

Class XI

Chapter-2: The Origin and Evolution of The Earth

Fundamentals of Physical Geography

Early Theories

Nebular Hypothesis

- Immanuel Kant, a German philosopher gave this theory.
- This theory was revised in 1796 by a mathematician Pierre-Simon Laplace.
- According to this hypothesis, the planets were formed out of a cloud of material associated with a young Sun, which was rotating slowly.

Binary Theories

- In 1901, Chamberlain and Moulton considered that a wandering star approached the sun. As a result, a cigar-shaped extension of material was separated from the solar surface. As the passing star moved away, the material separated from the solar surface continued to revolve around the sun and it slowly condensed into planets. Later on, the arguments considered of a companion to the sun to have been coexisting. These arguments are called binary theories.

Revised Nebular Hypothesis

- Revised Nebular Hypothesis was propounded by Carl Weizascar in Germany and Otto Schmidt in Russia.
- They regarded that a solar nebula surrounded the sun and that the nebula comprised of chiefly hydrogen, helium and something called dust.
- The collision of particles and the friction caused a disk-shaped cloud to be formed and then the planets were created via the accretion process.

Modern Theories

Big Bang Theory

- The Big Bang Theory is the most popular argument regarding the origin of the universe and is called the expanding universe hypothesis.
- The expansion of universe means increase in space between the galaxies.

- **Edwin Hubble provided evidence in 1920 that the universe is expanding.**

The Big Bang Theory considers the following stages in the development of the universe:

- **As per this theory, in the beginning, all matter or substance forming this universe existed at one place as a tiny ball. This tiny ball had an extremely small volume, infinite density and temperature.**
- **At the Big Bang, this ball blasted violently and led to a huge expansion which continues even to the present day.**
- **Now it is accepted that this event took place 13.7 billion years ago.**
- **Within first three minutes from the Big Bang event, the first atom was formed.**
- **Within 300,000 years from the Big Bang, temperature dropped down to 4,500 kelvin and gave rise to atomic matter. The universe became transparent.**

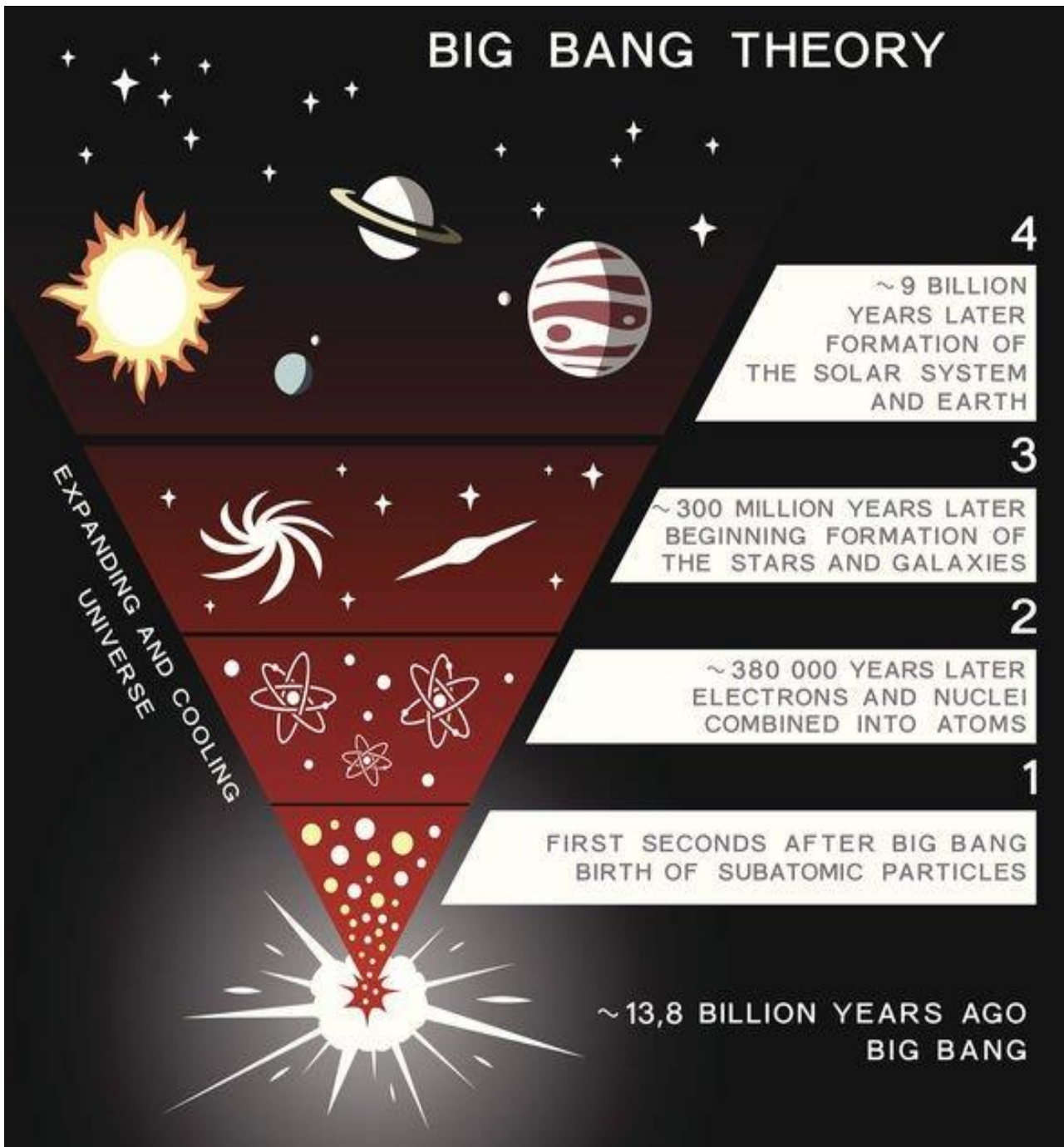


Figure1: The Big Bang Theory

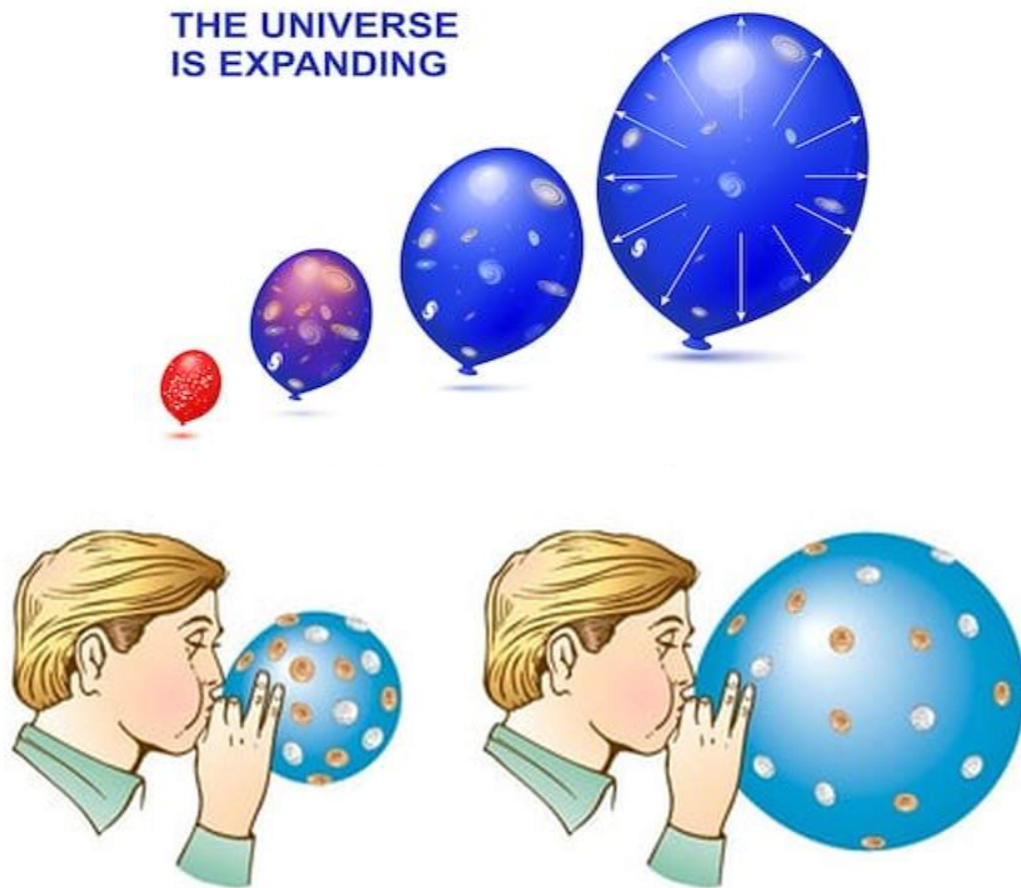


Figure 2: Showing Experiment of Big Bang Theory

The Star Formation

- The distribution of matter and energy in the early universe was not even. This gave rise to differences in gravitational forces and it caused the matter to get drawn together which provided the bases for development of galaxies.
- A galaxy has millions of stars and spread over vast distances that are measured in light years.
- A galaxy is formed by accumulation of hydrogen gas in the form of a very large cloud called nebula.
- Gradually, growing nebula develops localised clumps of gas which continue to grow into denser gaseous bodies, giving rise to formation of stars around 5-6 billion years ago.

The Light Year

- It is a unit of astronomical distance which is equal to the distance light travels in one year.
- A light-year is a measure of distance and not of time.
- Light travels at a speed of 300,000 km/second.

- The mean distance between the sun and the earth is 149,598,000 km.
- In terms of light years, it is 8.311.

Formation Of Planets:

The following are regarded as the stages in the planets' development:

- The stars are localised gas lumps inside a nebula.
- A core to the gas cloud as well as a spinning disc of dust and gas are created because of the gravitational force within the lumps.
- After this, the cloud of gas condenses and the matter over the core is changed into tiny rounded objects.
- These small round objects develop into what are called planetesimals by a cohesion process.
- The smaller objects start forming larger bodies by colliding with one another and they stick together because of gravitational force.
- In the last stage, these large number of small planetesimals aggregate to develop into a smaller number of large bodies called planets.

The Solar System

- Our solar system is supposed to have been formed from the Nebula about 4.6 billion years ago after nebula started its collapse.
- Our solar system consists of the sun, 8 planets, 63 moons, millions of asteroids and comets and huge quantity of dust-grains and gases
- Out of eight planets Mercury, Venus, Earth, Mars are called the inner planets because they lie between the sun and the belt of asteroids. They are also called Terrestrial planets as well-meaning earth like as they are made up of rock and metals and have relatively high densities.
- After an asteroid belt lie other four planets-Jupiter, Saturn, Uranus, and Neptune called the outer planets. They are also called Jovian or Gas Giant planets. Jovian means Jupiter-like because most of them are much larger than the terrestrial planets and have thick atmosphere, mostly of helium and hydrogen.

The Moon

- The moon is the only natural satellite of the earth.
- Present scientists believe that the formation of moon is an outcome of 'giant impact' or 'the big splat'.

- A body of the size of one to three times that of Mars collided into the Earth sometime shortly after the Earth was formed. It blasted a large part of the Earth into space. This portion of blasted material then continued to orbit the Earth and eventually formed into the present moon about 4.44 billion years ago.

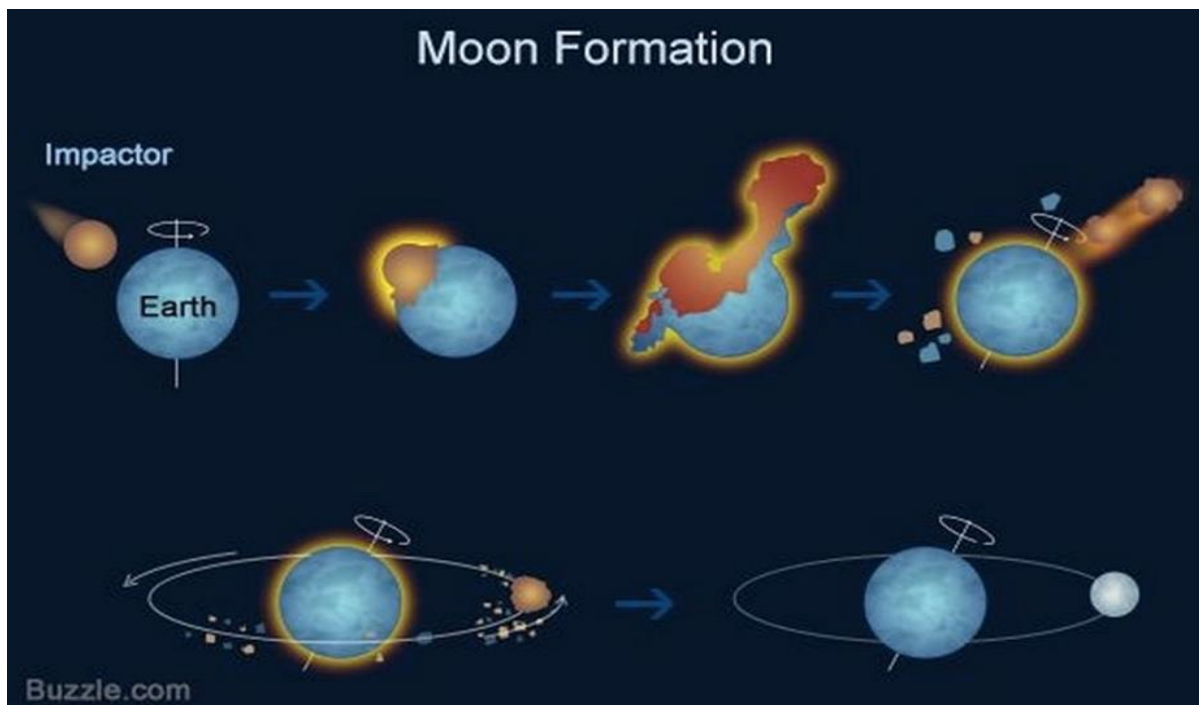
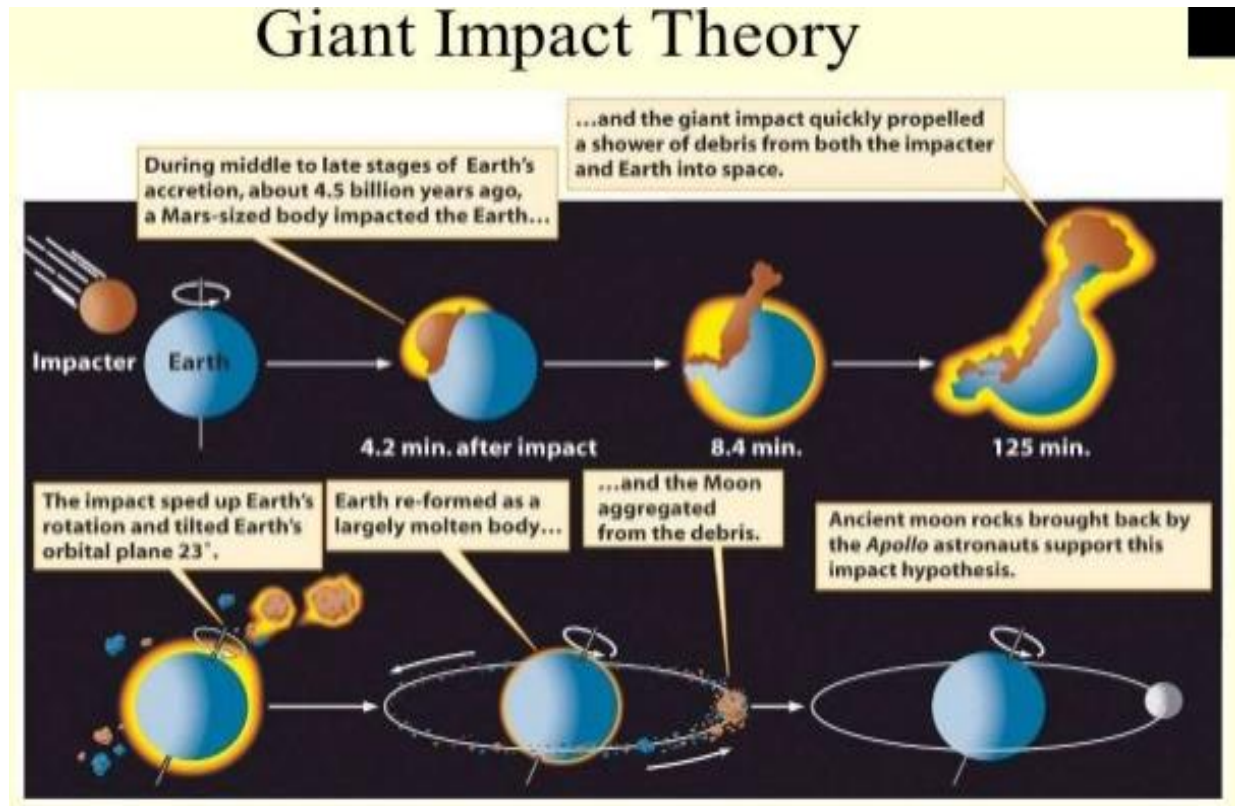


Figure3: The formation of Moon

The Evolution of Earth:

- The age of Earth is approximately one-third of the age of the universe. Earth formed around 4.54 billion years ago by accretion from the solar nebula.
- Initially earth was a barren, rocky and hot object with a thin atmosphere of hydrogen and helium which was turned to a beautiful planet with water and conducive atmosphere favouring life on it due to some events-processes between the 4,600 million years and the present.
- The earth has a layered structure made up of material that is not uniform.

The Evolution of Lithosphere:

- The earth was in a volatile state in its primordial stage.
- Due to gradual increase in density, the temperature inside earth increased.
- Increase in temperature led material inside the earth getting separated depending on the densities. Heavier materials such as iron started sinking towards the centre of the earth and lighter ones to move towards the surface. With passage of time, it cooled and solidified and condensed into a smaller size. This later led to the development of the outer surface in the form of a crust.
- It is through the process of differentiation that the earth forming material got separated into different layers such as the crust, mantle, outer core and inner core. From crust to core, the density of the material increases

The Evolution of Atmosphere and Hydrosphere

- There are three stages in the evolution of the present atmosphere:
 - a) The loss of primordial atmosphere: The early atmosphere of earth and other terrestrial planets which was made up of hydrogen and helium gases, was stripped off by the solar winds.
 - b) The hot interior of the earth contributed to the evolution of the atmosphere: The process of through which the gases were outpoured from the interior is called degassing. During the cooling of the earth, gases and water vapour were released from the interior of solid earth. This started the evolution of the present atmosphere.

Volcanic eruptions released water vapour and gases to the atmosphere. As the earth cooled, water vapour condensed to cause rain. The rain water collected in the depressions to give rise to oceans around 500 million years from the formation of the earth.
 - c) The composition of the atmosphere was modified by the living world through the process of photosynthesis: Around 2,500-3,000 million years before the present, the process of

photosynthesis got evolved. Life was confined to the oceans for a long time. Oceans began to have the contribution of oxygen through the process of photosynthesis. Eventually, oceans were saturated with oxygen and 2,000 million years ago oxygen began to flood the atmosphere.

The Origin of Life:

- It is assumed that life began to evolve sometime around 3,800 million years ago.
- However, around 2,500-3,000 million years before the present, the process of photosynthesis got evolved. Life was confined to the oceans for a long time.
- The record of life that existed on earth in different time periods is found in rocks in the form of fossils.
- The microscopic structures closely related to the present form of blue algae. Modern scientists refer to the origin of life as a kind of chemical reaction which first generated complex organic molecules and assembled them in such that they could duplicate themselves converting non-living matter into living one.

CHAPTER-2: THE ORIGIN AND EVOLUTION OF THE EARTH (BOOK-1)

1 Mark Questions

- Q1. Name the early theory revised by Laplace in 1776.
- Q2. Who propounded the 'Big Bang Theory'?
- Q3. What is a light year?
- Q4. What are Planetesimals?
- Q5. What is 'Nebula'?
- Q6. What is the mean distance between the sun and the earth?
- Q7. Name the natural satellite of the earth.
- Q8. Which two gases formed the initial thin atmosphere of our planet earth?
- Q9. Name the two main gases which constitute most part of our present atmosphere.
- Q10. Define 'degassing'.
- Q11. When did life of the earth begin to evolve?
- Q12. Name the process which helped evolution of life on the earth.
- Q13. Why are terrestrial planets rocky?
- Q14. What is meant by the process of differentiation?
- Q15. Make a list of the gases that our early atmosphere largely contained.

3/5 Marks Questions

- Q16. Explain early theories regarding the origin of the earth given by Immanuel Kant and revised by Laplace.
- Q17. What is the Big Bang Theory? What are its stages in the development of the universe? Explain.
- Q18. Prepare an explanatory note on the Solar System.
- Q19. Explain the 'Giant Impact' theory regarding the formation of the moon.
- Q20. Make a labelled diagram of planet earth showing all three layers of it.
- Q21. What are the three stages of the evolution of the present atmosphere? Explain.
- Q22. How did our earth get cooled? Explain as to how hydrosphere was formed on the earth.

Q23. Explain origin and evolution of life on the earth according to the modern scientists. Give any two evidences regarding the life that existed on earth in different periods.

Q24. Distinguish between inner planets and outer planets with examples of each.

Q25. What are various stages in the development of planets? Explain.

Q26. What was the nature of the earth initially? Explain the nature of earth that it has in present.