Science 10 Chapter 12 Worksheet

Chapter 12 – Thermal energy transfer drives plate tectonics

Be sure to use the website at http://www.bcscience.com/bc10/pgs/links_u4.html and scroll down to the Chapter 12 section.

Chapter 12.1 – Evidence for Continental Drift

1. Continental drift theory was first proposed by __Alfred Wegener__. The first piece of evidence for his theory came when he noticed the match between __South America's__ eastern coastline and __Africa's__ western coastline. He also noted similar __fossils__ and __rocks__ from ancient masses of ice on distant continents. All this led to the belief that all the continents were joined as a __supercontinent__, which was named __Pangea__.

2. How did Wegener's analysis of rocks and mountain ranges support his idea of Pangea?

   - Wegener noted that various mountain ranges began on one continent, end at the coastline, and then appeared to continue on a continent across the ocean.
   - He also noted similarities in the ages and folds of rocks on continents that are separated by oceans.

3. Wegener noticed some similarities with fossils on different continents. Explain how the sharp-toothed, freshwater reptile called Mesosaurus was especially intriguing in supporting the idea of Pangea.

   - Mesosaurus has only been found in two places on Earth: southeastern South America and southwestern Africa. Since this species was a small freshwater animal, it seemed unlikely it could have crossed the ocean between the continents.
   - This was taken as further evidence that the continents used to be closer together.

4. Scientists have obtained more supporting evidence of Pangea by studying __paleoglaciation__, which refers to the extent of ancient glaciers and to the rock markings they have left behind. It is very interesting to note the evidence of __glaciers__ in parts of the world that are now today tropical, such as __Africa and India__.

5. What evidence suggests that Antarctica was once located farther from the South Pole than it is today?

   - Coal forms from the decomposition of tropical swamp material are hard to account for in Antarctica if it has always had the same climate. This suggests that the climate on this continent may have one day been tropical.
   - Also, a fern known as Glossopteris, has been found in Africa, South America, India, Australia and Antarctica. Ferns do not grow in cold climates, suggesting that Antarctica previously had a warmer climate to support the growth of these plants.

6. Large slabs of rock that form Earth's surface , moving over a layer of partly molten rock are known as __tectonic plates__. Two catastrophic events that are related to these large slabs of rock are __volcanic eruptions__ and __earthquakes__.

7. A volcano is an opening in the Earth'__surface__, which spews out melted rock and gases when they erupt. Earthquakes are sudden, ground-shaking release of built up __energy__ at or under the Earth's __surface__. Volcanic eruptions and earthquakes occur in a particular pattern on Earth that outlines the__boundaries__ between tectonic plates.

8. Mountains don't only occur on land, ranges have been observed in the Atlantic Ocean. One such range lies right in the middle of the ocean floor, and is called the Mid-Atlantic Ridge .

9. Explain how the study of Paleomagnetism and the age of rocks from the Mid-Atlantic Ridge helped us better understand magnetic reversal.

   - **Scientists discovered that rocks closest to the ridge were the youngest in age and that the rocks became much older the further you moved away from the ridge.**
   - **Paleomagnetism is the study of the magnetic properties of ancient rocks. Iron and other magnetic metals in rocks align with Earth's magnetic fields. Scientists believed that every so many thousands of years the magnetic field of Earth reverses. Any rocks that are frozen in place preserve the strength and direction of Earth's magnetic field at the time the rock was formed.**
   - **The Mid-Atlantic Ridge showed a striking pattern known as magnetic stripping when it was observed with a magnetometer. This stripping supported that over time the magnetic field of the Earth must have reversed every so many thousands over years.**

10. What explanation did geologist Harry Hess come up with to tie together the data on the age of ocean rocks, sediment thickness and magnetic stripping?

    - **The explanation Hess came up with was a process called sea floor spreading. Hess suggested that magma rises because it is less dense than the material that surrounds it. The magma hardens once it breaks through the surface forming new sea floor. As convection currents cause more magma to rise, new magma forces apart the hardened material, and continuously forces older rock aside.**

11. J. Tuzo Wilson's work led to plate tectonic theory that helped to explain continental __drift__. He suggested that chains of volcanoes were formed when a __tectonic plate__ passed over a stationary hot spot. Hot spots are areas when __molten rock__ rises to the Earth's surface.

12. What natural occurrences did plate tectonic theory help explain?

    - **Plate tectonic theory helped to explain the formation of mountains, the formation of ocean basins, the cause of earthquakes and volcanic eruptions.**

Chapter 12.2 - Features of plate tectonics

1. Scientists believe that over 4.5 billion years ago the Earth began as __molten ball__. As the Earth cooled, the lighter materials floated to the top and formed the Earth's __crust__ and the heavier material __sank__ to the interior. The majority of the Earth's crust is made up of rocks known as __silicates__ which are composed of the elements __silicon__ and __oxygen__.

2. The Earth is made up of four layers: the __crust__, the __mantle__, the __outer core__, and the __inner core__.

3. The outermost core, the __crust__, is made from solid, brittle rock. __Continental__ crust is made of __lighter__ rock than ocean crust; however continental crust can be as thick as __70__ km.

4. The thickest layer of Earth's four layers is the __mantle__ which is approximately __2900__ km thick and makes up about __70 %__ of the Earth's volume. This layer is divided into two sections: the __upper mantle__, which has slow flowing magma, and the __lower mantle__, which is made of solid, dense rock containing magnesium and iron.

5. Unlike the other layers of Earth, the __outer core__ is liquid, about __2300__ km thick.

6. The __inner core__ is the layer that lies at the centre of the Earth. Temperatures in this layer range from __5000-6000°C__, however the layer is solid due to the extreme __pressure__.

7. The __lithosphere__ is made up of the __crust__ and the __uppermost mantle__. The rigid but mobile chunks of rock that make up the lithosphere are known as __tectonic plates__.

8. There are __12__ major tectonic plates and many smaller ones. Tectonic plates are categorized into two types: __ocean plates__ which contain dense rock basalt and __continental plates__ which contain large amounts of granite.

9. Right below the lithosphere is the __asthenosphere__, a partly molten layer in the upper mantle. In this layer the temperature varies partly due to __radioactive decay__ that heats up the mantle in spots where __radioactive__ elements, such as uranium occur.

10. Mantle __convection__ occurs as hotter, less dense material in the mantle __rises__, cools and then sinks again, only to be __reheated__. Mantle convection is one of the major driving forces behind __tectonic plate__ movement.

11. Rising currents of magma that occur in the ocean are called __oceanic ridges__. If these rising current occur on land they are called __rift valleys__.

12. Describe the process known as ridge push and how it is related to plate movement.

    - **Ridge push occurs when new material at a ridge or rift (cooling magma that has recently reached the surface) pushes older material aside. As this occurs the tectonic plates move away from the ridge.**

13. Subduction involves the action of one tectonic plate __pushing below__ another plate. This typically occurs when a dense __oceanic__ plate collides with a lighter __continental__ plate. Areas of subduction, called __subduction zones__, often experience major __earthquakes__ and __volcanic eruptions__.

14. Explain how slab pull contributes to keeping plates in motion.

    - **When the edge of a tectonic plate subducts deep into the mantle, it pulls the rest of the plate with it. Not only do convection currents and ridge push move plates, but slab pull actually pulls them as well, keeping plates in motion.**

15. The region where two tectonic plates are in contact is called a __plate boundary__. Plates can interact in three distinct ways: either they are spreading apart (which is known as __divergence__), they are moving together (which is known as __convergence__), or they are sliding by each other (which is known as __transform__). The exact way in which the two plates actually interact depends on: __the type of plate__ and __the direction the plates are moving__.

16. At divergent plate boundaries, plates are __spreading apart__ from each other. In the ocean, diverging plates can cause increased __volcanic__ activity.

17. What are the three major types of plate convergence?

    - **Oceanic-continental plate convergence, oceanic-oceanic plate convergence and continental-continental plate convergence.**

18. Describe what occurs during oceanic-continental plate convergence. Be sure to include the concepts of trenches, volcanic belts, and the formation of mountain ranges in your description.

    - **When a denser oceanic plate converges with a lighter continental plate, the ocean plate is forced to slide under the continental plate forming a deep underwater valley known as a trench.**
    - **At the plate boundary, cone-shaped volcanoes often form when magma works its way to the surface and may even form a volcanic belt (long chains of volcanoes). Mountain ranges also tend to develop during this type of plate convergence as the continental rock crumples and folds under the tremendous force involved in tectonic plate movement.**

19. Often colliding plates in oceanic-continental plate convergence resist the office of convection currents, ridge push and slab pull. However, when the stress is too great, the tremendous energy is released as an __earthquake__.

20. Oceanic-oceanic plate convergence involves __subduction__, as one plate will slide into the mantle when the two plates collide. The plate that is __denser__ will be the one that slide into the mantle. This type of plate convergence often results in the formation of volcanic islands known as a __volcanic island arc__.

21. Describe what occurs when continental plates converge and why subduction does not occur in this type of convergence.

- **When continental plates converge, subduction does not occur as the plates have similar densities, which prevents either plate from being forced into the mantle. So when these plates converge, their edges fold and crumple, forming enormous mountain ranges.**

22. Explain what drives plates to move at transform plate boundaries, what occurs at these boundaries.

- **Convection currents in the mantle often drive plates to slide past each other forming a transform plate boundary. At this boundary, mountains and volcanoes do not form, however transform faults (large breaks in rock layers that form at transform plate boundaries) and earthquakes are commonly observed.**

23. Friction between moving plates produces __stress__, which is relieved when the plates can no longer handle it, resulting in a massive release of __energy__ known as an earthquake. __95__ % of earthquakes occur along tectonic plate boundaries and approximately __80 %__ occur in a ring bordering the Pacific Ocean.

24. The location inside the Earth where an earthquake originates is called the __focus__. The point on the Earth's surface directly above the location inside the Earth where an earthquake originates is called the __epicentre__.

25. An earthquake with a deep focus often causes __less__ damage than an earthquake with a shallow focus as the energy must travel a __longer__ distance to reach the surface.

26. The energy released by an earthquake produces vibrations called __seismic waves__. The study of these vibrations and earthquakes is known as __seismology__.

27. There are two types of seismic waves: __body waves__ and __surface waves__.

28. Describe primary, secondary and surface waves. Be sure to include the type of wave, how quickly it arrives, the size of the wave, and how it travels where applicable.

- **Primary waves (P-waves) are a type of body wave that can travel through solids, liquids and gases. These waves are the fastest of the three wave types, travelling at about 6km/s. The ground squeezes and stretches in the direction of wave travel.**
- **Secondary waves (S-waves) are another type of body wave that only travel through solids. These waves are the second fastest of the three wave types, travelling at about 3.5km/s. The ground motion is perpendicular to the direction of wave travel. S-waves often cause more structural damage than P-waves because they are larger.**
- **Surface waves (L-waves) are not body waves. They travel along the Earth's surface and are the slowest of all three wave types (the last to arrive). The ground motion is a rolling action, like the ripples in a pond.**

29. Body waves, P-waves and S-waves, travel through the Earth's interior, however S-waves disappear in the __outer core__ since it is composed of liquid and S-waves only travel in __solids__.

30. Earthquakes are measured using __seismometers__ and they produce a record of ground motion called a __seismograph__.

31. Earthquakes are typically described by their __magnitude__, a number that rates the __strength__ of an earthquake. The strength of the seismic waves of an earthquake is __10__ times larger for every __one step__ increase on the magnitude scale.

32. There are three types of volcanoes that arise as a result of movement of tectonic plates: __composite volcanoes__, __shield volcanoes__, and __rift eruptions__. The type of volcano formed is related to the plate __boundary__ involved.

33. Describe the appearance, development, and location of composite volcanoes.

- **Composite volcanoes are cone-shaped mountains that discharge ash, rocks and lava. These volcanoes develop when thick magma approaches the surface, gas gets trapped, and pressure builds up. The cone-shape is as result of repeated eruptions building up layer after layer. These types of volcanoes are commonly found near subduction zones.**

34. Describe the location, size, type of eruptions observed, and development of shield volcanoes.

- **Shield volcanoes are the largest volcanoes on Earth. They do not occur over plate boundaries, but hot spots instead. The magma of these volcanoes is much thinner than the magma in composite volcanoes, making the eruptions much less explosive in nature. Similar to composite volcanoes, layer after layer of eruptions give shield volcanoes a shield-like appearance.**

35. Rift eruptions take place when magma erupts through long cracks in the __lithosphere__. These eruptions are not very explosive, but do tend to release large amounts of __lava__.

Vocabulary to Know

Write a concise definition of each of these terms found in this chapter.

Asthenosphere -

Continental Drift Theory -

Converging plates -

Crust -

Diverging plates -

Earthquake -

Epicentre -

Focus -

Hot spot -

Inner core -

Lithosphere -

Magnetic reversal -

Magnetic stripping -

Magnitude -

Mantle -

Mantle convection -

Outer core -

Paleoglaciation -

Pangea -

Plate boundary -

Plate tectonic theory -

Primary waves -

Ridge push -

Rift valley -

Secondary waves -

Slab pull -

Spreading ridge -

Subduction zone -

Surface waves -

Tectonic plate -

Transform plate -

Volcanic belt -

Volcano -