Earth has abundant water in its oceans but very little carbon dioxide in its relatively thin atmosphere. By contrast, Venus is very dry and its thick atmosphere is mostly carbon dioxide. The original atmospheres of both Venus and Earth were derived at least in part from gases spewed forth, or outgassed, by volcanoes. The gases that emanate from present-day volcanoes on Earth, such as Mount Saint Helens, are predominantly water vapor, carbon dioxide, and sulfur dioxide. These gases should therefore have been important parts of the original atmospheres of both Venus and Earth. Much of the water on both planets is also thought to have come from impacts from comets, icy bodies formed in the outer solar system.

1. According to paragraph 1, in what major respect are Venus and Earth different from each other?

A. Whether carbon dioxide was present in their original atmospheres

B. How thin their original atmospheres were

C. What their present-day atmospheres mainly consist of

D. How long ago they first developed an atmosphere

2. Why does the author mention "present-day volcanoes on Earth"?

A. To provide an example of an important difference between present-day Venus and present-day Earth

B. To help explain why Earth's atmosphere still contains traces of sulfur dioxide but Venus' does not

C. To indicate one source of information about the likely composition of the original atmospheres of Venus and Earth

D. To account for the fact that Earth's water supply no longer comes primarily from impacting comets

Paragraph 2

In fact, water probably once dominated the Venusian atmosphere. Venus and Earth are similar in size and mass, so Venusian volcanoes may well have outgassed as much water vapor as on Earth, and both planets would have had about the same number of comets strike their surfaces. Studies of how stars evolve suggest that the early Sun was only about 70 percent as luminous as it is now, so the temperature in Venus' early atmosphere must have been quite a bit lower. Thus water vapor would have been able to liquefy and form oceans on Venus. But if water vapor and carbon dioxide

were once so common in the atmospheres of both Earth and Venus, what became of Earth's carbon dioxide? And what happened to the water on Venus?

3. According to paragraph 2, what is one reason for thinking that at one time, there were significant amounts of water on Venus?

A. Because of Venus' size and mass, its volcanoes probably produced much more water vapor than volcanoes on Earth did.

B. The low temperature of Venus' early atmosphere can be explained only by the presence of water.

C. The presence of carbon dioxide in a planet's atmosphere is an indicator of water on that planet.

D. Venus probably was struck by roughly as many comets as Earth was.

4. The word "luminous" in the passage is closest in meaning to

A. dense

B. bright

C. large

D. active

Paragraph 3

The answer to the first question is that carbon dioxide is still found in abundance on Earth, but now, instead of being in the form of atmospheric carbon dioxide, it is either dissolved in the oceans or chemically bound into carbonate rocks, such as the limestone and marble that formed in the oceans. If Earth became as hot as Venus, much of its carbon dioxide would be boiled out of the oceans and baked out of the crust. Our planet would soon develop a thick, oppressive carbon dioxide atmosphere much like that of Venus.

5. Which of the sentences below best expresses the essential information in the highlighted sentence in the passage? Incorrect choices change the meaning in important ways or leave out essential information.

A. The first question to be answered is how Earth's atmospheric carbon dioxide either got dissolved in the oceans or got chemically bound into carbonate rocks.

B. The fact that Earth's abundant carbon dioxide is more often found in carbonate rock than dissolved in the oceans is the answer to the first question.

C. Earth still has abundant carbon dioxide, but instead of being in the atmosphere it is now dissolved in the oceans or chemically bound into ocean rocks.

D. The formation of limestone and marble used up the carbon dioxide that was dissolved in Earth's oceans so that only carbon dioxide in atmospheric form remained.

Paragraph 4

To answer the question about Venus' lack of water, we must return to the early history of the planet. Just as on present-day Earth, the oceans of Venus limited the amount of atmospheric carbon dioxide by dissolving it in the oceans and binding it up in carbonate rocks. But being closer to the Sun than Earth is, enough of the liquid water on Venus would have vaporized to create a thick cover of water vapor clouds. Since water vapor is a greenhouse gas, this humid atmosphere—perhaps denser than Earth's present-day atmosphere, but far less dense than the atmosphere that envelops Venus today—would have efficiently trapped heat from the Sun. At first, this would have had little effect on the oceans of Venus. Although the temperature would have climbed above 100° C, the boiling point of water at sea level on Earth, the added atmospheric pressure from water vapor would have kept the water in Venus' oceans in the liquid state.

6. According to paragraph 4, what is one factor that kept the amount of carbon dioxide in the atmosphere of early Venus relatively low?

A. The presence of water vapor clouds

B. The presence of oceans

C. Rapidly increasing temperatures at ground level

D. Low atmospheric pressures

Paragraph 5

This hot and humid state of affairs may have persisted for several hundred million years. But as the Sun's energy output slowly increased over time, the temperature at the surface would eventually have risen above 374°C. Above this temperature, no matter what the atmospheric pressure, Venus' oceans would have begun to evaporate, and the added water vapor in the atmosphere would have increased the greenhouse effect. This would have made the temperature even higher and caused the oceans to

evaporate faster, producing more water vapor. That, in turn, would have further intensified the greenhouse effect and made the temperature climb higher still.

B

7. The word "persisted" in the passage is closest in meaning to

A. improved

B. continued

C. weakened

D. evolved

C

8. According to paragraph 5, what happens when temperatures rise above 374°C?

A. Atmospheric pressure begins to decrease.

B. Water vapor disappears from the atmosphere.

C. Water evaporates regardless of atmospheric pressure.

D. More energy is required to evaporate a given volume of water.

Paragraph 6

Once Venus' oceans disappeared, so did the mechanism for removing carbon dioxide from the atmosphere. With no oceans to dissolve it, outgassed carbon dioxide began to accumulate in the atmosphere, intensifying the greenhouse effect even more Temperatures eventually became high enough to" bake out" any carbon dioxide that was trapped in carbonate rocks. This liberated carbon dioxide formed the thick atmosphere of present-day Venus. Over time, the rising temperatures would have leveled off, solar ultraviolet radiation having broken down atmospheric water vapor molecules into hydrogen and oxygen. With all the water vapor gone, the greenhouse effect would no longer have accelerated.

D

9. The phrase "mechanism for" in the passage is closest in meaning to

A. means of

B. importance of

C. need for

D. benefits of

B

10. According to paragraph 6, extremely high temperatures increased the amount of carbon dioxide in Venus' atmosphere by

A. increasing the rate which carbon dioxide was outgassed

B. baking out carbon dioxide from carbonate rocks

C. creating additional water vapor

D. replacing the previous mechanisms for removing carbon dioxide with less effective ones

11. The passage supports the idea that the basic reason that Venus and Earth are now so different from each other is that

A. early Venus had more frequent volcanic outgassing than early Earth did

B. early Venus had far less liquid water than early Earth did

C. volcanic activity stopped relatively early on Venus but continued on Earth

D. Venus is closer to the Sun than Earth is

12. Look at the four squares [■] that indicate where the following sentence could be added to the passage.

This cycle of rising temperatures following an increase in greenhouse gases is known as the runaway greenhouse effect.

This hot and humid state of affairs may have persisted for several hundred million years. But as the Sun's energy output slowly increased over time, the temperature at the surface would eventually have risen above 374°C. [■] Above this temperature, no matter what the atmospheric pressure. Venus' oceans would have begun to evaporate, and the added water vapor in the atmosphere would have increased the greenhouse effect. [■] This would have made the temperature even higher and caused the oceans to evaporate faster, producing more water vapor. [■] That, in turn, would have further intensified the greenhouse effect and made the temperature climb higher still. [■]

13. Directions: Select from the seven phrases below the 2 phrases that correctly characterize early Venus and the 3 phrases that correctly characterize present-day Venus. Drag each phrase you select into the appropriate column of the table. Two of the phrases will NOT be used. This question is worth 3 points.

Early Venus _____ _____

Present-day Venus _____ _____ _____

A. High percentage of water vapor in the atmosphere

B. Carbon dioxide present only in atmospheric form

C. An atmosphere quite similar to that of early Earth

D. Very dense but relatively cool atmosphere

E. Completely covered with water