9.1 Atmospheric proportions, evidence and carbon stores

Name: _____ Class: _____ Date: _____ **Total: 26 marks**

KEY WORDS photosynthesis • fossil fuel

Objective

Explain changes in the atmosphere using evidence, gas proportions and carbon stores. Original practice with authored marking guidance for 4.9.1.1–4.9.1.4, both tiers. Source questions and official schemes are separate.

1 Key knowledge and worked examples

Today's air is roughly four-fifths nitrogen and one-fifth oxygen, with small amounts of other gases. Use one consistent set of approximate proportions. Modern dry-air figures of about 78% and 21% leave about 1% for the other gases; this is not all CO_2.

The early **atmosphere** is inferred from limited evidence over 4.6 billion years. One theory links it to volcanoes: mainly CO_2, water vapour and nitrogen, with little/no oxygen. Ancient ice is not a record of the first atmosphere. Cooling → water **condenses** → oceans; CO_2 dissolves and carbonates form sediments.

Photosynthesis by algae began producing oxygen about 2.7 billion years ago. Later plants also removed CO_2 and released O_2. **Limestone** stores carbonate; coal forms from buried plants; oil/gas mainly from buried small marine organisms over millions of years. Burial stores carbon outside the air but not literally forever.

Worked proportion. For 300 cm^3 air at fixed temperature/pressure, use the syllabus fractions:

$$V(N_2) = \frac{4}{5}V = \frac{4}{5} \times 300 \text{ cm}^3 = 240 \text{ cm}^3$$

$$V(O_2) = \frac{1}{5}V = 60 \text{ cm}^3$$

Worked explanation. Photosynthesis removes CO_2 to make biomass and releases O_2. Some remains are buried before full decay; later fossil-fuel formation stores that carbon. Do not claim photosynthesis directly makes coal or supplies nitrogen.

2 Practice

2.1 Name the process that raised atmospheric oxygen. [1]

2.2 What happened to most early water vapour as Earth cooled? [1]

2.3 Give today's two main gases with their approximate proportions. [2]

2.4 A 500 cm^3 air sample is represented by 78% nitrogen, 21% oxygen and 1% other gases. Calculate the nitrogen volume and the volume of other gases, at unchanged temperature/pressure. [3]

3 Exam-style questions

3.1 Give two reasons why scientists cannot be certain of the first atmosphere's exact composition. [2]

3.2 Describe two processes that lowered atmospheric carbon dioxide. Explain how each removes or stores carbon. [4]

3.3 Explain the oceans' role in the change from the early atmosphere. Include their formation and carbon removal. [3]

3.4 Compare the formation of limestone and coal. For each, explain the original carbon-containing material and how it becomes a long-term store. [4]

3.5 Explain how crude oil and natural gas form. A student says they are made instantly when carbon dioxide dissolves in seawater. Correct this statement. [3]

3.6 A report says: "A modern volcano releases CO_2 and steam, so Earth's first atmosphere was exactly 90% CO_2." Evaluate the observation and conclusion. Give one additional kind of evidence that could strengthen a theory, without claiming certainty. [3]