates move when we feel that the ground is shaking?
   A. toward each other
   B. away from each other
   C. slide past each other
   D. all of the above

8. It is a landform produced when two continental plates converge.
   A. volcano B. fault C. mountain D. volcanic island

9. Most transform fault boundaries are found in the oceans; a few are on the continents. An example of this type is the San Andreas Fault located in
   A. Marikina, Philippines B. California, USA C. Japan D. Saudi Arabia

10. It is otherwise known as an underwater mountain.
    A. oceanic ridge B. trench C. hill D. volcanic island

11. It is a chain of volcanoes developed parallel to a trench or a crack under the ocean.
    A. mountain range C. volcanic island arc
    B. volcanoes D. mountainous

12. It is formed when ocean water flips upward, sometimes up to certain meters high, due to the great push caused by convergence of plates.
    A. wave C. tides
    B. tsunami D. storm

13. It is the point where two plates meet or collide while converging.
    A. collision zone C. subduction zone
    B. sinking point D. meeting point

14. The place where a subducting plate reaches the mantle during convergence.
    A. collision zone C. mantle plume
    B. subduction zone D. magma

15. The word used to refer to the shaking of the ground due to any activity in the lithosphere.
    A. intensity B. earthquake C. Volcanism D. wave

Your answers to the fifteen items must be checked immediately to determine whether you still need to go through the module or not. A score of 15 out of 15 would mean that you can skip the module; 8 to 14 out of 15 items implies that you must proceed.

Lesson 1 Processes and Landforms Along with Convergence of Plates

What's In

You have previously learned that the convection current in the Earth's mantle caused the crust to break into smaller segments. Spaces in between or at plate boundaries are created. These plate boundaries are named according to the relative movement of the plates with each other.

Do you still remember these three types of plate boundaries?

Which type of plate boundary is illustrated in each of the following figures below?

A.

B)

C) 

In A, the arrows point toward each other, so it shows a convergent boundary. With this type of boundary, plates meet or converge. In B, the arrows point away from each other, showing a divergent boundary. Here, the plates separate or move away or diverge. While in C, arrows slide past each other, illustrating a transform fault boundary.

Notes to the Teacher

There are three activities included in lesson 1 which involve comparing densities. A brief review on density formula will help the student understand why oceanic crust is denser than continental crust.

Thank you.

What's New

In your previous lesson, you have learned that the convergence of plates takes place between oceanic and continental plates, two oceanic plates, and two continental plates. Study carefully how each type of convergence produces landforms and geologic processes.

Activity : Convergence Between Plates

Objective:

Explain the processes that occur along a convergent boundary between
a. an oceanic and a continental plate
b. two oceanic plates
c. two continental plates

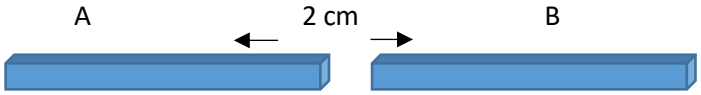
Materials:

- half cup of water
- 2 pieces of foam (8 centimeters x 16 centimeters each)
- a flat surface

Procedure:

A. Convergence between an oceanic and a continental plates

1. Soak half of the length of foam A into the water.
2. Place the foams on the flat surface at least 2 centimeters away from each other, as seen below.



3. Slowly push 4 centimeters inward each outer ends of the foams until they overlap.

4.Observe what happens. On a separate answer sheet, draw the final setup and answer the following questions.

Q1. Which foam curves above the other? Why do you think so?

Q2. If the foams were pieces of the Earth's crust, what type of plate or crust is foam A? foam B?

B. Convergence Between Two Oceanic Crusts

1. Use the same set of materials as in Procedure A, but this time soak entirely the two pieces of foams in water.

2. Repeat steps 1 to 3.

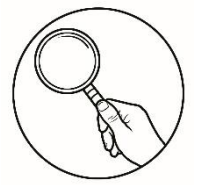
3. For items Q3 and Q4, answer the same questions given in Procedure A based on your observations in B.

C. Convergence Between Two Continental Crusts

1. Use two dry foams of the same size.

2. Do the same steps as in A.

3.For items Q5 and Q6, answer the questions given in Procedure A based on your observations in C.



What is It

In the activity setups, take note that the crusts are moving toward each other. The foams represent different types of crust. The dry foam represents a continental crust; the wet foam, an oceanic crust. They are converging.

A continental crust curves upward on top of the oceanic crust due to its lesser density. The oceanic crust, due to its greater density, stays below.

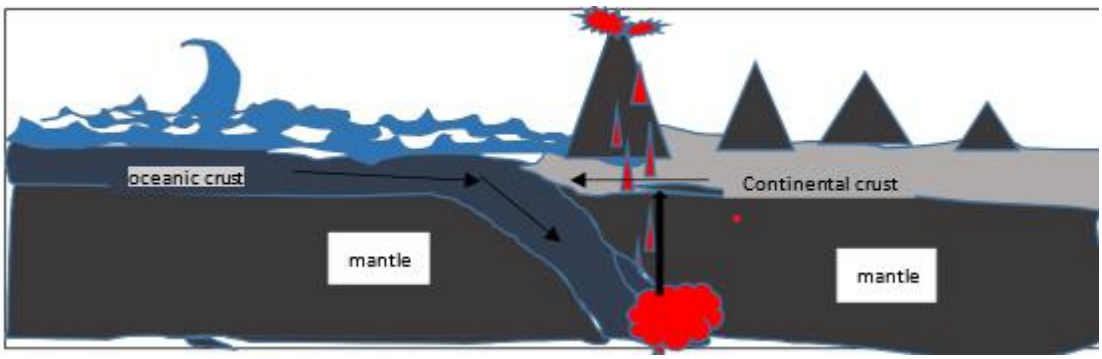


Figure 1. Convergence of oceanic and continental crust

When an oceanic crust converges with a continental crust, a crack between the crusts underwater, called **trench**, is formed. Since the oceanic crust has greater mass due to the presence of water on it, so, its density also is greater. This causes it to dive down or subduct under the overriding plate, the continental plate. **Subduction** is the process by which a plate dives under a less dense plate. At the mantle, the leading edge of the subducting plate melts or becomes fluid. It turns into a hot molten material which we call **magma**. Due to the heat in the mantle, the magma builds up a pressure that

enables it to push the ground above it. The column of rising magma is called a **mantle plume**. When there is volcanic activity such as an eruption, the ground moves, and so an **earthquake** is felt. Because subduction continues, a group of volcanoes, called **volcanic arc**, is formed at the surface of the continental crust along the boundary where the two crusts converged. The movement of the ground may cause a disturbance in the ocean. The water may flip or kick upwards to a few meters high. This is what we call ***tsunamis***, a Japanese term for harbor wave. This event is very dangerous when it moves inland, destroying lives and properties.

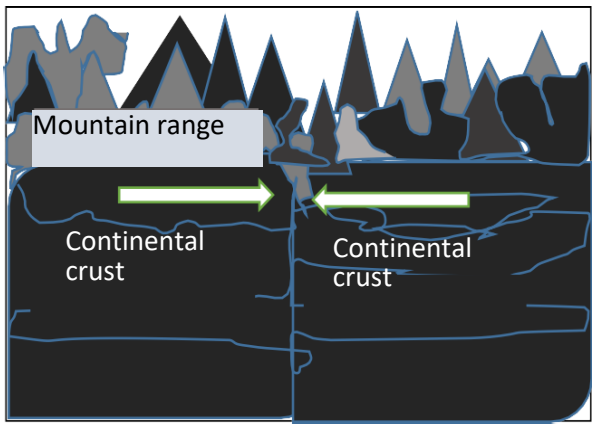
In the convergence between two oceanic crusts, one dives or subducts under the other.

The figure below shows two crusts underwater, so they are both oceanic crusts. You must have noticed that there is a boundary line between the crusts, a trench. It is a crack on the crust which is underwater

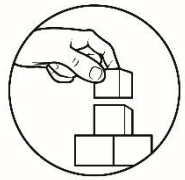
Figure 2. Oceanic Crusts Convergence

The convergence of two oceanic crusts results in some similar events compared to the first type of convergence. **Tsunamis** may be formed. **Earthquakes** may happen. There is also **subduction** because one plate is denser than the other. The front part of the subducting plate becomes magma upon reaching the mantle. Then it builds up pressure due to heat, pushes the crust above it, forming a volcano. This is a continuous process. Since the plates are moving, the volcano will move with the plate. It becomes extinct when it is no longer above the magma deposit in the mantle. A new volcano will then be formed. This series of volcanoes is called **volcanic island arc** since it is surrounded by water.

This explains why the Philippines is mostly loaded with volcanoes. The different islands were believed to have originated from the convergence of two oceanic crusts.



Converging continental crusts or plates result in a **collision zone,** which could cause shallow earthquakes. At that place, a crack called **fault** is formed. This type of convergence will cause **no subduction** since the two plates have the same densities. There would be **no volcanoes formed, no tsunamis**. The convergence will result in a group of high landforms that we call **mountain ranges**.



What's More

Study the map on the right.

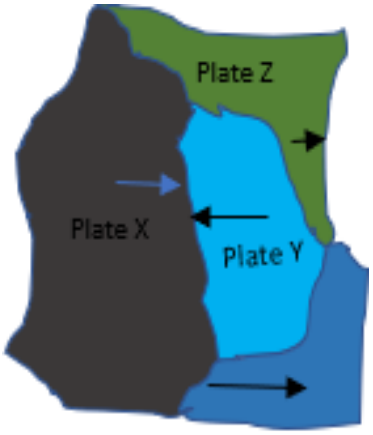


Figure 3. Map of Converging

Based on the map, answer the following:

1. Plate Y is an oceanic plate. When it converges with the continental Plate X, which of the following will most likely happen?
   - A. Part of the Plate Y will turn into magma.
   - B. Part of the Plate X will turn into magma.
   - C. Plate Y will vanish and become magma.
   - D. Plate X will become crust above the Nazca Plate.

2. Between Plates Y and X, which one will undergo subduction?
   - A. Plate Y
   - B. both of them
   - C. none of the two
   - D. Plate X

3. What will be formed on the surface of Plate X along its convergence zone with Plate Y ?
   - A. volcanic arc
   - B. fault
   - C. mountain range
   - D. trench

When two continental crusts converge, both crusts exert a pressure pushing each other. As the ground rises, a tall landform is created.

4. Is it possible to erupt?
5. What process does not take place in this type of convergence?

What I Have Learned

Fill in each blank with the correct word found in the parenthesis.

A) As continental plate converges with an oceanic plate, the (1) _____ (continental, oceanic) plate dives under the (2)_____(continental, oceanic) plate. The process of diving down towards the mantle is called (3)_____(subduction, floatation).

When the leading edge of the subducting plate reaches the mantle, it melts turning into (4)_____(magma, crust) which builds up a pressure making it push the ground above it forming at the surface a (5) _____(volcano, mountain).

At the oceanic plate, a depression called (6)_____(trench, fault) is formed along the boundary. Parallel to it, a series of volcanoes called (7)_____(volcanic island, volcanic island arc) may be formed.

Simultaneous with the convergence, the ground may shake, and so, we experience an earthquake. This shaking may disturb the water surface and may make the water flip upwards to a certain height. This event is called (8)_____(tsunami, wave).

B) When two oceanic plates converge, the denser plate subducts. Once its leading edge reaches the mantle, it melts into a magma, builds up a pressure that makes it push the ground above it, forming a (9)_____(volcanic island, mountain). At the collision zone, a crack called (10)_____(trench, fault) is formed. This depression could be the cause of the shaking of the ground, called an (11)_____(earthquake, storm). At the water surface, the overriding plate may push a big amount of water causing it to flip upwards forming a (12)_____ (tsunami, wave).

C) The convergence between two continental plates results to a landform called(13)_____(volcanic arc, mountain ranges). Since both plates have the same densities, no plate subducts under the other. There is (14)_____(no volcanic, volcanic) formation. However, since the ground moves, a phenomenon called (15)_____(earthquake, storm) may be felt in nearby places.

Lesson 2 Processes and Landforms Along Divergent Boundary

What's New

With the figure below, analyze the effect of the separation of the lithospheric plates. Identify the landforms created and the processes that take place with this type of boundary.

Figure 5: Divergence of Plates

Q1. From the picture, where does divergence of plates usually take place inland or under bodies of water?

Q2. As plates move apart, a tension zone is formed. Which between magma and water, rises to the tension zone?

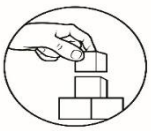
Q3. If divergence continues, what could probably happen to the size of the space between the splitting crusts? Will it widen or stay the same?

Q4. As the materials at the tension zone reach the surface and cool down, will the materials form a new crust or another layer of the mantle?

What is It

Divergent plate boundaries mostly happen under the oceans. As plates pull away from each other, a vertical space that may extend deep down into the lowest layer of the crust is created. It is a **rift valley**. The force of separation creates a **tension zone**. A shallow earthquake may happen with this plate movement.

Plate divergence is believed to be a slow continuous process. As the plates move away, the gap between them increases. While this happens, materials from the mantle may rise, filling up the space. These materials pile up near the tension zone forming mountain-like structures called **oceanic ridges**. But new materials from the mantle may push the old ones. The filled-up space between the plates becomes a new seafloor. This process is known as **seafloor spreading.**



What's More

Have you tried eating a half-cooked egg? As you cut open the white part with your spoon, what comes out of the cooked part? Yes, it is the half-cooked egg yolk. The divergence of plates is somewhat similar to a splitting open egg. As it opens, the half-cooked egg yolk gradually flows out.

Q5. If the cooked part of the egg is the crust, with what material could you compare the half-cooked egg yolk? Why?

Q6. If the half-cooked yolk solidifies when it cools off, what becomes of the magma when it cools down? Why did you say so?

Q7. The half-cooked egg yolk oozes out only when it is still hot. In the same manner, the magma also rises because of high temperature, in the mantle, or the crust?

What I Have Learned

Divergence of plates results to the creation of down faulted valleys called (Q8)_____(rift valleys, oceanic ridges) and underwater mountain ranges called (Q9)_____(rift valleys, oceanic ridges). At the tension zone, materials from the mantle may rise to the surface of the ocean floor, cools down and become new (Q10)_____(crust, mantle).

Lesson 3 Processes and Landforms Along Transform Fault Boundary

What's New

The next type of plate boundary is what everyone fears about these days. It is the transform fault boundary. With this type of boundary, another geologic feature is formed, and events happen. Study the figure below.

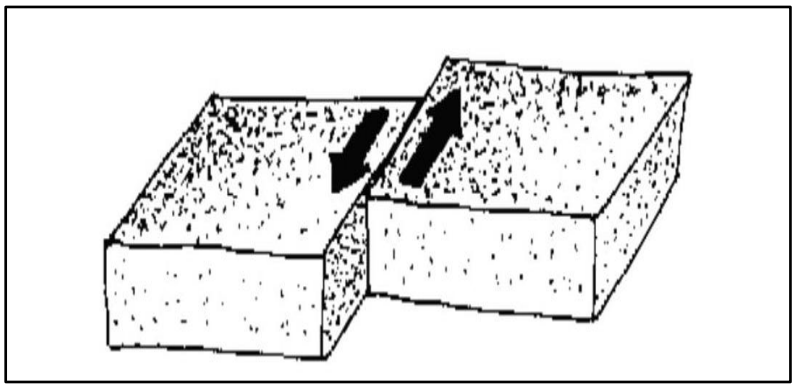


Figure 6: Transform Fault Boundary

Q11. As indicated by the arrows, analyze how the two plates move relative to each other. Do they move towards, away, or sliding past each other?

Q12. Due to this plate movement, what geologic event do you think may happen?

Q13. Since the two plates move, will a fault be formed or a trench, at the tension zone?

What is It

Transform fault boundary is mostly found in oceans, but there are few that traverse through continental crust .

Figure 7. A Faultline

This is characterized by plates moving horizontally against each other, producing a crack called fault on the ground. The force, the plates exert can break the rocks and other materials under the ground. The shaking usually ends abruptly. This is why it brings about strong earthquakes. The fault could swallow humans, cars, and buildings. Murky odorous water from under the ground may spring up from the fault. Most faults do not totally close when the shaking ceases since the adjoining edges have already moved farther from each other.

What's More

Are you aware of the different places along the West Valley Fault? What can you advise a friend who resides in a place traversed by the fault? If you have strong, sturdy furniture inside your house, can you use them to protect yourself from falling objects once the quake strikes? Different places are now designated as evacuation

areas where people could seek refuge in case the so-called “BIG ONE” strikes. The “duck, cover, and hold” safety tip is practiced in schools among students.

Q14. The word “duck” in “duck, cover, and hold” safety tip means that you must

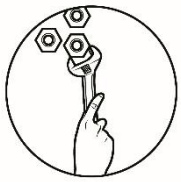
A. stand straight
B. lie down
C. kneel down on one knee
D. kneel down on both knees

Q15. During earthquakes, it is advisable to cover one’s _____

A. head
B. nose
C. mouth
D. face

What I Have Learned

When plates slide past each other, the geologic event that may take place is called (Q16)_____earthquake, storm). The geologic feature formed is known as (Q17)_____(fault, trench).



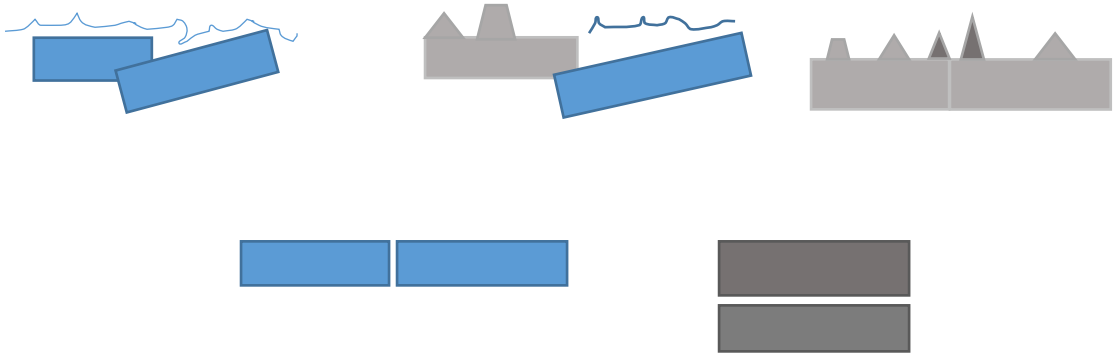
What I Can Do

A. Choose from the illustrations below and redraw the figure . Label it with the correct type of plate boundary.

B. Draw arrows to indicate plate movements .

C. Insert in their proper location the geologic feature/s formed and indicate the process/es that could take place.

Illustrations:



Legend:
brown/grey: continental crust
Blue: oceanic crust

Assessment

Directions: Choose the letter of the correct answer:

1. There is no formation of volcanoes in the convergence between _____.
   A. two oceanic plates
   B. two continental plates
   C. oceanic and continental plates
   D. none of these

2. When a plate is denser, it subducts toward the mantle and forms magma. This process ends up in the formation of _____.
   A. mountain range
   B. trenches
   C. volcanoes
   D. faults

3. Shallow earthquakes are associated with _____.
   A. volcanic eruption
   B. subduction process
   C. a tsunami in the ocean
   D. mountain formation

4. In the convergence between a continental and an oceanic plate, there is subduction. Which of the following statements does not support this fact?
   A. One plate carries water along with it.
   B. One plate is denser.
   C. The temperature in the mantle is higher than in the crust.
   D. One plate overrides the other.

5. Which of the following is formed in the convergence of two oceanic or oceanic and continental plates?
   A. Volcanic island arcs
   B. mountain range
   C. rift valley
   D. Oceanic ridge

6. Of the following, which event or process takes place when two continental plates converge?
   A. earthquake
   B. subduction
   C. tsunami
   D. magma formation

7. A crack on the ground underwater is produced when oceanic crust interacts with another crust. What do we call this geologic feature?
   A. fault
   B. trench
   C. ridge
   D. crack

8. It is a phenomenon that takes place due to the movement of plates during convergence.
   A. earthquake
   B. magma formation
   C. subduction
   D. tsunami

9. It is the crack on the dry ground or plate caused by horizontal plate movement.
   A. fault
   B. trench
   C. valley
   D. ridge

10. It is an event that may take place on the water surface when a great force pushes a significant amount of water upwards.
    A. ocean wave
    B. typhoon
    C. tsunami
    D. ocean tide

11. Subduction is illustrated in which of the following?
    A. convergent plate boundary
    B. transform fault boundary
    C. divergent plate boundary
    D. subducting plates

12. Which of the following correctly illustrates seafloor spreading?

A. 

C. 

B. 

D. 

13. Earthquake, as an effect of plate movement, results in boundaries where plates are
    a. converging b. sliding past c. diverging d. subducting
    A. a only B. b only C. a and b D. a, b, and c

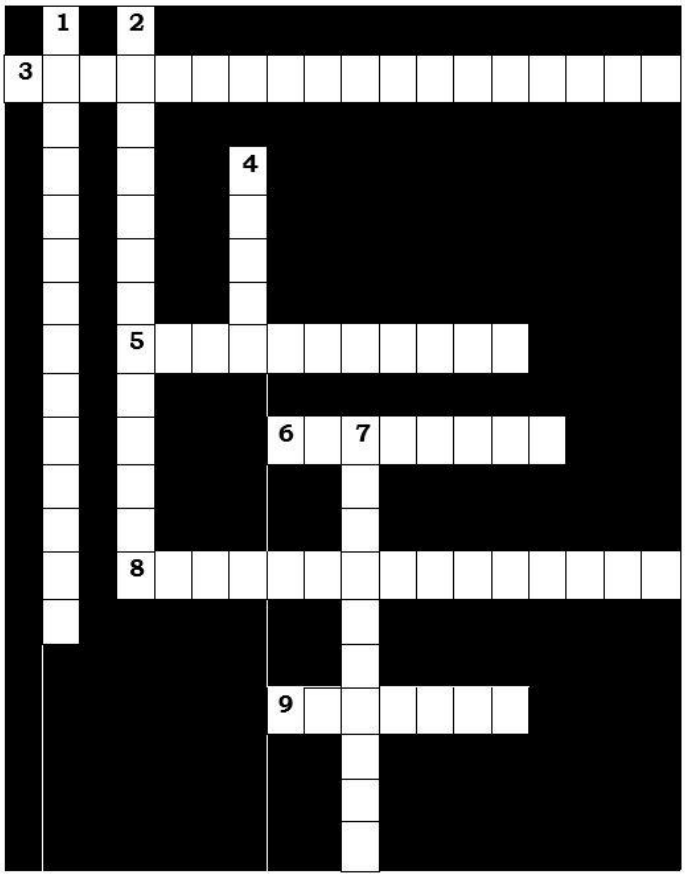
14. Most of the Philippine Islands were once part of island arcs. This means that along with this boundary, there once existed two _____.
    A. converging continental plates
    B. diverging plates
    C. converging oceanic plates
    D. plates sliding past each other

15. Why are volcanoes mostly found at places where continents meet the seas?
    A. It is where water meets land.
    B. It is where the oceanic plates subduct under the continental plate.
    C. Underneath it is a subduction zone.
    D. More magma is produced under the ground because of the muddy seafloor.

Additional Activities

Complete the **crossword** by filling in a word that fits each **clue**. Refer to the given clues on the next page.

Crossword



Across:

3 Land formation produced by the convergence of two oceanic plates

5 A valley formed when two oceanic plates diverged with each other.

6 A crack between converging oceanic crusts.

8 A process by which the leading edge of an oceanic crust submerged into the mantle.

9 A huge displacement of ocean water caused by plate movement.

Down:

1 Landform created by two converging continental plates.

2 Underwater mountain ranges.

4 A crack on a dry ground

7 The vibration of the Earth's Lithosphere.

Answer Key

Lesson 1

What's New	What's More	What I Have Learned
Q1. B; because it is less dense	1. A	1.oceanic
Q2. A is oceanic;B is continental	2. A	2.continental
Q3. A or B ;because it is the less dense	3. A	3.subduction
Q4. Oceanic;oceanic	4. No	4.magma
Q5. Neither of the two; they have equal densities	5. Subduction	5.volcano
Q6. A is continental; B is continental		6.trench
		7.volcanic island arc
		8.tsunami
		9.volcanic island
		10.trench
		11.earthquake
		12.tsunami
		13.mountain ranges
		14.no volcanic
		15.earthquake

What I Know

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

Lesson 2

What's New	What's More	What I Have Learned
Q1. under bodies of water	Q5. Mantle. It flows.	Q8. rift valleys
Q2. magma	Q6.new crust. It is on the top layer of the Earth.	Q9. Oceanic ridges
Q3. Widen	Q7. Mantle	Q10. Crust
Q4. new crust		

Lesson 3

What's New	What's More	What I Have Learned
Q11. Sliding past	Q14. C	Q16. Earthquake
Q12. earthquake	Q15. A	Q17. Fault
Q13. Fault		

What I Can Do

References

Printed Materials

Department of Education-Instructional Materials Council Secretariat (DepEd-IMCS) (2015) Science-Grade 10 Learner's Material. Rex Book Store, Inc.

Department of Education-Instructional Materials Council Secretariat (DepEd-IMCS) (2015) Science-Grade 10 Teacher's Guide. Rex Book Store, Inc.

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