

Chapter 1—Understanding Earth: A Dynamic and Evolving Planet

ESSAY

1. What distinguishes science from other forms of human inquiry?

ANS:

Scientific ideas are based on data and observation. They are testable. Other forms of inquiry are based on faith, emotion, or something else that is nontestable.

PTS: 1

REF: 1.3. Geology and the Formulation of Theories

2. What is scientific method?

ANS:

Scientific method is an orderly, logical approach to understanding our world that involves gathering and analyzing data about a natural phenomenon, formulating hypotheses to explain the phenomenon, testing the hypotheses, which, if it survives, is put forth as a theory.

PTS: 1

REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

3. How is a theory formulated?

ANS:

Theories are formulated using scientific method. Observations and data are gathered to test the problem. Tentative explanations, also called hypotheses, are then formulated to explain the observations and data. More tests are done and the data are analyzed. If the data show that the hypothesis is not correct, it is tossed out. If the data support the hypothesis, there are no significant data refuting it, and it is accepted by scientists, it becomes a theory.

PTS: 1

REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

4. How have natural resources been important in history?

ANS:

States, nations, and empires have risen and fallen, and they have fought for control of, or sometimes lost, natural resources.

PTS: 1

REF: 1.4. How Does Geology Relate to the Human Experience?

5. What is greenhouse effect and how does it work? What happens when greenhouse gas levels in the atmosphere increase?

ANS:

Carbon dioxide and other greenhouse gases are natural components of the atmosphere. These gases allow sunlight to pass through the atmosphere but trap some of the heat that radiates outward from Earth's surface. This is greenhouse effect. If the amount of greenhouse gases in the atmosphere increases, they can trap more heat and the atmosphere warms.

PTS: 1

REF: 1.6. Global Geologic and Environmental Issues Facing Humankind

6. What are some of the predicted consequences of global warming?

ANS:

Warmer temperatures overall; melting glaciers, ice caps, and sea ice; increased drought in some locations, increased precipitation in other locations; difficulty growing food in some agricultural areas; spread of tropical diseases into areas that have traditionally been too cold for them.

PTS: 1

REF: 1.6. Global Geologic and Environmental Issues Facing Humankind

7. Describe how the universe, galaxies, stars, and chemical elements formed.

ANS:

Scientists believe that the universe originated with the Big Bang approximately 15 billion years ago. At the moment of the Big Bang, there was only energy, no matter. In the first second following the Big Bang, the four basic forces separated and the universe experienced enormous expansion. Galaxies and stars came together because particles attracted to each other by gravity and angular momentum caused the material to rotate. In the early universe, the only chemical elements were hydrogen and helium. Nuclear reactions in stars formed the heavier elements and star explosions scattered them around space.

PTS: 1

REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

8. Briefly explain the current theory of Earth's origin, including how and why it came to be differentiated by composition.

ANS:

Formation began with uniform cold accretion of rocky material. Heat was generated by meteorite impacts, gravitational compression, and nuclear reactions. The heat caused the material to melt. Since it could now move, dense metals sank to the core and denser silicates to the mantle. Lighter silicates rose to form the crust.

PTS: 1

REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

9. How are the rock cycle and plate tectonics related?

ANS:

Interactions between plates determine, to some extent, which of the three rock groups will form. Plates may melt to form igneous rocks, be altered to form metamorphic, or sink to allow sediments to become sedimentary rocks.

PTS: 1

REF: 1.9. The Rock Cycle

10. What is the basic tenet of the theory of organic evolution? What is the mechanism for organic evolution called and how does it work?

ANS:

All living things are related and have descended with modification from organisms that lived in the past. The mechanism is called natural selection, which states that the organisms that are best adapted to their environment are the most likely to survive to reproduce and so their genes will be better represented in the next generation. It is these changes that cause species to evolve with time.

PTS: 1

REF: 1.10. Organic Evolution and the History of Life

11. Briefly explain how the themes of plate tectonics, organic evolution, and geologic time provide a cohesive history of Earth.

ANS:

Earth has evolved internally and externally. As internal processes were established, they played a role in what was happening on the surface of Earth as the atmosphere, hydrosphere, and landmasses developed. Organic evolution was directly dependent on development of favorable conditions for different life forms. The net result of the physical, chemical, and biological evolution of Earth has been profound, particularly in light of the amount of time necessary for those changes to take place (synthesis).

PTS: 1

REF: various

12. Briefly explain how geologists can formulate theories about events that occurred on Earth before humans were here to make observations.

ANS:

Geologists base their theories on two assumptions. First, that rocks record the processes that were involved in formation of those rocks. Second, that uniformitarianism is true, and the present is the key to the past. This means that basic physical, chemical, and biological processes have not changed, and that if we study and understand them today, we can apply what we learn to conditions in the past.

PTS: 1

REF: 1.11. Geologic Time and Uniformitarianism

13. Briefly explain the importance of the geologic time scale.

ANS:

The geologic time scale is the result of work by many geologists worldwide who used fossils, the rock record, and radiometric dating techniques to determine a chronology for the evolution of Earth and its life through time.

PTS: 1

REF: 1.11. Geologic Time and Uniformitarianism

14. Briefly explain the importance of the Principle of Uniformitarianism to the study of historical geology.

ANS:

Uniformitarianism provides the basis for interpreting the geologic history of Earth because geologists cannot travel back in time to study events. By using modern analogies, geologists can make reasonable interpretations about past events.

PTS: 1

REF: 1.11. Geologic Time and Uniformitarianism

SHORT ANSWER

1. What are two examples of geology-related environmental concerns? Briefly explain why geology holds an important position in environmental science.

ANS:

Water quality and distribution, finding and exploiting energy resources, soil formation and erosion, climate change--there are many to choose from. Geology is concerned with all aspects of the physical Earth and their interactions with the biosphere.

PTS: 1

REF: 1.6. Global Geologic and Environmental Issues Facing Humankind

2. What is one way in which geologic knowledge is used to help humans?

ANS:

There are several possible answers to this including finding mineral or energy resources, helping solve environmental problems, or predicting natural hazards.

PTS: 1 REF: various

3. What are planetesimals?

ANS:

Accreting masses of gases, liquids, and solids that eventually become true planets.

PTS: 1 REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

4. What are the characteristics of the terrestrial planets?

ANS:

The terrestrial planets – Mercury, Venus, Earth, and Mars – are all small and are composed of rock and metallic elements that condensed at the high temperatures of the inner solar nebula.

PTS: 1 REF: Geo-Insight. The Terrestrial and Jovian Planets

5. What are the characteristics of the Jovian planets?

ANS:

The Jovian planets – Jupiter, Saturn, Uranus, and Neptune – are all large, gaseous bodies with rings and heavy atmospheres.

PTS: 1 REF: Geo-Insight. The Terrestrial and Jovian Planets

6. What is Pluto now that it is no longer a planet, and what are the characteristics of that type of body?

ANS:

Pluto is now a dwarf planet. These bodies are similar to planets but they have not cleared their portion of space of debris. Pluto is found within the Kuiper belt of comets and other icy debris.

PTS: 1 REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

7. Why is Earth considered to be a dynamic (as opposed to static) planet?

ANS:

Earth has been continuously changed through its 4.6 billion year existence.

PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

8. On what bases are the concentric layers of Earth primarily distinguished?

ANS:

density differences as a function of variations in pressure, temperature, and composition

PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

9. How is Earth unique among the planets of the solar system?

ANS:

Earth supports life, has oceans of water, has a hospitable atmosphere, and has a variety of climate.

PTS: 1 REF: Geo-Insight. The Terrestrial and Jovian Planets

10. What is the difference between a rock and a mineral?

ANS:

A rock is an aggregate of minerals. Minerals are naturally occurring, inorganic, crystalline solids that have definite physical and chemical properties.

PTS: 1 REF: 1.9. The Rock Cycle

11. What are the three major groups of rocks?

ANS:

igneous, sedimentary, metamorphic

PTS: 1 REF: 1.9. The Rock Cycle

12. What is the sequence of steps in the formation of sedimentary rocks?

ANS:

weathering, erosion, transportation, deposition, and consolidation/lithification

PTS: 1 REF: 1.9. The Rock Cycle

13. How do metamorphic rocks form?

ANS:

The alteration of existing rocks is a result of heat, pressure, and chemical activity.

PTS: 1 REF: 1.9. The Rock Cycle

14. What is the basic premise of the principle of uniformitarianism?

ANS:

Present-day processes have operated throughout geologic time.

PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism

15. State the principle of uniformitarianism

ANS:

The physical and chemical laws of nature have remained the same over time and cannot be violated.

PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism

16. What is the name of the method that is used to determine the absolute age of a rock body?

ANS:

radiometric dating

PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism

17. What is the definition of the word "theory" as used in science?

ANS:

A theory is a coherent explanation for one or several related natural phenomena that is supported by a large body of objective evidence.

PTS: 1

REF: 1.3. Geology and the Formulation of Theories

18. What about Earth makes it suitable for a wide variety of life?

ANS:

A hospitable atmosphere, lots of liquid water, and a variety of climate types.

PTS: 1

REF: Geo-Insight. The Terrestrial and Jovian Planets

COMPLETION

1. Earth's six principal subsystems are _____, _____, _____, _____, _____, and _____.

ANS: atmosphere, hydrosphere, biosphere, lithosphere, mantle, core

PTS: 1

REF: 1.1. Introduction

2. A combination of related parts that interact in an organized fashion is a(n) _____.

ANS: system

PTS: 1

REF: 1.1. Introduction

3. The two primary materials that geologists use as clues to understand Earth's past are _____ and _____.

ANS:

rocks, fossils

fossils, rocks

PTS: 1

REF: 1.9. The Rock Cycle | 1.10. Organic Evolution and the History of Life

4. When the universe originated it was composed of 100 percent _____ and but now consists of _____ percent hydrogen and 2 percent _____ elements.

ANS: hydrogen and helium, 98, heavier

PTS: 1

REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

5. The four basic forces are _____, _____, _____, and _____.

ANS: gravity, electromagnetic, strong nuclear, weak nuclear

PTS: 1 REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

6. Any theory that explains the origin of the solar system must also explain the following properties of all or most of the planets: a(n) _____ direction of rotation and division into _____ planets and _____ planets, according to their chemical and physical properties.

ANS: counterclockwise, terrestrial, Jovian

PTS: 1 REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

7. The increasing percentage of heavier elements in the later universe results from nuclear _____, during the evolution of _____.

ANS: fusion, stars

PTS: 1 REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

8. Earth formed _____ billion years ago.

ANS: 4.6

PTS: 1 REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

9. The material in Earth's inner core is _____, while the outer core is _____.

ANS: solid, liquid

PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

10. Earth's solid portion is divided into concentric layers of rock and other materials that may be solid, liquid, or partially molten. From the center to the surface, these are known as the inner _____, outer _____, lower _____, upper _____, and _____.

ANS: core, core, mantle, mantle, crust

PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

11. The portion of Earth that has the largest volume is the _____.

ANS: mantle

PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

12. The crust and the underlying uppermost mantle make up the _____.

ANS: lithosphere

PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

13. The two types of crust are _____ and _____.

ANS:
oceanic, continental
continental, oceanic

PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

14. Plates of _____ move over the _____, partly as a result of _____ cells.

ANS: lithosphere, asthenosphere, convection

PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

15. Rocks that form from the crystallization of lava or magma are _____ rocks.

ANS: igneous

PTS: 1 REF: 1.9. The Rock Cycle

MULTIPLE CHOICE

1. Which of the following statements about a scientific theory is *not* true?
- It is an explanation for some natural phenomena.
 - It has a large body of supporting knowledge.
 - It is testable.
 - It is conjecture or guess.
 - None of these

ANS: D PTS: 1 REF: 1.3. Geology and the Formulation of Theories

2. Most scientists argue that the greatest environmental problem facing the world today is what?
- climate change
 - the ozone hole
 - water pollution
 - overpopulation
 - overfishing

ANS: D PTS: 1
REF: 1.6. Global Geologic and Environmental Issues Facing Humankind

3. The Big Bang took place approximately ____ years ago.
- 150 billion
 - 50 billion
 - 15 billion
 - 15 million
 - 10,000

ANS: C PTS: 1
REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

4. The age of the universe is estimated by ____.
- the temperature of the universal background radiation
 - the age of comets formed in interstellar space
 - the rate at which galaxies are moving away from one another

- d. the age of subatomic particles as determined by radioactive decay
- e. the age of the sun

ANS: C PTS: 1

REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

5. Among the evidence for the Big Bang origin of the universe is
- a. the separation of the four basic forces
 - b. galaxies are all moving away from one another
 - c. a universal background radiation slightly above zero
 - d. the separation of the four basic forces AND a universal background radiation slightly above zero
 - e. galaxies are all moving away from one another AND a universal background radiation slightly above zero

ANS: E PTS: 1

REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

6. At the moment of the Big Bang,
- a. all matter and energy were compressed into an infinitely small high-temperature and high-density state.
 - b. all matter and energy were infinitely expanded and equaled the size of the universe.
 - c. the universe was entirely made of infinitely dense matter; energy had not yet come into existence.
 - d. the universe that had existed previously inverted on itself and became the current universe.
 - e. all of the chemical elements that we see in the universe today were forged in the explosion.

ANS: A PTS: 1

REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

7. Identify the terrestrial planets.
- a. Jupiter, Saturn, Uranus, and Neptune
 - b. Mercury, Venus, Earth, and Mars
 - c. Earth, Mars, and Jupiter
 - d. Uranus, Neptune, and Pluto
 - e. Mercury, Earth, Mars, and Pluto

ANS: B PTS: 1

REF: Geo-Insight. The Terrestrial and Jovian Planets

8. The zone between the core and the crust is called what?
- a. innersphere
 - b. lithosphere
 - c. mantle
 - d. convection center
 - e. molten zone

ANS: C PTS: 1

REF: 1.8. Why Earth is a Dynamic and Evolving Planet

9. Earth's core is probably ____.
- a. composed of rock with high silica content
 - b. hollow
 - c. molten throughout
 - d. composed of potassium and aluminum rich silicates
 - e. composed mostly of iron and nickel

ANS: E PTS: 1

REF: 1.8. Why Earth is a Dynamic and Evolving Planet

10. Which of the following statements about the asthenosphere is *not* true?

- a. It lies beneath the lithosphere.
- b. It is a rigid rock layer.
- c. It behaves plastically.
- d. It acts like a lubricating layer allowing plates to move.
- e. It has the same composition as the lower mantle.

ANS: B

PTS: 1

REF: 1.8. Why Earth is a Dynamic and Evolving Planet

11. The ocean crust is composed mostly of what?

- a. granite
- b. peridotite
- c. basalt
- d. sial
- e. gneiss

ANS: C

PTS: 1

REF: 1.8. Why Earth is a Dynamic and Evolving Planet

12. The theory that all living organisms are descendants of different life forms that existed in the past is called ____.

- a. organic evolution
- b. astrology
- c. paleontology
- d. plate tectonics
- e. natural selection

ANS: A

PTS: 1

REF: 1.10. Organic Evolution and the History of Life

13. Fossils are ____.

- a. useful for reconstructing past environmental conditions
- b. evidence that evolution has occurred
- c. evidence that Earth has a long history predating humans
- d. the remains or traces of once living organisms
- e. all of these

ANS: E

PTS: 1

REF: 1.10. Organic Evolution and the History of Life

14. What are the three types of plate boundaries?

- a. mid-ocean ridge, trench, divergent
- b. mid-ocean ridge, divergent, convergent
- c. divergent, convergent, transform
- d. convergent, transform, trench

ANS: C

PTS: 1

REF: 1.8. Why Earth is a Dynamic and Evolving Planet

15. Sudden or catastrophic events, such as volcanic eruptions and tsunamis, can be explained by

- a. the big bang theory.
- b. the theory of natural selection.
- c. the third law of thermodynamics.
- d. the principle of uniformitarianism.

ANS: D

PTS: 1

REF: 1.11. Geologic Time and Uniformitarianism

TRUE/FALSE

1. The two types of crust are known as lithospheric and oceanic.

ANS: F PTS: 1 REF: 1.8. Why Earth is a Dynamic and Evolving Planet

2. Scientists have proven that there is no supernatural or spiritual realm.

ANS: F PTS: 1 REF: 1.3. Geology and the Formulation of Theories

3. The solar nebula theory of the formation of the solar system accounts for the differences in composition between the terrestrial and Jovian planets.

ANS: T PTS: 1
REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

4. Earth was originally of homogeneous composition.

ANS: T PTS: 1
REF: 1.7. Origin of the Universe and Solar System, and Earth's Place in Them

5. According to the theory of organic evolution, all living organisms are related and they descended, with some modifications, from organisms that lived in the past.

ANS: T PTS: 1 REF: 1.10. Organic Evolution and the History of Life

6. The central thesis of the theory of organic evolution is that there has always been the same diversity of species on Earth in the past as today.

ANS: F PTS: 1 REF: 1.10. Organic Evolution and the History of Life

7. Natural selection refers to survival of organisms that are best adapted to their environment.

ANS: T PTS: 1 REF: 1.10. Organic Evolution and the History of Life

8. Natural selection refers to organisms choosing the habitat in which they feel most comfortable.

ANS: F PTS: 1 REF: 1.10. Organic Evolution and the History of Life

9. In the 19th century, the geologic time scale was first developed using radiometric age dating techniques.

ANS: F PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism

10. In the 19th century, the geologic time scale was based primarily on sequence of fossils in the rock record.

ANS: T PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism

11. The Principle of Uniformitarianism is based on the idea that modern processes have operated throughout geologic time.

ANS: T PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism

12. According to the Principle of Uniformitarianism, processes have occurred at the same rates throughout geologic time.

ANS: F PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism

13. Geologists use the Principle of Uniformitarianism as a basis to interpret the past and predict the future.

ANS: T PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism

14. In order for geologists to use the Principle of Uniformitarianism to interpret the geologic record, they do not need to study modern geologic processes.

ANS: F PTS: 1 REF: 1.11. Geologic Time and Uniformitarianism