Chapter 2: The Origin and Evolution of the Earth

Exercises — Exercises

Q1 Multiple choice question (i): Which one of the following figures represents the age of the earth? (a) 4.6 million years (b) 13.7 billion years (c) 4.6 billion years (d) 13.7 trillion years

(c) 4.6 billion years. The chapter places the earth's evolution over the period from 4,600 million years ago to the present, which is 4.6 billion years. The figure of 13.7 billion years is the time since the Big Bang, which marks the origin of the universe, not of the earth.

Q2 Multiple choice question (ii): Which one of the following is not related to the formation or modification of the present atmosphere? (a) Solar winds (b) Differentiation (c) Degassing (d) Photosynthesis

(b) Differentiation. Differentiation is the separation of earth-forming material into layers such as crust, mantle and cores, so it relates to the earth's interior. Solar winds stripped the primordial atmosphere, degassing released gases from the interior, and photosynthesis added oxygen to the atmosphere.

Q3 Multiple choice question (iii): Life on the earth appeared around how many years before the present? (a) 13.7 billion (b) 3.8 million (c) 4.6 billion (d) 3.8 billion

(d) 3.8 billion. The chapter states that life began to evolve around 3,800 million years ago, which equals 3.8 billion years. Fossil evidence of blue-algae-like structures in rocks older than 3,000 million years supports this.

Q4 Answer in about 30 words: (i) What is meant by the process of differentiation?

Differentiation is the process by which earth-forming material separated into layers according to density. Heavier materials like iron sank towards the centre, while lighter ones moved to the surface, producing the crust, mantle, outer core and inner core.

Q5 Answer in about 30 words: (ii) What was the nature of the earth surface initially?

Initially the earth was a barren, rocky and hot object, mostly in a volatile state, with only a thin atmosphere of hydrogen and helium. Only later did it cool, solidify and develop a crust, oceans and a life-supporting atmosphere.

Q6 Answer in about 30 words: (iii) What were the gases which initially formed the earth's atmosphere?

The earth's earliest atmosphere consisted of hydrogen and helium, which solar winds later stripped away. The next atmosphere, released by degassing from the interior, contained mainly water vapour, nitrogen, carbon dioxide, methane and ammonia, with very little free oxygen.

Q7 Answer in about 150 words: (i) Write an explanatory note on the 'Big Bang Theory'.

The Big Bang Theory, also called the expanding universe hypothesis, is the most popular explanation for the origin of the universe. Edwin Hubble showed in 1920 that galaxies are moving apart, so the universe is expanding. The theory describes these stages. First, all matter existed in one place as a tiny ball (singular atom) of unimaginably small volume, infinite temperature and infinite density. Second, this ball exploded violently, causing a huge expansion that continues today. The bang is generally accepted to have occurred 13.7 billion years ago. Some energy was converted into matter, expansion was very rapid within fractions of a second and has since slowed, and the first atom began to form within three minutes. Third, within 300,000 years the temperature dropped to 4,500 K, giving rise to atomic matter, and the universe became transparent. Later, density differences led gravity to draw matter together, forming galaxies and stars. Hoyle's steady state concept was an alternative, but evidence for expansion made scientists favour the Big Bang.

Q8 Answer in about 150 words: (ii) List the stages in the evolution of the earth and explain each stage in brief.

The earth's evolution had these main stages. 1. Evolution of the lithosphere: the earth was initially volatile, and rising density raised its temperature. Through differentiation, heavier materials such as iron sank to the centre and lighter ones rose, giving the crust, mantle, outer core and inner core. The giant impact that formed the moon further heated the earth, and cooling and solidification produced the crust. 2. Evolution of the atmosphere and hydrosphere: the hydrogen-helium primordial atmosphere was stripped off by solar winds. Degassing from the hot interior, aided by volcanic eruptions, released water vapour and gases such as nitrogen, carbon dioxide, methane and ammonia. As the earth cooled, the vapour condensed into rain and filled depressions, forming oceans within 500 million years. 3. Origin of life: around 3,800 million years ago life began as chemical reactions produced self-duplicating organic molecules. Photosynthesis evolved 2,500-3,000 million years ago, and about 2,000 million years ago oxygen began to flood the atmosphere.