

Student Study Guide

for use with

Environmental Geology

Sixth Edition

Carla Montgomery
Northern Illinois University



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ENVIRONMENTAL GEOLOGY, SIXTH EDITION
CARLA MONTGOMERY

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CHAPTER 1

AN OVERVIEW OF OUR PLANETARY ENVIRONMENT

Important Concepts

1. Most astronomers believe that the universe originated in a “Big Bang” about 15 to 20 billion years ago.
2. The formation of the *solar system* from a rotating cloud of gas and dust was eventually complete about 4.5 billion years ago.
3. The *planets* of the solar system differ in their compositions as a function of their distance from the sun. The composition of the earth is quite different from the composition of most of the planets, and so far it is the only planet known to contain life.
4. The early earth, which lacked oceans and an atmosphere, was heated by two main processes:
 - (a) impact of colliding meteorites and dust particles; and
 - (b) decay of radioactive elements within the earth.
5. The melting and subsequent cooling of the earth resulted in the formation of three main compositional zones:
 - (a) the high-density, central *core*, composed mainly of iron and nickel;
 - (b) the surrounding *mantle*, composed mainly of iron, magnesium, silicon, and oxygen; and
 - (c) a low-density, thin *crust*, composed mainly of oxygen and silicon.
6. The heating and subsequent differentiation of the early earth led to the formation of the atmosphere and the oceans. The early atmosphere lacked free oxygen and probably consisted of nitrogen, carbon dioxide, methane, ammonia, and various sulfur gases. The later accumulation of free oxygen in the atmosphere is attributed to the photosynthetic activity of primitive plantlike organisms (single-celled blue-green algae).
7. The first multicellular, oxygen-breathing organisms appeared on earth about one billion years ago; the first modern humans (*Homo sapiens*) appeared about half a million years ago.
8. *Geology* is an interdisciplinary science that seeks to explain geologic phenomena and provide solutions to problems posed by geologic hazards. Two factors that complicate the interpretation of geologic phenomena are the large scale and the extremely slow rate of most geologic events.
9. The earth is a changing, dynamic planet. Many geological and chemical processes are interrelated and cyclic in nature.
10. Human activities cause or accelerate significant changes in natural systems. The impact of these activities is broadly proportional to the size of the population and the level of technological development.
11. The world’s population, which has been growing at an exponential rate, exceeded six billion in the year 2000 and is predicted to reach about nine billion by the year 2050. At the current growth rate of 1.4% per year, the *doubling time* of the world’s population is about 50 years.
12. The global population may be on the verge of exceeding the earth’s *carrying capacity*, its ability to sustain its population at a basic, healthy, moderately comfortable standard of living. An additional problem is the uneven distribution of population growth and natural resources.

13. Extraterrestrial colonization is not a practical solution to global overpopulation.

Key Terms

carrying capacity
core
crust
doubling time
exponential growth

hypothesis
mantle
scientific method
solar system
theory

Multiple Choice

1. Most astronomers believe that the universe
 - a. has existed in its present state since the beginning of time.
 - b. formed from a huge rotating cloud of gas.
 - c. came into existence as the result of a "Big Bang."
 - d. is no more than five billion years old.
2. Most of the mass of the solar system is concentrated in
 - a. Jupiter and Saturn.
 - b. Earth.
 - c. the planets.
 - d. the sun.
3. The solar system formed about
 - a. 5 million years ago.
 - b. 4.5 billion years ago.
 - c. 10 billion years ago.
 - d. 15 to 20 billion years ago.
4. The planet closest to the sun is
 - a. Venus.
 - b. Mars.
 - c. Mercury.
 - d. Earth.
5. Which of the following planets most closely resembles Earth in size?
 - a. Mercury
 - b. Mars
 - c. Pluto
 - d. Venus
6. A planet whose density reflects a significant iron content and relatively little gas is
 - a. Neptune.
 - b. Jupiter.
 - c. Venus.
 - d. Saturn.

7. A planet that has ice caps composed of carbon dioxide ice is
 - a. Earth.
 - b. Mars.
 - c. Mercury.
 - d. Jupiter.

8. Which of the following was an important heat source for melting of the primitive earth?
 - a. volcanic activity
 - b. the "Big Bang" that started the universe
 - c. collisions of infalling particles
 - d. heat energy radiated by the sun

9. Continental crust differs from oceanic crust in that it
 - a. has a composition more like that of the mantle.
 - b. is denser than oceanic crust.
 - c. is thinner than oceanic crust.
 - d. contains more light minerals than oceanic crust.

10. Of the earth's major compositional zones, the largest is the
 - a. inner core.
 - b. outer core.
 - c. mantle.
 - d. crust.

11. The earth's outer core is
 - a. solid.
 - b. semisolid.
 - c. liquid.
 - d. gaseous.

12. The earth's core is composed mostly of
 - a. iron.
 - b. silicon.
 - c. nickel.
 - d. magnesium.

13. The three most abundant elements in the earth's crust are oxygen, silicon, and
 - a. iron.
 - b. magnesium.
 - c. calcium.
 - d. aluminum.

14. Earth's early atmosphere
 - a. was similar in composition to the present atmosphere.
 - b. consisted mainly of sulfur gases.
 - c. consisted mainly of methane and ammonia.
 - d. contained little or no oxygen.

15. There are few fossils of the earth's earliest living organisms because
- most of the rocks containing these fossils have been destroyed by various geologic processes.
 - most of the rocks containing these fossils are deeply buried beneath younger strata and are not available for examination.
 - most early life lived in the sea, thus making their fossils difficult to locate.
 - the earliest living organisms were soft-bodied and thus did not preserve well as fossils.
16. Of the following eras of geologic time, the correct sequence from oldest to youngest is
- Cenozoic, Paleozoic, Mesozoic.
 - Cenozoic, Mesozoic, Paleozoic.
 - Mesozoic, Paleozoic, Cenozoic.
 - Paleozoic, Mesozoic, Cenozoic.
17. A scientific theory
- is proven beyond doubt and is never subjected to revision.
 - is an untested trial answer to a scientific question.
 - represents a "common sense" explanation of a natural phenomenon that cannot be tested in a laboratory.
 - may be modified or completely discarded if it fails to explain new kinds of data or observations.
18. Which one of the following regions of the world had the highest average population growth rate (% per year) between 1990 and 1995?
- Europe
 - South America
 - Africa
 - Asia
19. North and Central America are projected to contain _____ percent of the world's population by the year 2025.
- 8.9
 - 6.0
 - 7.4
 - 4.1
20. The term "carrying capacity" refers to
- the maximum number of people a spacecraft can transport to another planet.
 - the ability of the earth to sustain its population in reasonably healthy and comfortable conditions.
 - the maximum number of people that could inhabit the earth.
 - the maximum amount of food one acre of farmland can produce without the use of fertilizers and mechanized equipment.

Fill In the Blanks

- Each planet of the solar system is believed to have formed from an accumulation of dust and gas drawn together by _____.
- The planet having the largest diameter relative to earth is _____.
- The process by which simple plantlike organisms introduced free oxygen into the earth's atmosphere is called _____.

4. The dinosaurs appeared about _____ million years ago.
5. The means of discovering basic scientific principles is called the _____.
6. Food, unlike minerals or land, is considered to be a _____ resource.
7. On a global scale, the human population increases when its birthrate exceeds its _____ rate.
8. Population growth is _____ when the number of individuals added per unit of time increases over time.
9. _____ time is the length of time required for a population to double in size.
10. The average worldwide population growth rate is about _____ percent per year.

True or False

Indicate whether the following statements are true or false. If false, correct the statement to make it true.

- ____ 1. According to most theories of the formation of the solar system, the sun formed independently from the planets, and the planets were later captured by the sun's gravitational field.
- ____ 2. The composition of a planet within the solar system is largely a function of its distance from the sun.
- ____ 3. Earth is unique among the planets of the solar system in having an abundance of surface water.
- ____ 4. The first mammals appeared on earth approximately 75 million years ago.
- ____ 5. The emphasis of geology today is on the observation and description of natural processes.
- ____ 6. A hypothesis is a generally accepted explanation for a set of data or observations.
- ____ 7. About 100 million tons of waste is generated in the United States per year.
- ____ 8. The country having the highest per capita consumption of most mineral and energy resources is the United States.
- ____ 9. Concern over human disruption of natural systems is largely unjustified, since natural phenomena such as severe storms, volcanoes, and earthquakes disrupt natural systems to a greater extent than do human activities.

_____ 10. Every hour, the world population increases by about 1500 people.

Review Questions

1. How is the present earth different from the primitive earth that formed about 6.4 billion years ago?
2. If all the planets of the solar system formed at the same time, then why are their compositions so different? Is there a pattern to the compositional variation among the planets?
3. What tests would you apply to determine if geology qualifies to be included as a science subject in the university's curriculum?
4. Explain, with sketches as necessary, the difference between linear and exponential growth. Why is the world's population growth always exponential, even if the growth rate is constant? Would the growth be exponential if we manage to bring down the current growth rate of 1.4% to less than 1%?
5. Do you believe in the concept that the earth has a certain "carrying capacity"? Justify your answer.

Surfing the Net

An excellent overview of the solar system, including its origins:

<<http://seds.lpl.arizona.edu/nineplanets/nineplanets/overview.html>>

Create an image of any planet or moon as viewed from another body, using the Solar System Simulator (NASA):

<<http://space.jpl.nasa.gov/>>

A wide selection of earth images and animations (NASA):

<<http://visible.earth.nasa.gov>>

World population information, including World Population Clock (U.S. Census Bureau):

<<http://www.census.gov/cgi-bin/ipc/popclockw>>

U.S. population tables and demographic information (U.S. Census Bureau):

<http://www.census.gov/stat_abstract/pop.html>

General resource for population and environmental information (World Resources Institute):

<<http://www.wri.org>>

CHAPTER 1 ANSWER KEY

Multiple Choice

- | | | | | |
|------------------|-------------------|--------------------|--------------------|---------------------|
| 1. c | 5. d (table 1.1) | 9. d (figure 1.3) | 13. d (table 1.2) | 17. d |
| 2. d | 6. c (table 1.1) | 10. c (figure 1.3) | 14. d | 18. c (table 1.4) |
| 3. b | 7. b (figure 1.2) | 11. c (figure 1.3) | 15. d | 19. c (figure 1.14) |
| 4. c (table 1.1) | 8. c | 12. a | 16. d (figure 1.4) | 20. b |

Fill In the Blanks

- | | |
|------------------------|----------------|
| 1. gravity | 6. renewable |
| 2. Jupiter (table 1.1) | 7. death |
| 3. photosynthesis | 8. exponential |
| 4. 200 | 9. doubling |
| 5. scientific method | 10. 1.4 |

True or False

1. False. The sun and the planets formed together from a single rotating cloud of gas.
2. True
3. True
4. False. Mammals first appeared on earth approximately 200 million years ago.
5. False. Rather than merely describing natural processes, the modern science of geology seeks to explain how natural processes operate.
6. False. A hypothesis is a tentative explanation for a set of observations or data. A hypothesis that is repeatedly supported by experimentation may be elevated to the status of a theory, which is a generally accepted explanation for a set of observations or data.
7. False. About 300 million tons of waste is generated in the United States per year.
8. True
9. False. Natural systems tend toward a balance among opposing forces, whereas human activities tend to cause or accelerate significant changes in natural systems.
10. False. Every hour, the world population increases by about 10,000 people!