SCIENCE LINKS

Teacher's Resource Material

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FIRST QUARTER – EARTH AND SPACE
Unit I – Plate Tectonics

Summary:

This unit discusses how plate tectonics accounts for important features of Earth's surface and major geologic events. As a basis for understanding this concept, the students will know the evidence of plate tectonics is derived from the fit of the continents; the location of earthquakes, volcanoes, and mid-ocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.

Part of the unit is a discussion on the Earth's composition which includes a cold, brittle lithosphere; a hot, convecting mantle; and a dense, metallic core. Here the students will know lithospheric plates the size of continents and oceans move at rates of centimeters per year in response to movements in the mantle.

Content Standards:

The Learners demonstrate an understanding of:

- the relationship among the locations of volcanoes, earthquake epicenters, and mountain ranges

Performance Standards:

The Learners shall be able to:

- demonstrate ways to ensure disaster preparedness during earthquakes, tsunamis, and volcanic eruptions
- suggest ways by which he/she can contribute to government efforts in reducing damage due to earthquakes, tsunamis, and volcanic eruptions

Grade Level Standards:

Learners realize that volcanoes and earthquakes occur in the same places in the world and that these are related to plate boundaries. They can demonstrate ways to ensure safety and reduce damage during earthquakes, tsunamis, and volcanic eruptions.

Learners explain the factors affecting the balance and stability of an object to help them practice appropriate positions and movements to achieve efficiency and safety such as in sports and dancing. They can analyze situations in which energy is harnessed for human use whereby heat is released, affecting the physical and biological components of the environment.

Learners will have completed the study of the entire organism with their deeper study of the excretory and reproductive systems. They can explain in greater detail how genetic information is passed from parents to offspring, and how diversity of species increases the probability of adaptation and survival in changing environments.

Learners explain the importance of controlling the conditions under which a chemical reaction occurs. They recognize that cells and tissues of the human body are made up of water, a few kinds of ions, and biomolecules. These biomolecules may also be found in the food they eat.

Overarching KU:

- The Plate Tectonic theory states that the Earth's outermost layer is fragmented on large and small plates that are moving on another while riding atop a hotter and more mobile material known as the asthenosphere. Considered a milestone in geological science, plate tectonics has provided men with a solid framework for interpreting the structure, composition and internal process occurring inside the Earth and its land surface.

Overarching KQ:

- How would you describe the Earth?
- How is plate tectonics related to geological processes such as volcanic eruptions and earthquakes?
- At your age, what can you contribute to lessen the impacts of natural disasters?

Resources:

* Aquino, M. et al. Science Links-10. REX Publishing. 2013
* Valdoz, M. et al. Science Links Integrated Science. REX Publishing. 2012

Anticipation/Prediction Guide

Pre-Assessment:

Plate Tectonics

Anticipation/Prediction Guide

Read the following statements and use your prior knowledge to respond whether you think each is true or false. On the column pertaining to your response, discuss briefly the reason for your answer.

True	Statement	False
	1. Scientists know exactly what the composition is of each layer of Earth's interior.	

	2. Matter and energy move from Earth's interior toward the surface.	
	3. There is one type of crust near Earth's surface, and it is found on the continents.	
	4. Most earthquakes occur in the middle of lithospheric plates.	
	5. A magnitude –4 earthquake releases about twice as much energy as a magnitude 3 earthquake.	
	6. Subduction occurs when oceanic and continental lithospheric plates move toward each other.	
	7. Faults are surfaces where rocks break and move.	
	8. Tsunamis are huge tidal waves.	

Lesson 1: Location of Plate Tectonics (3 days)

Lesson Focus: Earth as a planet, Plate Tectonics

Introduction:

A. **Activating Prior Knowledge.**

1. Introductory Journal Writing: Tell the class to imagine they have just returned from their travel to the center of the Earth. Since it was a very exciting adventure, it is important that they describe in their journal what they have experienced as they journeyed to the depths of our planet. Remind them that their journal is like a science features article—one where they may discuss scientific ideas such as the varied temperatures that they would have been exposed to, the materials they would have passed through, etc.
2. Process the activity and illicit existing ideas (pre/misconception) about plate tectonics

Body:

A. **Cooperative Learning. Have the students do the Loop Activity.**

B. **Brainstorming & Questioning:** As a follow up to the first activity, have students take out their brainstorm about their pre-understanding of the theory of Plate Tectonics. Ask them the following:

- What are these so-called plates, and where are they located on/in Earth?
- Are all landmasses and oceans on plates of their own?

C. **Puzzle-Making.** For this activity, the teacher should be able to first discuss the different ideas about the origin of the continents, which scientists believe had always been the same shape and in the same place. Several of them even said that all the continents could be joined together like giant puzzle pieces to create one large continent surrounded by one huge ocean. This very idea was proposed by Alfred Wegener (1880-1930) in 1912 and explained that the continents plowed through crust of ocean basins.

The teacher will either ask students to bring or provide the students copies of continent pieces along with scissors, glue and a sheet of blue construction paper. Then, tell the students to cut

KU:

- The Earth is made up of multiple plates and several different layers. These plates are continually moving, colliding, or pulling apart relative to each other.

KQ:

- How would you describe the Earth?
- How does the theory of plate tectonics help explain the locations of earthquakes, volcanoes, and mountain ranges?

Knowledge:

- The generally accepted Plate Tectonic Theory states that the surface curst of the Earth is composed of large and small segments called plates. These plates have the ability to move *horizontal*ly by gliding over the asthenosphere. As the plates collide with each other at the plate boundaries, subduction occurs resulting to the occurrence of volcanic eruption, earthquakes and mountain building.

More resources on **Acquisition Strategies** are available in the **Technology Enhancement CD**

out the continents and arrange them on the construction paper in an alternate layout according to coastline shapes. The teacher should allow the students to hypothesise about what clues do scientists look for or expect to find, as basis of their belief that all the continents used to be a single vast land mass.

D. **Hands On Activities:** Let the students prepare two 50 mL beaker containing equal amount of fine gravel (about 1 cm depth) completely mixed with candle wax (about 2 cm depth) cut into fragments about the same size as the pieces of gravel. With this materials, let them demonstrate how partial melting occurs when heat is applied to one of the beakers. Allow them to heat one of these beakers over a Bunsen burner until the candle wax melts and the gravel sinks to the bottom. Then, set aside the beaker to cool until a layer of pure wax at the top has solidified.

Ask the class to relate the results of partial melting to the lesson on plate tectonics.

– Practical Activity (Chemistry Integration): Using improvised dough made from sodium tetraborate (borax) and PVA glue, let students create an analogue model of the asthenosphere.

D. **Short Quiz**

*Based on what you know about the interior of the earth and plate tectonics decide if the statement is true or false. On the space provided, write **T** if the statement is true. Leave the space blank if the statement is false.*

_____ 1. The concepts of plate tectonics state that the continents of Africa and South America are gradually approaching each other.

_____ 2. Scientists believe that continents are larger now than they were in the past.

_____ 3. Seafloor spreading increases the size of the earth gradually.

_____ 4. Tectonic plates drift in oceans of melted magma just below the surface of the earth.

_____ 5. A colder, denser and older oceanic plate is stronger and subducts the newer, warmer oceanic plate after colliding with it.

Choose the letter of the best answer.

_____ 6. It is the older plate.

a. Continental b. Oceanic

_____ 7. It is the thicker plate.

a. Continental b. Oceanic

_____ 8. It happens when two oceanic plates move apart and new crust is formed.

a. Crustal integrating b. Seafloor spreading

- Vocabulary Words: fit of the continents, mid-oceanic ridges, fossils, ancient climatic zones, subduction, etc.

Skills:

- Describe the Earth as a planet
- Explain the plate tectonics theory
- Analyze the relationship among the locations of volcanoes, epicenters and mountain ranges
- Demonstrate ways to ensure disaster preparedness during earthquakes, tsunamis and volcanic eruption

Integration with Arts & Language: "Puzzle Making"

21st Century Skills: Develop strategies to address problems

(Thinking and Problem Solving Skills)

Integration with Chemistry: "Asthenosphere Model"

Formative Assessment

_____ 9. It happens when one plate is pushed under another plate as they collide.

a. Subduction b. Mantle induction

_____10. It is the phenomenon that can happen when two plates slip past one another.

a. Earthquakes b. Subduction

_____11. It can form when two continental plates collide.

a. Fold mountains b. Volcanoes

_____12. It creates new crust.

a. Magma from the mantle

b. Sediments from eroded continents

Conclusion:

A. Exit Pass. Have students complete their 3-2-1s.

B. HOMEWORK: Read about plate boundaries.

Summative Assessment

Lesson 2: Plate Boundaries (4 Days)

More resources on **Learning Objectives** are available in the **Technology Enhancement CD**

Lesson Focus: Different Plate Boundaries

Introduction:

Activating Prior Knowledge.

KWL Chart. Have students spent a few minutes *list*ing what they know and what they would like to know about plate boundaries in the first and second columns of the chart; this could include the effects of plate boundaries on human life. The last column may be left blank until the conclusion of the lesson.

Body:

A. **Role Playing and Creative Drawing.** In this activity, the students will describe the different plate boundaries creatively by role playing and illustrating.

Procedure:

1. Form four groups and have the groups choose a plate boundary:

   Group 1: Transform

   Group 2: Converging - Colliding

   Group 3: Converging - Subducting

   Group 4: Diverging

2. Tell them to discuss as group the movement and characteristics of the plates assigned to them. Ask them to answer these questions:

   a. How can you effectively act out the plate boundary?

   b. What "characters" will you need? What role will they take?

KU:

Due to the cycle of heat that occurs within the Earth, these plates move over long periods of time.

A plate boundary is the point where two plates meet. Earthquakes and volcanoes are most likely to occur either on or near plate boundaries.

More resources on **Acquisition Strategies** are available in the **Technology Enhancement CD**

KQ:

Why and how do plates move?

Knowledge:

- The Earth's lithosphere is broken into tectonic plates. The boundaries between the plates are called plate boundaries each of which has its own characteristic geologic features and processes.

c. How can you portray it through acting with no talking?

Instruct students to include in their discussion the directions plate move, the resulting landform(s), the possible natural hazard(s) associated with the plate movement, what happens to the land (any melted rock, pressure, movement of plates due to convection, etc.)

3. Give students 10 minutes to come up with a skit that tackles the information they have discussed from #2 regarding the type of plate boundary assigned to them and the plate's movement.
4. Tell students that they can make their skit more creative by using appropriate improvised *cost*umes to help describe their characters. Materials including construction paper, butcher paper, tape, markers, and scissors may be used in making their *cost*umes.

   You may give this suggestion to help your students complete their skit. Examples of types of roles/characters: Crust (either continental or oceanic), Convection Current(s),

   Magma/Lava, Volcano, Mountains, Valley, Trench, earthquakes, etc.
5. Remind the class that for better scores, they must be able to draw the two plates in at least two sheets of paper—one for each plate—and include arrows to indicate direction of plate movement. Also, tell them to present a well-executed skit so that the audience will be able to determine what type of plate boundary and movement their group will be portraying.
6. During the actual performance, each group will perform their skit in front of the class for three minutes. With each performance, the audience, as a form of assessment, will observe the groups and write down the type of plate boundary and its movement.

B. **Learning Stations**

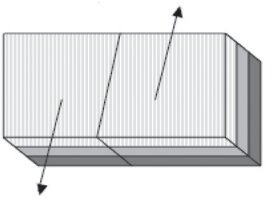
After the introduction about how the Earth is moving beneath their feet, have the students work through this lab activity.

Procedure:

In groups of 4 - 5 students, let them rotate between the different stations to investigate the differences between plate boundaries. Tell them to answer the questions presented at each station and rotate when instructed. They will need a digital camera to document the results of their visit in each station. Upon completion of the task, the groups will prepare a report bearing their learning, experiences, and documentation as a final collaborative *output*.

Station 1: Transform Boundary

In this station, there should be three different colors of clay (colored dough), to be used in representing rock units, and plastic knife.



- Based upon their motion with respect to one another, these plate boundaries are classified into three: convergent, divergent and transform.
- Vocabulary Words: convergent, divergent, transform, etc.

Skills:

- Describe what a plate boundary is
- Enumerate and explain the different types of plate boundaries
- Locate the different plate boundaries on Earth

Integration with Dramatic Arts

21st Century Skills: Develop strategies to address problems

(Thinking and Problems Solving Skills)

Persists until job is completed

(Employability Skills)

Differentiated Activity (Readiness, Interest, and Learning Profile): Learning Stations

WHAT TO DO:

Create and layer three "rock units" using colored dough of different colors. Draw and label your rock units indicating the oldest and youngest layers. Cut your rock units in half with your plastic knife so that you have two sections of "rock" each with three units. With the two halves together, slide them past each other in opposite directions as shown on the right. Describe in your own words what happens to the blocks. Before moving on to the next station, document your *output*. Finally, separate the different colors of dough and place them back in the correct containers.

Questions for Analysis:

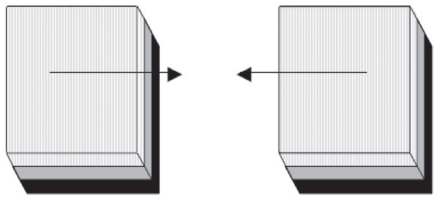
How could this simple experiment be related to everyday life?

In what specific areas would this type of plate movement be a concern?

Station 2: Convergent Boundary

In this station, there should be three different colors of clay (colored dough), to be used in representing rock units, and plastic knife.

WHAT TO DO:



Create and layer three "rock units" using colored dough of various colors. Draw and label your rock units indicating the oldest and youngest layers. Cut your rock units in half with your plastic knife so that you have two sections of "rock" each with three units. Align the two sections of "rock" and push them together as indicated on the right. Before moving on to the next station, document your *output*. Finally, separate the different colors of dough and place them back in the correct containers.

Questions for Analysis:

How could this simple experiment be related to everyday life?

In what specific areas would this type of plate movement be a concern?

Station 3: Convergent Boundary

In this station, there should be a container with water, Styrofoam, string, and gram masses. At this station, the students will begin to investigate subduction at a convergent plate boundary.

WHAT TO DO:

Place the two pieces of Styrofoam in the middle of the container. You will notice that the Styrofoam pieces are floating. Why does Styrofoam float in the water? What do you think would happen if two pieces of Styrofoam with different densities collided?

Use a string to tie a small gram mass of different amounts to each of the Styrofoam pieces. Be sure to leave several inches of string that can be used for pulling the mass.

Integration with Technology: "Learning Stations"

Place the two pieces back in the water to see if they will still float. If they are unable to float, tie smaller masses to the Styrofoam pieces. Using the strings, pull the two pieces of Styrofoam together so they collide. Describe what happens upon impact. What causes this to occur?

Questions for Analysis:

What features could occur with this type of collision?

What effect would these features have for human life and the environment?

Station 4: Convergent Boundary

In this station, a *computer* with Internet access must be available.

WHAT TO DO:

Using the *computer*, go to http://pubs.usgs.gov/gip/dynamic/understanding.html. Scroll down to the section that is titled "Convergent Boundaries". Answer these following questions or prompts in complete sentences.

Questions for Analysis:

What are the three types of convergent boundaries?

Compare and contrast the convergent boundaries.

How does each of the convergent boundaries affect geology and the environment?

If you had to live along a type of convergent boundary, which would you choose and why?

Station 5: Divergent Boundary

In this station, a *computer* with Internet access must be available.

WHAT TO DO:

Using the *computer*, go to http://www.seed.slb.com/en/scictr/watch/living_planet/mountains.htm. Select and watch "Divergent Plate Movement". Record your observations regarding the position of continents, ocean depth, and position of magma relative to time. Identify the cause of divergent plate movement. Next, go to http://www.wwnorton.com/earth/egeo/animations/ch2.htm. Scroll down to section entitled Sea Floor Spreading and click on the "View Animation" icon on the right side of the screen.

Answer these following questions or prompts in complete sentences.

Questions for Analysis:

Why causes divergent plate movement?

In what areas are the youngest rock units located? The oldest?

What do you notice about the shape of the mid-ocean ridge in relation to the shape of continents?

How might a scientist test this hypothesis of sea-floor spreading?

Conclusion:

A. Ask the students to accomplish the third column of the KWL Chart by *list*ing what they have learned about plate boundaries.

Summative Assessment

Integration with Arts: Snack Tectonics

More resources on **Practice Strategies** are available in the **Technology Enhancement CD**

B. Homework assignment—Discuss what would the earth look like in the future. Create a picture (either a sketch or continent collage like the one created in class) of where the continents might be. Explain why you have pictured the Earth like that.

Snack Tectonics: To make the task more interesting, let students use edible ingredients when they make their collage.

Lesson 3: Processes and Landforms Along Plate Boundaries (3 Days)

Lesson Focus: Different Landforms

Introduction:

Activating Prior Knowledge

Have students perform the Inquiry Lab activity and let them discuss briefly what they have gathered from the said activity.

Body:

A. **Investigate Activity.** Have the students do Investigate on the worktext where they will create a simple seismo*graph*, demonstrate the formation of tsunamis during earthquake, and explain the relationships between plate tectonics to the phenomenon experienced by human both in land and in water.
   - Post Lab Activity: Think Pair Share. What triggers the occurrence of tsunamis?

B. **Collaborative Learning.** Have students discuss the effects of tsunamis. Have them watch a documentary downloaded from Youtube which focuses on the tsunami disaster that hit India. Let them talk about their ideas on how they will react to the situation if the same happened to them.

C. **Volcano Model Making.** Even though they may have already tried their hand in making models of volcanoes, let them prepare volcano eruption models and discuss with the elementary pupils what proper steps must be undertaken in the event of volcanic eruptions.

Conclusion:

Exit Pass. Have students answer these prompts:

- Identify the three main plate boundaries and describe the characteristics of each boundary.
- What type of boundary give rise to the formation of volcanoes?
- What boundary or boundaries are found in the middle of the Atlantic Ocean?
- Tell me one neat thing you have learned so far about plate boundaries.

KU:

- The structure of the earth shaped by plate tectonics, influences how organisms live, use resources, and develop into communities.
- Physical, chemical, and biological processes change land forms by altering the chemical and physical structure of rocks.

More resources on **Acquisition Strategies** are available in the **Technology Enhancement CD**

- Plate tectonic theory allows for prediction of natural hazards and their impacts.

KQ:

- What are the types of plate boundaries and their associated landforms?
- What systems result in a change of landforms?
- What natural hazards are associated with plate boundaries and landforms?

Knowledge:

- Landforms are the natural features of the Earth's surface such as the mountains, hills, plateaus, etc.
- Geologic processes are dynamic processes which are responsible for shaping the Earth's landforms and surfaces. They are the products of a combination of constructive forces and destructive such as deposition of sediments,

weathering, erosion and plate tectonics.

- Vocabulary Words: Aeolian landforms, Erosional landforms, Mountainous landforms, Glacial landforms, Fluvial landforms, Coastal Landforms, etc.

Skills:

- Outline the different landforms along plate boundaries
- Explain the process involved in land formation
- Link the processes and landforms to tectonic plates

21st Century Skills:
Evaluates results (Thinking and Problem Solving Skills)

Integration with Arts:
"Volcano Models

Lesson 4: Internal Structure of Earth (2 Days)

KU:

- To determine the internal structure of the Earth, scientists use the travel times of seismic waves. The velocity of P or primary waves (one of the major sets of earthquake waves) changes based on the composition, phase (solid or liquid), and density of the medium through which they are traveling.
- Heat rising and falling inside the mantle creates convection currents generated in the Earth's core.

KQ:

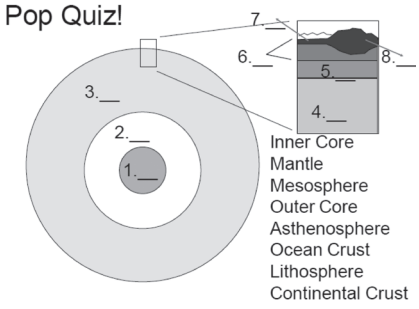
- How do differences in temperature cause convection current?
- How is plate tectonics related to geological processes such as volcanic eruptions and earthquakes?

Lesson Focus: Layers of the Earth

Introduction:

A. **Activating Prior Knowledge**

1. Bring to class any unfamiliar spherical object and ask the students how they can find out what's inside. They may suggest cutting open the sphere or drilling into it; ask them what they will do if these options are not allowed. They may then suggest that using X-rays, they can peep inside the solid object. Ask them another what if question: What if there the sphere is massive and cannot be physically placed under an X-ray machine. For example, suppose the sphere is our planet, how will they know what is inside the Earth?
2. **Pop Quiz.** Have the class fill in the required information regarding the Earth layers in the table below.



Body:

A. **Teacher Demonstration.** Pose this question to the students: What do you know about the layers of the earth? After eliciting responses from them, conduct a short demonstration using an apple to explain how the fruit is like a model of the earth. Cut the apple in half and discuss each part of the apple and what its layer represents (Skin ~ crust; Meat/Flesh ~ mantle; Seed casing ~ outer core; Seed ~ inner core.)

B. **Group activity**: Create a working model of the Earth's interior using different colors of clay (dough).

C. **Questioning**: Lead the class into a discussion on how the structure of the earth's interior is related to the plate tectonic theory. Call one of the students and ask him/her to close his/her eyes and imagine standing on pieces of plywood that are lying in a muddy field. Ask the students to predict what would happen if he/she tried to walk across the pieces of wood.

   Possible answers: He or she would slip and bump into the pieces next to them; as he/she move to the next piece the other piece will be pushed away; etc.

   Ask students: What is the Earth's crust? (The outer most layer of rock that surrounds earth). Is the crust a single solid piece? (No, It is made up of moving plates).

D. **Short Review.** Have the students recall their prior knowledge of the earth's crust and mantle by dividing them into small groups. Give each group their respective eggs and have them relate the earth's composition to the materials that make up the egg. For example, (1) how the earth's crust is like an egg shell, very thin and brittle; (2) how the egg when gently cracked relate to the earth's plates; (3) how some of the cracked pieces overlapped with other pieces while in other places there are spaces where pieces have pulled apart, etc.

   Tell the students to use a marker and carefully outline the edges of the cracked pieces. Have them carefully move one of the broken pieces along the egg. Have the students discuss with each other what is happening to the other pieces as one moves slowly across the mantle (white of the egg).

   Ask them: How do you think giant moving plates change Earth's surface? (They can create mountains, volcanoes, earthquakes.)

   Call for a volunteer to explain that the cracked pieces are the sections of the crust referred to as plates.

Knowledge:

- The Earth is composed of several layers: crust, mantle and the core.
- Temperature gradually increases with depth in our planet's interior.
- Heat coming from the core produces convection current which then exhibits a Dynamo effect that produces the Earth's magnetic field.

More resources on **Acquisition Strategies** are available in the **Technology Enhancement CD**

- Vocabulary Words: lithosphere, convecting mantle, metallic core, lithospheric plates, asthenosphere, rock cycle, interior compositions, continental crust, oceanic crust, magnetic field, dynamic, physical state depth, etc.

Skills:

- Gain conceptual understanding of the internal structure and processes of the Earth
- Illustrate the composition of the Earth using various materials
- Prove that the Earth is composed of different layers using other geological events

Formative Assessment

Integration with Arts & Language:

"Egg as the Earth Model"

Conclusion:

Evaluation. Have the class fill in the required information regarding the Earth layers in the table below.

Earth Layers	Temperature	Thickness	Composition
Crust	930 ° F	(1)	(2)
Mantle	(3)	1800 miles	(4)
Outer Core	(5)	(6)	Liquid nickel and iron
Inner Core	12,600 ° F	(7)	(8)

Answer Key: (1) 5-25 miles, (2) Basalt and granite, (3) 4,000 ° F, (4) Molten silicon, oxygen, magnesium, and iron, (5) 9,000 ° F, (6) 1400 miles, (7) 800 miles, and (8) Solid nickel and iron.

Summative Assessment

Lesson 5: Mechanism of Plate Tectonics (3 days)

Lesson Focus: Mantle Convection Theory, Slab Pull Theory

Introduction:

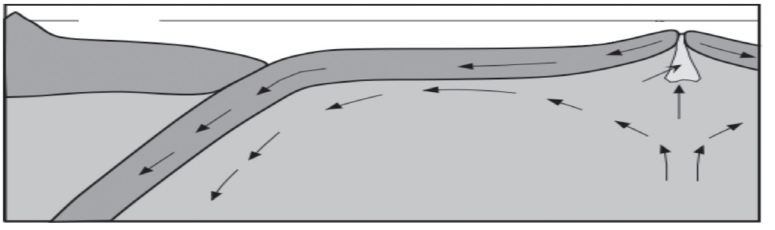
Activating Prior Knowledge

Tell students to write at least two para*graph*s discussing how heat transfer applies to the mechanism of plate tectonics.

Body:

Picture Analysis. Show the class this image from Earth Science Australia – website:

http://earthsci.org/processes/geopro/introgeo/introgeo.html. Give the students a few minutes then tell them that to comment on this statement: Plate Tectonics is happening because the Earth is trying to cool off.



Let the students explain and relate their ideas to the picture above. Then, after hearing their ideas, give them a short lecture on how plate tectonics occur.

As shown above, the earth is still hot from its formation, and also radioactive heating is happening in the mantle. The heat escapes through convection in the mantle: cold mantle (which is denser) sinks and warm mantle (which is less dense) rises where to the surface where it can cool off. The marked arrows show the convection cells, even though the plates are not only moved by convection. Slab Pull refers to the edge of a subducting plate being heavy (dense) and actually pulling the rest of the plate along. Ridge push similarly refers to a potential (minor) force at the spreading centers.

KU:

- Mantle convection cells occur due to differences in temperature within the mantle. Slab push is a force thought to occur at spreading centers, which occur at areas where hot mantle material rises. Slab pull is a force thought to occur at subduction zones. As the dense plate sinks, gravity serves to pull the plate down and reinforce the direction of movement of the plate.

More resources on **Acquisition Strategies** are available in the **Technology Enhancement CD**

KQ:

- How was the earth formed due to Mantle Convection and Slab Pull Theories?

Knowledge:

- Convective flow in the mantle is thought to consist of buoyant plumes of hot rock and downward flow of cool, dense slabs of lithosphere. This thermally generated convective flow is the driving force that propels lithospheric plates across the globe.

Conclusion:

Show the Word Splash Pre-Assessment. Have them check their own work. Let them add more sentences using the given words in the box.

- Vocabulary Words: Mantle Convection Theory, Slab Pull Theory

Skills:

- Evaluate the different theories explaining the possible cause of plate tectonics
- Demonstrate convection current
- Understand the importance of plate tectonics to the survival of the Earth and its inhabitants.

Integration with Technology:

"Picture Analysis"

Lesson 6: Evidences of Plate Movement (4 days)

Lesson Focus: Paleontologic Evidences, Evidence from glaciation, structure and rock type, and paleoclimates

Introduction

Activating Prior Knowledge

Have the students brainstorm to discuss evidence and support for the theory of Plate Tectonics. When they are ready, ask them to identify a *list* of the evidence scientists have compiled in

support of the plate tectonics theory.

Possible answers: (1) fossils and rock types along the eastern coast of South America matched those on the western coast of Africa, (2) same fossils found in South America, Africa, India,

Antarctica and Australia, (3) chain of Appalachian Mountains in North America continued as the

Caledonian Mountains in northern Europe, (4) Parallel Magnetic Bands in Atlantic Ridge, (5) In 1912, Wegener proposes idea of continental drift, (6) In 1930, Holmes suggests convection explains continental drift theory, (7) The discovery of the Great Global Rift in 1953, and (8) Hess proposes sea-floor spreading in 1960.

Body

A. **Puzzle Making**. After downloading and printing the Pangaea puzzle at http://secsciencecohort2013.org/ kathleenjeffery/files/2012/04/PangeaFossilClues.pdf, the teacher will distribute the copies to students who will work with their partner in piecing together the puzzle pieces using the dinosaur fossil clues. To monitor the students' progress, the students will be asked these questions:

- What clues did you use/are you using to put the continents together?
- How did Alfred Wegner put the continents together using clues? Did he find patterns or match anything?

KU:

- Plate tectonics is the culmination of different theories that, by themselves, were incorrect or incomplete. The first of these theories, Continental Drift, was proposed in 1915 by Alfred Wegener, an astronomer and meteorologist from Germany. The second of these theories, Sea Floor Spreading, was proposed in 1962 by Harry Hess, a geology professor at Princeton.

KQ:

- What evidence are there concerning plate movements in the past as well as in the future?
- At your age, what can you contribute to lessen the impacts of natural disasters?

Knowledge:

- The Pangaea is a single giant landmass that was broken into several .continents due to plate tectonics.

– Show me how you pieced together the puzzle. Are your fossil clues matching?

– The pieces fit, but the dinosaur and plant fossils on these two continents are not matching. How could you make them match?

B. **Class Discussion.** Ask for volunteers who will show how they arranged the continents and explain the reason for their arrangement. Here, the teacher should note how the students used the dinosaur and grass clues in the explanations of the students. Also, elicit similar or opposing ideas from the rest of the class in order to check if the exercise has deepened the students understanding of the evidence of plate tectonics.

C. **Flip Book Making.** Give each student a Pangaea flip book worksheet (available at http://secsciencecohort2013.org/kathleenjeffery/files/2012/04/PangaeaFlipbook.pdf.) Tell the class to color each continent with a different color across every frame, with each frame showing the probable position of the continents at some number of millions of years ago. Instruct them to determine the order of the frames, starting at Pangaea and ending at the present day, based on the positions of the continents in each frame. When they have the pages in chronological order, they must bind the pages together to create a flip book. As they create the flipbook, evaluate the students' understanding of continental drift and how the Earth's surface has changed by asking them these questions:

– What is Pangaea?

– If the continents started as the supercontinent Pangaea, how do you think they must have moved to become spread out like they are today?

– Why did you decide to put the frames in that order?

– How does your flip book show continental drift?

– What do you think caused the continents to move?

D. **Demonstration.** The teacher will explain seafloor spreading using a small demonstration. The teacher may focus in the following ideas:

– Magma from inside the Earth's crust rises up through cracks in the ocean floor (four strips of paper spread out from a center point).

– The metal in the magma aligns with the Earth's magnetic pole (draw colored arrows going the same direction on the four strips of paper).

– After thousands of years later, more magma rises up from inside the Earth and creates new crust on the seafloor, again the metal aligns with Earth's magnetic field (show how this pushes the other floor out – it spreads – and draw in arrows).

– Then, the magnetic pole of the Earth changes, so when the magma rises up again, the metal changes how it aligns (draw colored arrows going the opposite way on the strips).

Several evidences were presented to support these theory such as the appearance and structure of continental coastlines, fossil and coal distribution, glaciations and paleomagnetism.

More resources on **Acquisition Strategies** are available in the **Technology Enhancement CD**

- Vocabulary Words: paleontologic, glaciations, structure and rock type evidence, paleoclimates, pangea, etc.

Skills:

- Compile the different evidences of plate movements
- Conform or contradict the different evidences of plate movements

Integration with Technology:

"Puzzle Making" and "Flip Book Making"

21st Century Skills: Uses language accurately (Language Skills)

Conclusion

A. **Show the Word Splash Pre-Assessment**. Have them check their own work. Let them add more sentences using the given words in the box.

B. **KPUP Summative Test (Unit 1)**. Have students answer a short assessment in preparation for the teacher-prepared summative test that covers the topics discussed in this quarter.

Summative Assessment

KPUP SUMMATIVE ASSESSMENT

A. **Check Your Knowledge**

Complete the following sentences by *supply*ing the blanks with the correct terms.

1. Lithospheric plates float on top of the _____.
2. The Earth's _____ has reversed itself many time since the beginning of time.
3. When tectonic plates collide resulting to the sinking of one plate below the other, _____ occurs.
4. The Earth has formed about _____ years ago.
5. _____ is a technique of inverting seismological data to retrieve a three-dimensional image of the anomalies in seismic wave velocity within the media they cross.

B. **Process What You Know**

Answer the following questions:

1. To what degree do plate tectonics affect life on Earth?
2. Using a world map, identify and label the types of plate boundaries on Earth.

C. **Check Your Understanding**

1. Write short summary describing what you have learned about how plate movements and their interactions at plate boundaries affect and change the arrangements of continents and ocean basins on the Earth.
2. Gather data about the possible effects of the San Andreas Fault to Western California. With the researched information, is it possible that the said state will drop into the ocean because of the movement along the fault?

D. **Apply What You Have Learned**

1. Make a pamphlet /brochure/poster that will create awareness on the Dos and Don'ts before, during and after an earthquake. Students are also encouraged to demonstrate and briefly explain the reasons and importance of the guidelines they included in their materials.

DIFFERENTIATED SUMMATIVE ASSESSMENT TASK

Goal	The goal is to launch a campaign that is focused on creating awareness and preparedness during geological events.
Role	You can either be a: a. film maker b. web designer c. visual artist
Audience	Audience for this activity shall be composed of the high school students particularly those enrolled under Environmental Science and History classes
Situation	In 2013, a *total* of 1,193 earthquakes with a magnitude ranging from 5-9.9 were recorded in the world history. The quake in Bohol which occurred last October 15 ranked 2nd place in terms of death toll. Some analysts state that one factor that contributes to the number of fatalities during natural calamities is the lack of knowledge on disaster preparedness among Filipinos. To address this concern, your school will be holding a one-day art festival to demonstrate understanding of plate tectonics at the same time, ensure disaster preparedness during earthquakes, tsunamis and volcanic eruptions.
Product/ Performance	Your task is to gather materials (photo*graph*s, video clips) and information about major geological events which occurred in 2013. It is a must that you include in your material the steps to be undertaken to ensure preparedness during the said calamities. You may create any of these products: Product 1: A short teledrama that re-enacts the darkest hours of the Filipinos during the earthquake in Bohol. Historical structures damaged by the event should be enumerated and presented. Product 2: A powerpoint presentation about Japan's journey after it was hit by a tsunami. The location of Japan and the frequency of earthquakes in its boundaries should be given importance during the film making. Product 3: A visual presentation (photos essay, paintings, etc) depicting the impacts of volcanic eruption in a province or country of your choice.
Standards	Your product/performance will be evaluated based on criteria: Concept/Script/Storyboard/Content/Organization/Quality/ Teamwork/Timeliness

Rubric for Plate Tectonics

CRITERIA	DESCRIPTION				Score
	4	3	2	1	
Concept	Displays a clear picture of what the students are trying to achieve. It is centered around a concept that shows highly developed awareness and preparedness during geological events. Adequate description of what they are trying to do and generally how his/her work will contribute to the final project.	Has a fairly clear picture of what they are trying to achieve. It is closely related to the concept and shows developed awareness and preparedness during geological events. Can describe what they are trying to do overall but has trouble describing how his/her work will contribute to the final project.	Has brainstormed their concept, but no clear focus has emerged. Goals/final product not clearly defined.	Little effort has been spent on brainstorming and refining a concept. Unclear on the goals and how the project objective will be met.	
Script/ Storyboard	The storyboard illustrates a presentation that is easy to comprehend. All elements are clearly written, labeled or drawn with no mistakes on grammar and spellings. Presentation is structured with thumbnail, notes of proposed transition, special effects, sound and title tracks include: text, color, placement, *graph*ics, etc.	The storyboard is easy to read and most elements are clearly written, labeled or drawn with little mistakes on grammar and spellings. Presentation includes thumbnail sketches of each video scene and includes text for each segment of the presentation, descriptions of background audio for each scene, and notes about proposed shots and dialogue.	The storyboard is hard to read with incomprehensible labels and drawings. Grammar and spellings are generally incorrect. The thumbnail sketches on the storyboard are not in logical sequence and do not provide complete descriptions of the video scenes, audio background, or notes about the dialogue.	There is no evidence of a storyboard or script.	

Content/ Organization	The content includes a clear statement of purpose or theme and is creative, compelling and clearly written. A rich variety of supporting information in the video contributes to the understanding of the project's main idea. Events and messages are presented in a logical order. Includes properly cited sources.	Information is presented as a connected theme with accurate, current supporting information that contributes to understanding the project's main idea. Details are logical and persuasive information is effectively used. The content includes a clear point of view with a progression of ideas and supporting information. Includes properly cited sources.	The content does not present a clearly stated theme, is vague, and some of the supporting information does not seem to fit the main idea or appears as a disconnected series of scenes with no unifying main idea. Includes few citations and few facts.	Content lacks a central theme, clear point of view and logical sequence of information. Much of the supporting information is irrelevant to the overall message. The viewer is unsure what the message is because there is little persuasive information and only one or two facts about the topic are articulated. Information is incorrect, out of date, or incomplete. No citations included.	
Quality	Movie was completed and had all required elements. The video was well edited and transits smoothly from scene to scene with proper use of transitions. Audio and other enhancements were well used.	Movie was completed and contained all required items. Editing was not done as well as it should have been. Some poor shots remain. Movie is still somewhat choppy. Audio and other enhancements were utilized, but not for maximum effect.	Movie was made, but had very little if any editing. Many poor shots remain. Video was very fragmented and choppy with little to no audio reinforcement.	There was no movie, or tape was *total*ly unedited with no transitions or audio support of any kind.	

Teamwork	Students met and had regular discussions. All students on the team contributed to the discussion and were part of the final project. Team members showed respect with each other. No adult supervision is required.	Students met and had regular discussions Most of the students on the team contributed to the discussion and were part of the final project. Team members mostly showed respect with each other. A little adult supervision is required.	Only a couple of team meetings were held. Most of the students on the team contributed at some level, but a majority of the work was done by one or two. Several conflicts arose that required adult supervision.	Meetings were not held and/or some of the team members did not contribute at all to the project. Low levels of respect were evident within the team. A considerable adult intervention is required to settle issues among team members.	
Timeliness	All project deadlines were met.	Most project deadlines were met. Those that were late did not have significant impact on the finished project.	Many project deadlines were not met, resulting in some impact on the finished project.	Deadlines were regularly missed, having a significant impact on the final project.	
					TOTAL SCORE: _____/___