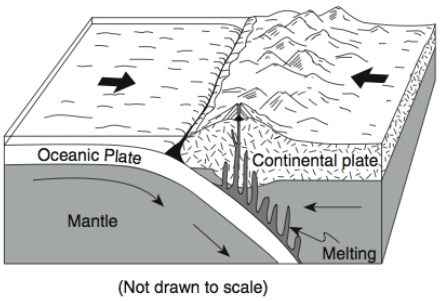
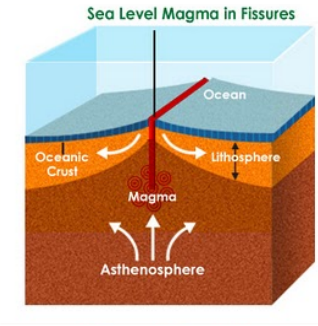
FREE RESPONSE QUESTIONS FOR
UNIT 1: The Earth

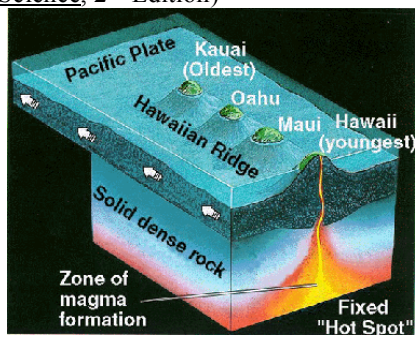
(Taken from Barron's AP Environmental Science, 2nd Edition)



A



B



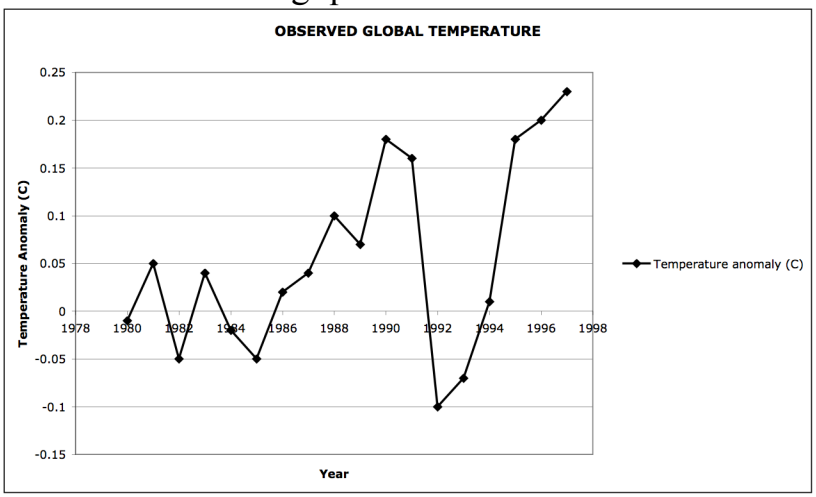
C

(a) Geologic features A-C above are formed as a consequence of plate tectonics. Choose TWO of these features and..

(i) describe what is occurring there
(ii) give an actual geographic example

(b) Charles Darwin was the geologist, botanist, and zoologist on the research vessel *Beagle* when he made observations that lead to his book, *The Origin of Species,* in which the theory of evolution and natural selection was first introduced. A century later, scientists developed the theory of plate tectonics, describing how the solid earth formed. Describe two ways in which evolution may occur as a consequence of plate tectonics.

(c) Mount Pinatubo in the Philippines erupted in 1991. Examine the temperature graph below and answer the following questions.



(i) Compare Earth's climate before and after the eruption of Mount Pinatubo.
(ii) Explain how the eruption of Mount Pinatubo might affect short-term and long-term climate change.

FREE-RESPONSE ANSWERS

(a) **Feature A** is a subduction zone. One lithosperic plate is subducting (sinking) below another, largely due to differences in density (the denser plate sinks). This is an example of a convergent plate boundary. As the subducted plate sinks to greater depths, the temperature increases to the point where it begins to melt. This molten magma is less dense then solid rock around it, so it rises up and forms a chain of volcanic mountains parallel to the plate boundary. The *Cascade Mountain Range* in Washington State are examples of a volcanic arc. When two oceanic plates converge, they create an island arc-a curved chain of volcanic islands rising from the deep seafloor and near a continent. They are created by subduction processes and occur on the continent side of the subduction zone. Japan is an example of an island arc.

Feature B is a divergent plate boundary. Lithosperic plates are moving apart. The space created between them is filled by hot magma coming apart. The *Mid-Atlantic ridge/range* is an example. When they form on continental crust, they are kown as rift valleys, such as the *African Rift Valley*.

Feature C is a hot spot. This is a place in the asthenosphere where the temperature is higher than average such that localized melting occurs. This molten rock, being less dense due to its temperature and state of matter, rise up. It forms a volcano on earth's surface. Over geologic time, the location of the hot spot remains constant, whereas the lithospheric plate moves over it. This causes a chain of volcanoes to form over time from a single hot spot. The *Hawaiian Islands* are an example of the consequences of hot spots.

(b) Evolution may occur as a consequence of geographic separation of one population of a species into two or more populations. Plate tectonics may cause this separation by either of two methods.

First, a divergent (constructive) plate boundary could cause one land mass to be divided into two or more distinct parts, perhaps even separated by an ocean. For example, identical fossils can be found on the east coast of South Africa and the west coast of Africa, indicating that these were once the same connected landmass. After these two continents diverged, different species would evolve from this common ancestor as a reaction to the different evironments and consequent environmental pressures on the different land masses.

Second, faulting occurring as a consequence of plate tectonics may cause a river to be diverted. The new path of the river could divide a population into two and serve as a geogrphic barrier preventing gene flow (immigration/emigration of individuals across the barrier). Different conditions in geographically separated regions would eventually lead to the evolution of different species as each population adapted to its environment in different ways.

(c) After the eruption of Mount Pinatubo, Earth's temperature was approximately 0.3°C lower for the next two years. Earth's temperature rose by approximately 0.1°C during the third year. By the fourth year after the eruption, Earth's temperature had returned to the pre-eruption level.

In the short term, dust and other particulates released into the atmosphere from the eruption would block the sun's rays. This descrease in solar energy reaching Earth would result in lower global temperatures.

In the long term, gases such as carbon dioxide relase during the eruption would accumulate in the stratosphere. There they would contribute to the greenhouse effect. They would absorb energy radiated back from the earth, leading to an increase in global temperature. The degree of temperature change form the Mount Pinatubo eruption via this mechanism would be much less than that by dust blocking the sun, but the effect would last much longer.