Evolution of the Earth's Atmosphere

Read the comprehension sheet and then answer the questions below.

1. What percentage of the Earth's atmosphere today is made up of:

   nitrogen? _____

   oxygen? _____

2. Which other gases are found in today's atmosphere?

   _____

   _____

   _____

3. The Earth formed 4600 million years ago.

   What percentage of the Earth's age has the atmosphere been its current composition?

   Give your answer to 3 significant figures.

   _____

   _____

   _____ %

4. Why can scientists not be certain about the composition of the early atmosphere?

   _____

   _____

   _____

5. Why is it useful for scientists to study the atmospheres of other planets?

   _____

   _____

   _____

   _____

6. Scientists estimate that there was around 4% water vapour in the Earth's early atmosphere. Explain why this is different to the percentage of water vapour in today's atmosphere.

7. Explain how the evolution of plants helped to form a world that was able to support animal life.

8. Explain how carbon dioxide in the atmosphere decreased.

9. Using the information given, and your own knowledge, explain how burning fossil fuels or wood as fuel affects the Earth's atmosphere and suggest how we can overcome this problem.

10. Scientists studying gases trapped in ancient rocks discovered that the composition of the noble gas xenon is different to the composition of xenon in the atmosphere today. In 2016, the Rosetta spacecraft measured the amount of xenon in a comet's atmosphere during a flyby and found it was in a similar composition to that trapped in the ancient rocks on Earth.

    How does this information compare with current theories about where gases in the Earth's early atmosphere came from?

Evolution of the Earth's Atmosphere **Answers**

Read the comprehension sheet and then answer the questions below.

1. What percentage of the Earth's atmosphere today is made up of:

   nitrogen? **80% (conversion from $\frac{4}{5}$) or 78%**

   oxygen? **20% (conversion from $\frac{1}{5}$) or 21%**

2. Which other gases are found in today's atmosphere?

   carbon dioxide

   water vapour

   noble gases

3. The Earth formed 4600 million years ago.

   What percentage of the Earth's age has the atmosphere been its current composition?

   Give your answer to 3 significant figures.

   $\frac{200\ 000\ 000}{4600\ 000\ 000}$ **= 0.043478...**

   0.043478... × 100 = 4.35%

   4.35%

4. Why can scientists not be certain about the composition of the early atmosphere?

   The early atmosphere occurred 4.6 billion years ago.

   There is limited evidence for us to study.

5. Why is it useful for scientists to study the atmospheres of other planets?

   The early atmosphere was probably full of carbon dioxide with little or no oxygen and that is very similar to the atmospheres on Mars and Venus today.

6. Scientists estimate that there was around 4% water vapour in the Earth's early atmosphere. Explain why this is different to the percentage of water vapour in today's atmosphere.

   As the Earth cooled down, water vapour in the atmosphere condensed to form rain. This settled to form the oceans, so there is less water vapour in the atmosphere today compared to the early atmosphere.

7. Explain how the evolution of plants helped to form a world that was able to support animal life.

   Plants make food by photosynthesis. This chemical reaction removes carbon dioxide from the atmosphere and releases oxygen. The increase of oxygen was needed to support respiration in animals. In addition, plants transfer energy from the sun into energy stores in their tissues. Animals rely on this process for food since they cannot photosynthesise themselves.

8. Explain how carbon dioxide in the atmosphere decreased.

   Carbon dioxide in the atmosphere dissolved in newly formed oceans to form soluble carbonate compounds. These compounds precipitated as sedimentary rocks. Sedimentary rocks, such as limestone, were also formed as the shells and skeletons of animals were covered with layers of sediment. The pressure of the layers forms the rocks, locking the carbon from the atmosphere in the Earth's crust.

   Photosynthesis of plants removes carbon dioxide from the atmosphere and is used to make plant materials. This locks carbon into the plant tissues, which is transferred to animals when they feed.

   When plants and animals die in swamps or oceans, they become buried in sediments. The absence of oxygen means that oxidation does not occur. The heat from the Earth's crust and pressure from layers of sediment over millions of years causes plant remains from swamps to form coal, and marine plant and simple animal remains to form crude oil and natural gas.

9. Using the information given, and your own knowledge, explain how burning fossil fuels or wood as fuel affects the Earth's atmosphere and suggest how we can overcome this problem.

   The carbon that is locked in fossil fuels or trees is released as carbon dioxide when the fuels are burnt. This increases the amount of carbon dioxide in the atmosphere. We can overcome the problem by planting more trees or plants to take in the extra carbon dioxide.

   Students may also recognise that fuels are burnt to generate electricity and offer renewable methods to generate electricity in their answers.

10. Scientists studying gases trapped in ancient rocks discovered that the composition of the noble gas xenon is different to the composition of xenon in the atmosphere today. In 2016, the Rosetta spacecraft measured the amount of xenon in a comet's atmosphere during a flyby and found it was in a similar composition to that trapped in the ancient rocks on Earth.

    How does this information compare with current theories about where gases in the Earth's early atmosphere came from?

    Current theories suggest that gases that make up the Earth's atmosphere came from volcanoes. However, the information only mentions nitrogen, carbon dioxide, ammonia and methane. It is thought that oxygen was released into the atmosphere when algae and plants evolved and began to photosynthesise.

    The information does not mention noble gases/xenon being released into the atmosphere from volcanoes, however, the gas from ancient rocks shows that it was present at the time. The evidence from the Rosetta spacecraft suggests that some substances in the Earth's atmosphere could have come from comets instead of, or as well as, being released from volcanoes.