Prentice Hall Brief Review

Earth Science:
The Physical Setting

Jeffrey C. Callister

Ordering Information

Send orders to:
Pearson Customer Service
P.O. Box 2500
Lebanon, IN 46052-3009

or call toll free:
1-800-848-9500
(8:00 A.M.-6:00 P.M. EST)

School orders:
k12.oasis.pearson.com

Individual orders:
pearsonschool.com/nybriefreviews

PEARSON

ALWAYS LEARNING

About the Author

Jeffery C. Callister received his B.S. in Secondary Education from SUNY New Paltz and his M.S. in Earth Science from Union College, Schenectady. He taught both earth science and geology at Newburgh Free Academy in Newburgh, N.Y., for over 30 years in addition to being a part time instructor of geology at various SUNY colleges. Mr. Callister has authored five publications for the National Science Teachers Association (NSTA) and part of the second edition of the Earth Science Curriculum Project. He is a current member of American Association for the Advancement of Science, NSTA, National Association of Geoscience Teachers, National Earth Science Teachers Association, New York State Science Teachers Association and New York State Earth Science Teachers Association.

Teacher Reviewers and Contributors

Timothy Denman
Planetarium Director, Retired
Newburgh Free Academy
Newburgh, New York

Tom Elkins
John L. Miller Great Neck North High School
Great Neck, New York

David Keith
Science Chair
John L. Miller Great Neck North High School
Great Neck, New York

Peter Le Rose
Mount Saint Mary College
Newburgh, New York

Elise Russo, Ed.D.
Administrator for Secondary Curriculum
Amityville Union Free School District
Amityville, New York

Peter Suchmann
Science Chair, retired
Great Neck South Middle School
Great Neck, New York

Harold P. Coyle
Science Education Department
Harvard-Smithsonian Center for Astrophysics
Cambridge, MA

Acknowledgments begin on page I-9 and constitute an extension of this copyright page.

ISBN-13: 978-0-32-885850-7
ISBN-10: 0-32-885850-1

PEARSON

1 2 3 4 5 6 7 8 9 10 V011 19 18 17 16 15

Earth Science: The Physical Setting

Separate Answer Key Contents:

About This Book

This book is designed to enhance review of the concepts, skills, and application of the Physical Setting/Earth Science Core Curriculum that may be tested on the Regents Examination for The Physical Setting: Earth Science. Students can use the book in any order as each topic is independent except for the introduction of vocabulary words.

Features

Content Review

The presentation features aids for accessing the basic content that will be tested on the Regents Examination as well as practice for interpreting and answering Regents Examination questions.

Illustrations Graphics are designed to visualize the concepts and vocabulary of earth science as well as familiarize students with the types of drawings they will be required to interpret on the Regents Examination.

Vocabulary An understanding of the language of earth science is needed to answer many Regents Examination questions.

Bold Words The vocabulary listed at the beginning of a topic are terms defined within that topic and are shown in bold type.

Underlined Words Terms that are underlined are either words that appear as bold in other topics or are terms describing basic earth science concepts. These may be used in Regents Examination questions.

Sidebars

Memory Jogger This sidebar helps you recall relevant information covered elsewhere in this book or previous science courses.

Digging Deeper This sidebar provides specific examples of some concepts or expands core content.

Review Questions Questions similar to those on Regents Examinations, totaling more than 680, appear throughout each topic to clarify and reinforce understanding.

Practice Questions for the New York Regents Exam

A total of more than 580 practice questions are written and organized for each topic in the format of the Regents Examination.

Part A These multiple-choice questions test your knowledge of concepts from the core curriculum.

Part B Both multiple-choice and constructed response questions test understandings and skills outlined in the core curriculum.

Part C These questions often require an extended constructed response. The number in brackets tells how many points the question is worth on a Regents Examination.

Reference and Support

Strategies for Answering Test Questions Support to help you interpret and answer the range of Regents Examination questions.

Appendix 1 *Earth Science Reference Tables* The Reference Tables are integral to this content review and are indicated by an (R). Review and Practice Questions also refer you to them.

Appendix 2 *Earth Science Performance Test* Part D of the Regents Examination on laboratory and classroom procedures is partly described.

Appendix 3 *Landscape Regions of New York State* This map and descriptions support review.

Appendix 4 *Paths of the Sun at Different Times and Latitudes* shows 24 different paths of the sun based on an observer's view. For easy reference while reading, look for the (A4) icon, which will direct you from relevant topics in the text back to the Appendix.

Glossary Defines all bold vocabulary words and underlined words in the topics.

Index Cross-references concepts in the topics.

Regents Examinations

Several of the most recent Regents Examinations are reproduced at the end of this book to provide practice in taking actual Regents Examinations.

Strategies for Answering Test Questions

This section provides strategies to help you answer various types of questions on the Regents Examination for Physical Setting: Earth Science. Strategies are provided for answering multiple-choice and constructed-response questions as well as for questions based on diagrams, data tables, and graphs and questions that use the *Earth Science Reference Tables,* which are reproduced in the Appendix.

Strategies for Multiple-Choice Questions

Multiple-choice questions will likely account for more than 50 percent of the Regents Examination for Physical Setting: Earth Science. Part A is comprised totally of multiple-choice questions, and Part B includes some. Therefore, it is important to be good at deciphering multiple-choice questions. Here are a few helpful strategies. For any one question, not all strategies will need to be used. The numbers are provided for reference, not to specify an order (except for Strategies 1 and 2).

1. Always read the entire question, but wait to read the choices. (See Strategy 4.)
2. Carefully examine any data tables, diagrams, photographs, or relevant part(s) of the *Earth Science Reference Tables* associated with the question.
3. Underline key words and phrases in the question that signal what you should be looking for in the answer. This will make you read the question more carefully. This strategy applies mostly to questions with a long introduction.
4. Try to think of an answer to the question before looking at the choices given. If you think you know the answer, write it on a separate piece of paper before reading the choices. Next, read all of the choices and compare them to your answer before making a decision. Do not select the first answer that seems correct. If your answer matches one of the choices, and you are quite sure of your response, you are probably correct. Even if your answer matches one of the choices, carefully consider all of the answers because the obvious choice is not always the correct one. If there are no exact matches, re-read the question and look for the choice that is most similar to your answer.
5. Eliminate any choices that you know are incorrect. Lightly cross out the numbers for those choices on the exam paper. Each choice you can eliminate increases your chances of selecting the correct answer.
6. If the question makes no sense after reading through it several times, leave it for later. After completing the rest of the exam, return to the question. Something you read on the other parts of the exam may give you some ideas about how to answer this question. If you are still unsure, go with your best guess. There is no penalty for guessing, but answers left blank will be counted as wrong. If you employ your best test-taking strategies, you just may select the correct answer.

Answer Key with Diagnostics and Quizzes A separate Answer Key includes all answers to the Review and Practice Questions plus topic-by-topic Diagnostic Tests to help determine which concepts require more intensive review and Topic Quizzes for quick assessment with different questions.

Strategies for Constructed-Response Questions

Some questions in Part B and all questions in Part C of the Regents Examination for Physical Setting: Earth Science require a constructed response. No matter which type of answer is requested, the following strategies will help you write constructed responses.

1. Always read through the entire question.
2. Underline key words and phrases in the question that signal what you should be looking for in the answer. This will make you read the question more carefully.
3. Look over the *Earth Science Reference Tables* for any helpful information related to the question.
4. Write a brief outline, or at least a few notes to yourself, about what should be included in the answer.
5. Pay attention to key words that indicate how to answer the question and what you need to say in your answer. Several of these words are very common. For example, you might be asked to discuss, describe, explain, define, compare, contrast, or design. The table above lists key words and directions for your answers.

Using Key Words to Direct Your Answers

Key Word	What Direction Your Answers Should Take
Analyze	• Break the idea, concept, or situation into parts, and explain how they relate. • Carefully explain relationships, such as cause and effect.
Discuss	• Make observations about the topic or situation using facts. • Thoroughly write about various aspects of the topic or situation.
Describe	• Illustrate the subject using words. • Provide a thorough account of the topic. • Give complete answers.
Explain	• Clarify the topic of the question by spelling it out completely. • Make the topic understandable. • Provide reasons for the outcome.
Define	• State the exact meaning of the topic or word. • Explain what something is or what it means.
Compare	• Relate two or more topics with an emphasis on how they are alike. • State the similarities between two or more examples.
Contrast	• Relate two or more topics with an emphasis on how they are different. • State the differences between two or more examples.
Design	• Plan an experiment or component of an experiment. Map out your proposal, being sure to provide information about all of the required parts.
State	• Express in words. • Explain or describe using at least one fact, term, or relationship.

6. When you write your answer, don't be so general that you are not really saying anything. Be very specific. You should use the correct terms and clearly explain the processes and relationships. Be sure to provide details, such as the names of processes, names of structures, and, if it is appropriate, how they are related. If only one example or term is required, do not give two or more. If one is correct and the other is wrong, your answer may be marked wrong.
7. If a question has two or three parts, answer each part separately. This will make it easy for the person scoring your paper to find all of the information. When writing your answer, don't shortchange one part of the question by spending too much time on another part.
8. Note that you will not lose points for incorrect grammar, spelling, punctuation, or poor penmanship. However, such errors and poor penmanship could impair your ability to make your answer clear to the person scoring your paper. If that person cannot understand what you are trying to say, you will not receive the maximum number of points.

Strategies for Questions Based on Diagrams

Both multiple-choice and extended-response questions frequently include diagrams or pictures. Usually the diagrams provide information needed to answer the question. The diagrams may be realistic, or they may be schematic. Schematic drawings show the relationships among parts and sometimes the sequence in a system. Follow these steps:

1. First study the diagram and think about what the diagram shows you. Be sure to read any information, such as titles or labels, that goes with the diagram.
2. Read the question. Follow the strategies for either multiple-choice or constructed-response questions listed previously.

Strategies for Questions Based on Data Tables

Most data tables contain information that summarizes a topic. A table uses rows and columns to condense information and to present it in an organized way. Rows are the horizontal divisions going from left to right across the table, while columns are vertical divisions going from top to bottom. Column headings name the type of information included in a table. Sometimes different categories of information are listed down the left-hand column of the table. See the sample data table, and identify the kind of information in the columns and rows. When answering a question with a data table, use the following strategies.

1. Find the title of the table. It is usually located across the top.
2. Determine the number of columns in the table and their purpose.
3. Determine the number of rows and their purpose.
4. Read across the rows and down the columns to determine what the relationships are.
5. Now you are ready to read the question with the data table. Answer the question by using the suggested strategies for multiple-choice or constructed-response questions listed previously.

Table 1. Planet Data

Planet	Average Distance From the Sun (AU)	Average Orbital Speed (km/s)
Mercury	0.4	48.0
Venus	0.7	35.0
Earth	1.0	30.0
Mars	1.5	24.0
Jupiter	5.2	13.0
Saturn	9.6	10.0
Uranus	19.0	7.0
Neptune	30.0	5.1

Strategies for Questions Based on Graphs

Graphs represent relationships in a visual form that is easy to read. Three different types of graphs commonly used on science Regents Examinations are line graphs, bar graphs, and circle graphs. Line graphs are the most common, and they show the relationship between two changing quantities, or variables. When a question is based on any of the three types of graphs, the information you need to correctly answer the question can usually be found on the graph.

When answering a question that includes a graph, first ask yourself these questions:

- What information does the graph provide?
- What are the variables?
- What seems to happen to one variable as the other changes?

After a careful analysis of the graph, use the appropriate strategies for multiple-choice or constructed-response questions.

Use of the Earth Science Reference Tables to Help Answer Questions

In recent Regents Examinations between 35% to 45% of the questions have involved the use of the *Earth Science Reference Tables.* You should become thoroughly familiar with all details of these tables. Sometimes the questions will specifically refer you to the reference tables, but most often you will be expected to know what information is included within the reference tables. The text helps you become familiar with the content of the reference tables by referring to the tables within the text presentation. These references are indicated by an Ⓡ on the pages in each topic. Listed below are some of the ways the reference tables are used in Regents Examination questions.

- to find a specific fact, such as the composition of Earth's inner core
- to find the relationship between two facts on different parts of the reference tables, such as the latitude and longitude of the center of the Tug Hill Plateau
- using an equation on the reference tables to solve a problem, such as a rate of change of an event
- graphing or recognizing the correct graph of data on the reference tables, such as the percent by mass of the elements in Earth's crust
- decoding a graphic symbol in a question, such as present weather or air mass type on a weather map
- performing a procedure using part of the reference tables, such as determining the distance of a location to an epicenter using the Earthquake P-wave and S-wave Travel Time graph
- interpretation of data on the reference tables, such as the temperature of white dwarf stars

Introduction to Earth's Changing Environment

TOPIC 1

How Scientists Study Earth's Changing Environment

Would a piece of wax float in melted wax?

Every day you probably observe the property of density just by getting a cold drink. You know ice floats in water because ice, or solid water, is less dense than liquid water. But how does the density of other solid and liquid phases of the same substance compare? If you dropped a chunk of solid candle wax into a container of liquid wax, would it sink or float? What do you think would happen to a chunk of iron in a tub of melted iron?

If you lived 200 years ago, you likely wouldn't have to think about the answer because you would have observed what happened while candles or iron horseshoes were being made. Now, you probably think about the ice in your drink first. The truth is, for almost all substances, when the solid, liquid, and gas of the same substance are in the same environment, they will naturally arrange themselves in order by density with the denser solid at the bottom, the least-dense gas at the top, and the liquid in between. Thus for almost all substances, the solid would sink into the liquid of the same material. The major exception to this principle is the substance water, since liquid water is denser than solid water (ice).

TOPIC 1

Introduction to Earth's Changing Environment

Vocabulary

classification	interface	percent deviation
cyclic change	mass	pollution
density	measurement	prediction
dynamic equilibrium	natural hazard	rate of change
inference	natural resources	universe
instrument	observation	volume

Topic Overview

Earth science is the study of Earth and its position in the universe. Often Earth science is considered a combination of four science disciplines:

- Geology is the study of the history, structure, processes, and composition of Earth's solid surface down to Earth's center.
- Oceanography is the study of all aspects of Earth's oceans.
- Meteorology is the study of Earth's atmosphere, including weather and climate.
- Astronomy is the study of the **universe**—that is all matter, time, energy, and space.

Note to student: *Much of the information presented in this topic explains process skills that you will use as you study earth science. You have probably already used some of these process skills. Most of the information in this topic will be discussed in more detail elsewhere. While you will not be tested on concepts in this topic independently, many of these concepts will be tested in conjunction with specific concepts. For example, you will be expected to use equations found in this topic to solve problems in percent deviation, density, and rate of change.*

Observations

An **observation** is the perception of some aspect of the environment by one or more human senses—sight, hearing, touch, taste, or smell.

Observing with Senses and Instruments

The senses are limited in range and precision. An **instrument** is a human-made device that extends the senses beyond their normal limits, thus enabling them to make observations that would otherwise be impossible or highly inaccurate. For example, a microscope makes it possible to see objects and details too small for the unaided eye to detect, and a magnet allows one to observe something the senses do not perceive at all. We would not even know about many forms of energy—such as X-rays, radio, microwave, and ultraviolet—without certain instruments.

Inferences and Misconceptions

An **inference** is an interpretation of an observation. It is a mental process that proposes causes, conclusions, or explanations for what has been observed. For example, the observation of an impression shaped like a dog's foot leads to the inference that a dog has been present. This inference may or may not be correct. Additional observations may make the inference more likely to be true.

A prediction of a future event, such as a hurricane or snowstorm, is a type of inference. Misconceptions about environmental characteristics often result from incorrect inferences that become commonly believed. A misconception is a mistaken belief or a misunderstanding. For thousands of years, humans believed the inference that Earth was the center of the universe and didn't spin or move around the sun.

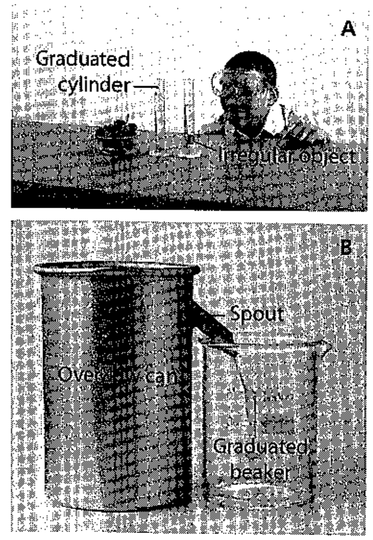


Figure 1-1. Measuring volume of irregular objects: (A) To measure the volume of an irregular object that will fit in a graduated cylinder, pour water to a known level in a graduate around halfway up and carefully record the volume shown by the meniscus. Then tip the graduated cylinder and carefully slide the unknown solid into the graduate. Observe the new level of the meniscus. The difference in the two values is the volume of the unknown solid object. (B) For larger irregular objects, use an overflow can. Fill the overflow can so that water easily pours out the spout until the flow stops. Discard this water. Carefully drop the irregular object into the overflow can (without splashing). Collect and measure the water from the spout in a graduated cylinder or graduated beaker. The volume of the water in the beaker equals the volume of the unknown solid.

Classification

Scientists group together similar observations and inferences to make the study of objects and events in the environment more meaningful or easier to understand. This grouping is called **classification**. In later topics, you will study classifications of objects and events such as planets, stars, minerals, storms, types of energy, and natural disasters.

Measurement

A **measurement** is a means of expressing an observation with greater accuracy or precision. It provides a numerical value for an aspect of the object or event being observed. Every measurement includes at least one of the three basic dimensional quantities—length, mass, and time—which are defined as follows:

- Length may be described as the distance between two points.
- The amount of matter in an object is its **mass**. It is often determined by using a balance. Mass should not be confused with weight, which is the pull (force) of Earth's gravitation on an object. The weight of an object may vary with its location, but its mass remains the same.
- Time is often described as our sense of things happening one after another or as the duration of an event.

Some types of measurements require the mathematical combination of basic dimensional quantities. For example, a unit of volume is actually a unit of length cubed, as in 25 cm^3 (25 cubic centimeters). **Volume** is the amount of space that an object occupies. The volume of solid objects is often determined by finding the volume of water an object displaces when it is placed in water in an instrument such as a graduated cylinder. (See Figure 1-1.) Other examples of such types of measurement are density (mass per unit volume, as in 4 g/cm^3) and speed (distance per unit time, as in 9.8 km/sec).

All measurements of the basic quantities (length, mass, and time) are made by a direct comparison to certain accepted standard units of measurement. For example, length is measured by comparing it to a standard unit such as the centimeter, mass to a unit such as the gram, and time to a unit such as the second. Imagine you asked some friends how much time an experiment took to perform, and they answered 60. Wouldn't you have to ask 60 of what? A measurement must always state the units used, for example, 27.9 grams or 26 kilometers.

Percent Deviation or Percent Error No measurement is perfect because of the imperfection of the senses and of instruments. People may also introduce errors by carelessness or the improper use of an instrument. Any measurement is therefore an approximation of a true value and must be considered to contain some error.

Science has accepted values for some given qualities (for example, 1 g/cm^3 for the density of liquid water at 4°C). It is therefore possible to determine the accuracy, or amount of error, of a given measurement by comparing it with the accepted value.

$$\textbf{percent deviation} = \frac{\textbf{difference from accepted value}}{\textbf{accepted value}} \times 100\%$$

For example, suppose a student measures the mass of an object as 127.5 grams and the accepted value is 125.0 grams. Then,

$$\begin{aligned}\text{amount of deviation} &= \text{difference from accepted value}\\ &= 127.5\text{ grams} - 125.0\text{ grams}\\ &= 2.5\text{ grams}\end{aligned}$$

$$\begin{aligned}\text{percent deviation} &= \frac{\text{amount of deviation}}{\text{accepted value}} \times 100\%\\ &= \frac{2.5\text{ grams}}{125.0\text{ grams}} \times 100\%\\ &= 2.0\%\end{aligned}$$

When the amount of error is expressed as a percentage, it is called **percent deviation**, or percent error. The percent deviation is obtained by dividing the difference between the measured and accepted values by the accepted value and multiplying the result by 100 percent.

Review Questions

1. In the classroom during a visual inspection of a rock, a student recorded four statements about the rock. Which statement about the rock is an observation?

(1) The rock formed deep in Earth's interior.
(2) The rock cooled very rapidly.
(3) The rock dates from the Cambrian Period.
(4) The rock is black and shiny.

2. To make observations, an observer must always use

(1) experiments
(2) the senses
(3) proportions
(4) mathematical calculations

3. Which statement made by a student after examining a rock specimen is an inference?
   (1) The rock is of igneous origin.
   (2) The rock has rounded edges.
   (3) The rock is light-colored.
   (4) The rock contains large fragments.

4. A measurement is best defined as
   (1) an inference made by using the human senses
   (2) direct comparison to a known standard
   (3) an interpretation based on theory
   (4) a group of inferred properties

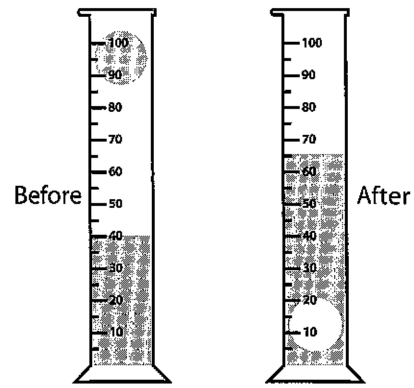
5. A student measures the velocity of the water in a stream as 2.5 meters per second. The actual velocity of the water is 3.0 meters per second. What is the approximate percent deviation of the student's measurements?
   (1) 0.50% (2) 17% (3) 20% (4) 50%

6. Which statement best illustrates a classification system?
   (1) A glacier melts at the rate of one meter per year.
   (2) Ocean depths are measured using sound waves.
   (3) Snowfall predictions for winter storms vary.
   (4) Stars are grouped according to color.

7. A classification system is based on the use of
   (1) the human senses to infer properties of objects
   (2) instruments to infer properties of objects
   (3) observed properties to group objects with similar characteristics
   (4) inferences to make observations

8. Organizing information in a meaningful way is an example of
   (1) prediction (3) observation
   (2) measurement (4) classification

9. A sphere was dropped into water in a graduated cylinder as shown in the following diagram. The water level rose to the new level shown.



What is the volume of the sphere?
   (1) 15 mL (2) 25 mL (3) 40 mL (4) 65 mL

Density

The concentration of matter in an object is known as its **density**. If we model matter with students, then a full classroom with 35 students has a high density, and a classroom with only 2 students has a low density. The density of an object is the ratio of its mass to its volume; that is, density is the mass per each unit of volume. Density is important in the study of earth science. This is because density is a property of materials that affects the way in which materials interact in the environment.

Computing Density

To determine the density of an object, divide its mass by its volume. This formula for density is found in the *Earth Science Reference Tables:* Ⓡ

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

The density of a material does not depend on the size or shape of the sample as long as the temperature and pressure remain the same. For example, a cube of the mineral graphite with a volume of 20 cm^3 has a mass of 44 g. Its density is 44 grams divided by 20 cm^3 = 2.2 g/cm^3. A graphite ball with a volume of 40 cm^3 (twice the volume of the cube) will have a mass of 88 g (twice the mass of the cube), but its density will be the same: 88 g/40 cm^3 = 2.2 g/cm^3.

Determining Relative Density

An object immersed in a liquid is buoyed by a force equal to the weight of liquid it displaces (Archimedes' principle). If the density of the object is less than the density of the liquid, the weight of displaced liquid will be greater than the weight of the object. Therefore, the upward force will be enough to support the object, and it will float in the liquid.

Flotation of objects in liquids (and in gases) is one method of determining their relative, or comparative, densities. The lower the density of a floating object, the higher it floats in the liquid. This means that a greater percentage of the object's volume is above the surface of the liquid. As the density of a floating object increases, it sinks relatively deeper into the liquid. If its density is greater than that of the liquid, it will sink to the bottom. If an object and a liquid have exactly the same density (for example, a fish in water), the object can remain stationary anywhere in the liquid. (See Figure 1-2.)

Physical Changes That Affect Density

Changes in temperature and pressure affect the densities of substances, especially those of gases. If the temperature of a gas increases and its pressure remains the same, its molecules move farther apart (the gas expands). The temperature rise thus results in less mass per unit volume, so that the density of the gas decreases. This explains why hot air rises when surrounded by cooler air. This rising of less-dense objects and falling of more-dense objects results in the convection currents, which affect movements in many portions of Earth and help to distribute heat energy.

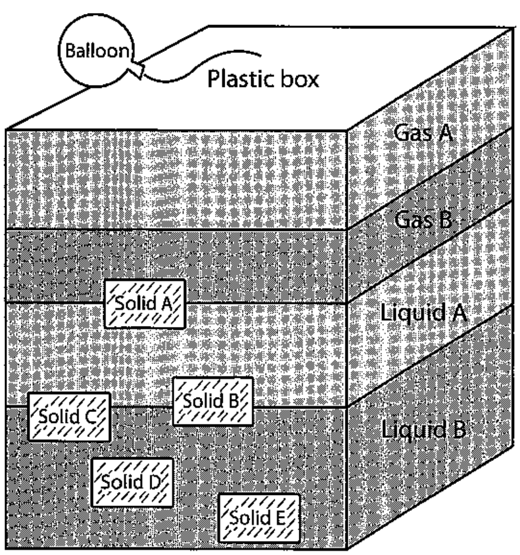


Figure 1-2. Density and height of flotation: The various substances in the plastic box are arranged by the height at which they float. Make inferences about the relative density of the substances before you continue to read. From highest to lowest, the relative densities of the substances are solid E, solid D and liquid B (about equal), solid C, solid B, liquid A, solid A, gas B, gas A, and the balloon.

If the pressure on a gas increases, the molecules come closer together (the gas contracts). The pressure rise thus results in more mass per unit volume, and the density increases. The effects of pressure on liquids and solids can be significant. This is illustrated by the increasing densities of the zones of Earth's interior illustrated in the Inferred Properties of Earth's Interior in the *Earth Science Reference Tables.* Ⓡ

Phases of Matter and Density

Matter on Earth usually exists in three forms: solid, liquid, and gas. Each form is known as a phase, or state, of matter. The density of a substance changes with changes in its phase. The layering of the outer spheres of Earth is the result of the effects of gravity pulling differently on solids, liquids, and gases due to their density differences. Almost all substances increase in density as they change from gas to liquid and from liquid to solid. They have their highest density as a solid because the atoms are closest together in that phase.

Water is an exception; its highest density is in the liquid state at a temperature of 3.98°C. Therefore, solid water (ice) floats on liquid water, while in most substances the solid sinks in the liquid. Water at 4°C will also lie below layers of water at any other temperature.

Review Questions

10. A student finds the density of an ice cube to be 0.80 g/cm^3; it is actually 0.90 g/cm^3. What is the percent deviation (percent error) in this calculation?

(1) 6 percent (3) 13 percent
(2) 11 percent (4) 88 percent

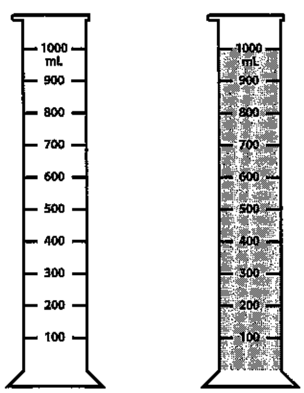
11. The amount of space a substance occupies is its

(1) mass (2) volume (3) density (4) weight

12. Under the same conditions of temperature and pressure, three different samples of the same uniform substance will have the same

(1) shape (2) density (3) mass (4) volume

13. As shown in the following diagram, an empty 1000 mL container has a mass of 250 g. When filled with a liquid, the container and the liquid have a combined mass of 1300 g.



Empty Filled
Mass = 250.0 g Mass = 1300 g

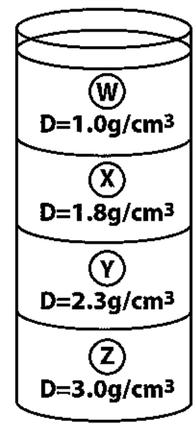
What is the density of the liquid?

(1) 1.00 g/mL (3) 1.30 g/mL
(2) 1.05 g/mL (4) 0.95 g/mL

14. An empty 250 mL beaker has a mass of 60 g. When 100 mL of oil is added to the beaker, the total mass is 140 g. The density of the oil is approximately

(1) 1.7 g/mL (3) 0.8 g/mL
(2) 1.4 g/mL (4) 0.6 g/mL

15. The diagram at the right represents a cylinder containing four liquids—W, X, Y and Z—each with a different density (D), as indicated. A piece of solid quartz having a density of 2.7 g/cm^3 is placed on the surface of liquid W. When the quartz is released, it will pass through



(1) W, but not X, Y, or Z
(2) W and X, but not Y or Z
(3) W, X, and Y, but not Z
(4) W, X, Y, and Z

16. A student mixed several different 12 mm plastic beads together by mistake. Luckily the beads had different densities. One group of beads had a density of 0.6 g/cm^3; the other beads had a density of 1.2 g/ cm^3. Describe a method the student can use to sort the beads.

17. A student has a sample of a mineral that is too big to fit in a graduated cylinder. The density of the sample is known. How can the student determine the volume of the sample?

18. Which is the best definition for the mass of an object?

(1) the amount of space the object occupies
(2) its ratio of weight to volume
(3) the quantity of matter the object contains
(4) the force of gravity acting on the object

The Changing Environment

Human observations indicate that most, if not all, environments of Earth and the rest of the universe are undergoing changes. Much of the study of earth science involves analysis of these environmental changes.

What Change Is

A change occurs when the properties or characteristics of a part of the environment have been altered. As a result, descriptions of an environment at two different times are never exactly the same in all details. The occurrence of a change in the properties of an object or a system is called an event. Events may be almost instantaneous, as in the case of lightning and meteors, or they may occur over long periods of time, as in changes in sea level or elevation of mountains.

Change can be described with respect to time and space (location). Time and space are called the frames of reference for studying change. As an example, you might say that Earth's moon changes because we observe it in different locations in the sky and in different phases at different times during a month.

Rate of Change

How much a measurable aspect of the environment, called a field, is altered over a given time—years, hours, or seconds—is the **rate of change.**

Consider the information in the data table and graph in Figure 1-3. The rate of change in temperature—the field—can be estimated by comparing the steepness (how close the plotted line is to a vertical) of the plotted line. In part A of the graph, the rate of temperature change is greater than that of part B. In part C, there is a zero rate of change, as shown by a horizontal line. More precision about rate of change can be obtained by using the following equation, which is similar to one found in the *Earth Science Reference Tables.* Ⓡ

$$\text{rate of change} = \frac{\text{change in field value}}{\text{change in time}}$$

Based on the data table in Figure 1-3, what is the rate of change in rock temperature from 2:10 to 2:13 P.M.? The amount of change in the temperature (the field value) is 40°C – 30°C, or 10°C. The amount of change in time is 2:13 P.M. – 2:10 P.M., or 3 minutes.

$$\text{rate of change} = \frac{10°\text{C}}{3\text{ min}} = 3.3°\text{C/min}$$

Time (P.M.)	Rock Temperature (°C)
2:10	30
2:11	33
2:12	38
2:13	40
2:14	41
2:15	42
2:16	43
2:17	43
2:18	43

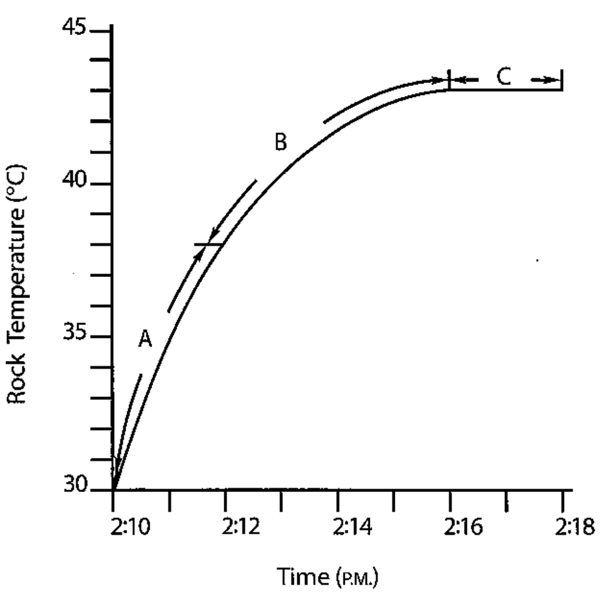


Figure 1-3. Data to be used to compute sample rate of change problems: The data represents the temperature of an area of rock that is exposed to nearby lava (liquid rock at Earth's surface) that just erupted from a volcano in Hawaii.

Cyclic Change

Many changes in the environment occur in some orderly fashion in which the events constantly repeat. Such an orderly change is called a **cyclic change.** Some cyclic changes are the movement of celestial objects (sun, moon, stars, planets), the numbers of sunspots, tides, seasonal events, and the water and rock cycles.

Prediction of Change

A **prediction** is a type of inference about the conditions and behavior of the environment in the future. Predictions can be made if the amount, type, and direction of change can be determined. For example, because eclipses are cyclic, astronomers can predict the occurrence of solar and lunar eclipses many hundreds of years into the future.

It is important in protecting against loss of life, personal injury, and loss of property that we have accurate predictions of natural hazards. A **natural hazard** is a non-human-related object, process, or situation that has the possibility of causing loss of life, personal injury, or loss of property. Natural hazards include asteroid impacts, blizzards, earthquakes, floods, hurricanes, thunderstorms, tornadoes, heat waves, tsunamis, and volcanic eruptions.

In the United States from 1975 to 1994, approximately 24,000 people died from natural disasters, and there were approximately 120,000 injuries. The loss of property in these same years was approximately $500 billion. Weather-related events accounted for approximately 80 percent of the deaths, injuries, and loss of property in this time period. Worldwide, about one in 100,000 people die each year in natural disasters. Each of these types of natural hazards will be discussed in later topics. With accurate predictions of these hazards, people can use predetermined escape routes and follow emergency action plans.

Energy, Interfaces, and Change

All change involves a flow of energy from one part of the environment (that loses energy) to another part (that gains it). For example, during an earthquake, internal Earth energy stored in rocks is released, or lost, from the rocks and converted into sound, heat, and the mechanical energy of the Earth's shaking surface. Energy is usually exchanged across an **interface**, which is the boundary between regions with different properties. In the case of an earthquake, there is an interface between the place where the rocks break and start moving and Earth's surface where the shaking occurs. Other interfaces are where Earth's atmosphere blends into outer space or at the shoreline where Long Island, New York, borders the Atlantic Ocean.

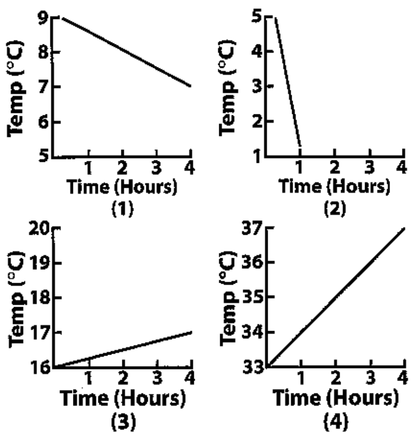
Environmental Equilibrium

Although change occurs continuously throughout the environment, certain general characteristics tend to remain constant. For example, the wooded shore of a lake tends to look the same from one day to the next. Although it may go through a cycle of seasonal changes, it tends to look the same each year at the same season. This is the result of a natural balance among all the changes taking place, called environmental equilibrium. This equilibrium is easily upset on a small scale, for example by the burrowing of a worm in the soil, but it is normally not upset on a large scale. Human activities, however, often severely disrupt the environmental equilibrium. For example, construction equipment can rapidly change a rain forest into an urban area, thus introducing change on a large scale.

Environmental equilibrium resulting from opposing forces or actions balancing out is called a **dynamic equilibrium.** An example would be the level of a lake remaining the same even though thousands of liters of water move in and out of the lake per day. Another example would be the stable amount of oxygen in the atmosphere. Billions of molecules of oxygen are moving into and out of the atmosphere each day, but the total amount stays the same. In your lifetime, the elevation of a local mountain, the amount of gravity pulling on your body in your house, or the average distance to a star in the night sky will stay about the same. When environmental equilibrium results from little noticeable change it is static equilibrium.

Review Questions

19. Which graph represents the greatest rate of temperature change?

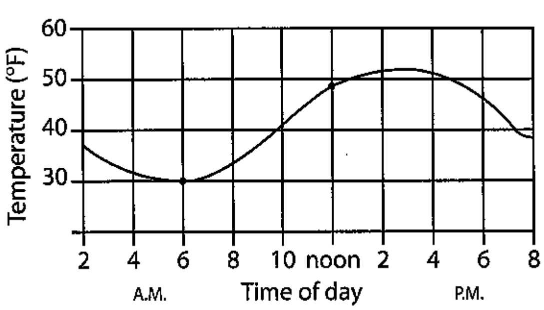


20. Refer to the following data table. At approximately what rate did the temperature rise inside the greenhouse between 8:00 A.M. and 10:00 A.M.?

Time Average	Greenhouse Temperature
6:00 A.M.	13°C
8:00 A.M.	14°C
10:00 A.M.	16°C
12:00 noon	20°C

(1) 1.0°C/hr
(2) 2.0°C/hr
(3) 0.5°C/hr
(4) 12.0°C/hr

21. The following graph shows temperature readings for a day in April.



The average rate of temperature change, in Fahrenheit degrees per hour, between 6 A.M. and noon was

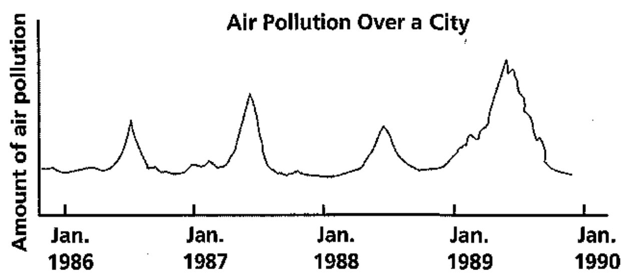
(1) 6°/hr (2) 8°/hr (3) 3°/hr (4) 18°/hr

22. Some changes that occur on Earth are cyclic—they occur over and over again at regular intervals. List two changes that occur on a regular basis and can be considered cyclic and two changes that are not cyclic.

23. Which of the following is NOT a natural hazard?

(1) blizzard
(2) flood
(3) dynamite blasting
(4) asteroid impact

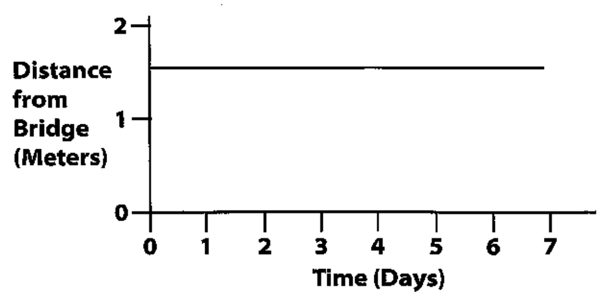
24. The following graph shows the relative amount of air pollution over a city for several years.



Which statement about air pollution over this city is best supported by the graph?

(1) It is decreasing at a constant rate.
(2) It is increasing at a constant rate.
(3) It is a cyclic event.
(4) It has no pattern.

25. A student measures the distance from a bridge to a rock every day for a week.



What is indicated by the graph of the student's data?

(1) No change in time or distance took place.
(2) As distance decreased, time increased.
(3) As distance increased, time decreased.
(4) As time increased, distance remained the same.

26. What always happens when a change occurs?

(1) Pollution is produced.
(2) The temperature of a system increases.
(3) The properties of a system are altered.
(4) Dynamic equilibrium is reached.

27. Which statement is true about the environment of most of Earth?

(1) It is usually greatly unbalanced.
(2) It is usually in equilibrium and hard to change.
(3) It is usually in equilibrium but easy to change on a small scale.
(4) It is normally heavily polluted by natural occurrences.

28. Humans can cause rapid changes in the environment that may result in catastrophic events. Which statement below is the best example of this?

(1) Concrete and brick buildings cause a city to absorb more heat than surrounding areas do.
(2) A project to straighten out a river causes flooding at a city downstream.
(3) A new housing development uses well water, causing the water table level to drop.
(4) Streetlights make it more difficult to observe stars and planets at night near a city.

Human Interaction with the Environment

Natural Resources

The materials and energy sources found in the environment that humans use in their daily lives are **natural resources**. Natural resources include the air you breathe, the water you drink, the plants and animals you use for food and clothing, and the energy from the sun. Natural resources also include fossil fuels and rock and mineral resources.

Individuals and societies are always in conflict over the ownership, supply, and use versus preservation of often-limited natural resources. There have to be trade-offs between the use of a natural resource and other uses of the land, water, or air. Often, through the use of human technology, natural resource shortages can be solved by substituting one material for another or by recycling limited resources so that "new" resources don't have to be harvested, mined, or otherwise acquired.

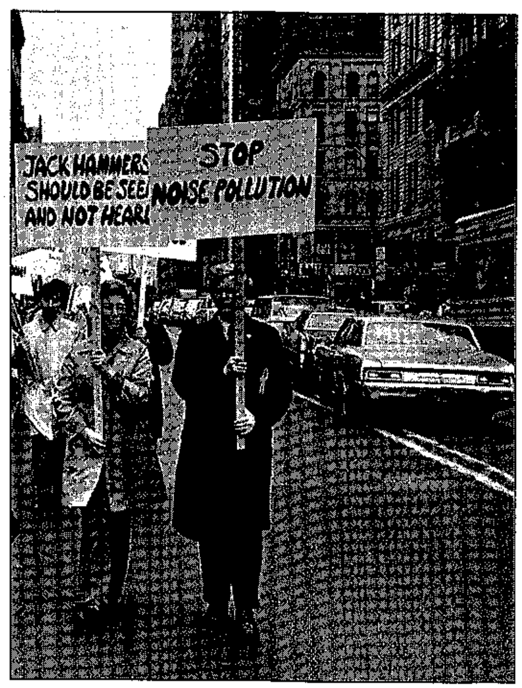


Figure 1-4. Protesting noise pollution: Not all pollution is caused by substances, some pollutants are types of energy such as sound (noise). Think of the times when loud or intrusive sounds have interfered with your life.

Pollution of the Environment

Pollution of the environment occurs when the concentration of any substance or form of energy reaches a proportion that adversely affects people or their property, or other life forms. The key word in defining a polluted situation is concentration. Think of sodium chloride (NaCl), rock salt, which is essential to life. If the concentration of salt in an organism's body is too high, it can cause injury or death.

Causes of Pollution Many forms of pollution are the result of technology, which often produces and distributes harmful concentrations of substances and forms of energy. Other forms of pollution are the result of natural events or processes and would occur without the presence of people.
High concentrations of pollen in the air, volcanic ash and gases from volcanic eruptions, and X-rays from uranium and radon in rocks and soil are examples of natural pollution. Substances and forms of energy that pollute—pollutants—include solids, liquids, gases, biologic organisms, and forms of energy such as

heat, sound, visible light, and nuclear radiation. Generally, the more urban an environment and the more industrial the processes, the higher the pollutant levels.

Review Questions

29. Which of the following statements is an example of a way of conserving our natural resources?

(1) opening new mines for valuable metals that are running out
(2) using well water in desert areas for growing crops and building golf courses
(3) finding alternate sources and materials to replace natural petroleum products
(4) building industrial plants in national parks where they are away from populated areas

30. When organisms, sound, and radiation added to the environment reach a level that harms people, these factors are referred to as environmental

(1) interfaces
(2) pollutants
(3) phase changes
(4) equilibrium exchanges

31. List three substances or forms of energy that are common natural (NOT caused by humans) pollutants.

32. Which energy source is LEAST likely to pollute the environment?

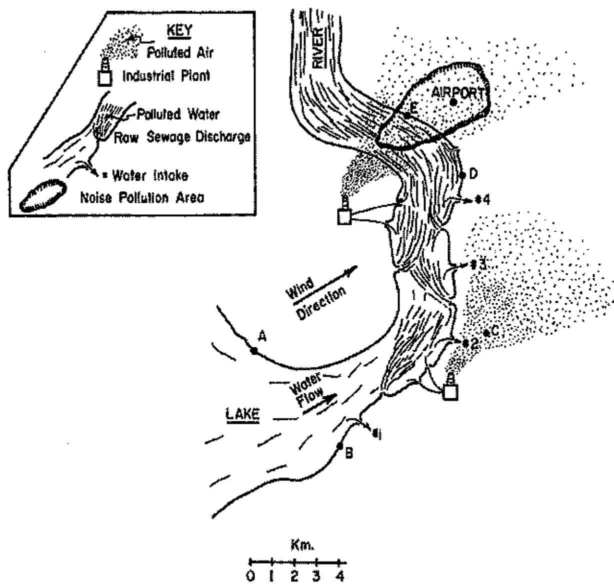
(1) solar
(2) petroleum
(3) coal
(4) wood

33. Which type of human environment usually has the highest pollution levels?

34. A major argument against the construction of nuclear-powered electric generation stations is the claim that they pollute bodies of water by discharging large quantities of

(1) noise
(2) carbon dioxide
(3) heat
(4) ozone

Base your answers to questions 35 through 39 on the diagram below, which shows, air, water, and noise pollution in a densely populated industrial area.



35. Air pollution would probably be greatest at which location?

(1) *A* (2) *B* (3) *C* (4) *D*

36. Water pollution would probably be greatest at which location?

(1) *A* (2) *B* (3) *C* (4) *D*

37. Noise pollution would be greatest at which location?

(1) *B* (2) *C* (3) *D* (4) *E*

38. Which location is subjected to the greatest number of pollution factors?

(1) *A* (2) *B* (3) *D* (4) *E*

39. If the water intakes supplied drinking water to the area, which intake would most likely require the most extensive purification procedures?

(1) 1 (2) 2 (3) 3 (4) 4

Practice Questions 1

Directions

Review the Test-Taking Strategies section of this book. Then answer the following questions. Read each question carefully and answer with a correct choice or response.

Part A

Base your answers to questions 1 through 4 on the graph below, which shows the masses and volumes of four Earth materials.

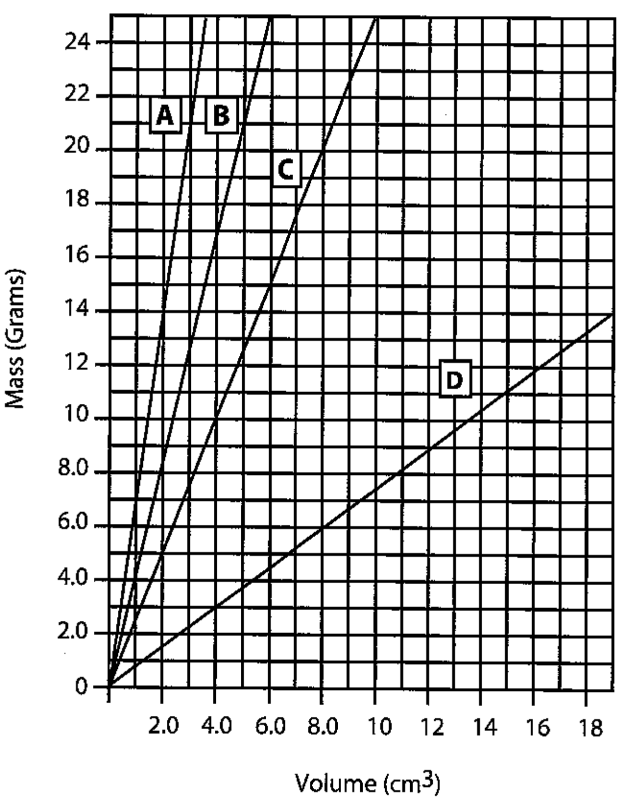
1 Which material has the greatest density?
(1) A (2) B (3) C (4) D

2 If the density of water is 1 g/cm^3, which material will float in water?
(1) A (2) B (3) C (4) D

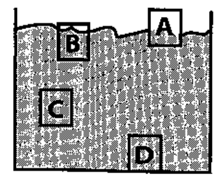
3 If the volume of sample C is 3.0 cm^3, what is its mass?
(1) 7.5 g (2) 2.1 g (3) 3.0 g (4) 21 g

4 Which material has a density of about 4.0 g/cm^3?
(1) A (2) B (3) C (4) D

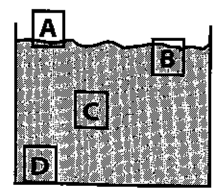
Masses and Volumes of Earth Materials



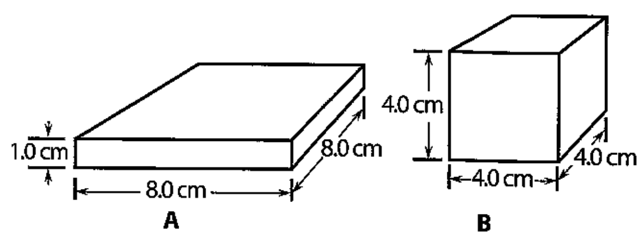
5 Substances A, B, C, and D are at rest in a container of liquid as shown by the following diagram. Which choice lists the substances in order of lowest to highest density?
(1) A, B, C, D
(2) A, D, C, B
(3) D, C, B, A
(4) C, B, A, D



6 Substances A, B, C, and D are at rest in a container of liquid as shown in the following diagram. Which substance probably has a density closest to that of the liquid?
(1) A
(2) B
(3) C
(4) D

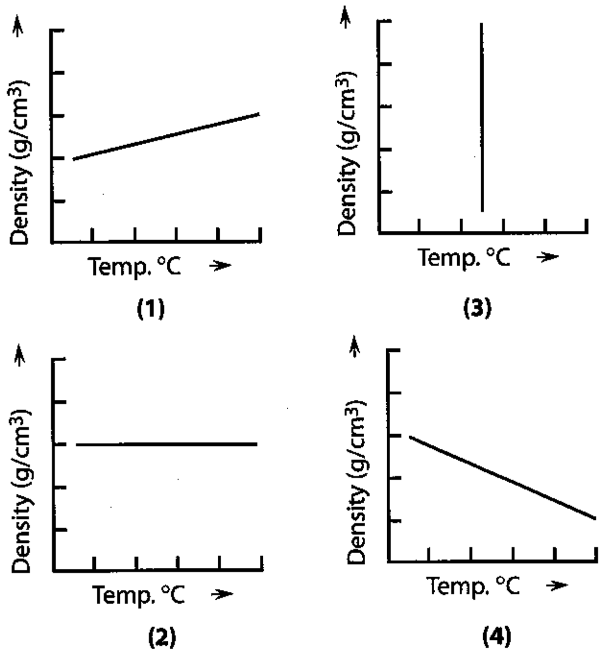


Base your answers to questions 7 through 11 on the following diagrams. Objects A and B are solid and made of the same uniform material.



7 If object B has a mass of 173 g, what is its density?
(1) 0.37 g/cm^3
(2) 2.7 g/cm^3
(3) 3.7 g/cm^3
(4) 5.7 g/cm^3

8 Object A expands when it is heated. Which graph best represents the relationship between the temperature and the density of object A?



9 A student measures the mass of object B as 156 g, but the actual mass is 173 g. What is the student's approximate percent deviation (percentage of error)?

(1) 1 percent
(2) 5 percent
(3) 10 percent
(4) 20 percent

10 A third object is made of the same uniform material as object B, but it has twice the volume of object B. How does the density of this third object compare to the density of object B?

(1) It is one-half as dense as B.
(2) It has approximately the same density as B.
(3) It is twice as dense as B.
(4) It is four times as dense as B.

11 How does the mass of object B compare to the mass of object A?

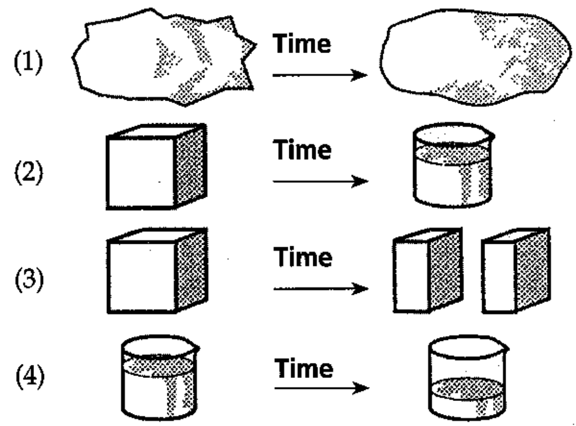
(1) The mass of B is less than the mass of A.
(2) The mass of B is greater than the mass of A.
(3) The mass of B is the same as the mass of A.

---

12 If pressure is applied to a rock until its volume is reduced by one half, how does its new density compare to its original density?

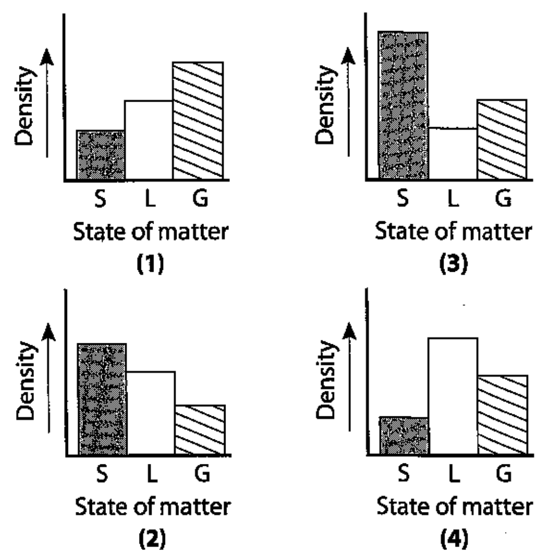
(1) It is half its original density.
(2) It is twice its original density.
(3) It is the same as its original density.
(4) It is one-third its original density.

13 The following diagrams show physical changes in four materials over time. The chemical composition of each material remains the same. Which material most likely changed in density?



14 Which graph best represents for most Earth materials, excluding water, the relationship between the density of a substance and its state of matter (phase)?

[Key: S = solid, L = liquid, G = gas]



15 After the mass of a mineral was measured, the mineral sample was dropped and a piece chipped off the sample before the volume of the sample was measured. How would the calculated value of the sample's density compare to the value of the density of the sample if it had not been chipped?

(1) The calculated density value would be greater (without the chipping).
(2) The calculated density value would be less (without the chipping).
(3) The calculated density value would be the same (without the chipping).

16 A prediction of next winter's weather is an example of
(1) a measurement (3) an observation
(2) a classification (4) an inference

17 The rising and setting of the sun are examples of
(1) noncyclic events (3) predictable changes
(2) unrelated events (4) random motion

18 Future changes in the environment can best be predicted from data that are
(1) highly variable and collected over short periods of time
(2) highly variable and collected over long periods of time
(3) cyclic and collected over short periods of time
(4) cyclic and collected over long periods of time

19 An interface can best be described as
(1) a zone of contact between different substances across which energy is exchanged
(2) a region in the environment with unchanging properties
(3) a process that results in changes in the environment
(4) a region beneath the surface of Earth where change is not occurring

20 Which condition exists when the rates of water flowing into and out of a lake are balanced so that the lake's depth appears to be constant?
(1) dynamic equilibrium (3) precipitation
(2) transpiration (4) saturation

Part B

21 Three students tried to guess Joe's weight. They guessed 140 lb, 150 lb, and 160 lb. If Joe really weighed 146 lb, calculate each person's percent deviation. [5]

22 The springs and geysers in Yellowstone National Park contain enough heat energy to provide for the annual electric needs of New York City. Why is this energy not being used?
(1) Energy from hot water is not easy to convert to electricity.
(2) No electric transmission lines connect Yellowstone National Park with the rest of the United States.
(3) It has been decided to protect the natural environment of Yellowstone National Park.
(4) Using the geyser and spring water would cause a drought in the Yellowstone National Park region.

23 A student placed a 20-cm plastic foam ball and a 5-cm piece of sandstone in a container of water. The sandstone sank and the ball floated. Propose a reason why the larger object floated and the smaller object sank. [1]

Base your answers to questions 24 through 28 on the following data table. The table shows the mass of three liquids—A, B, and C—each of which has a volume of 500 mL.

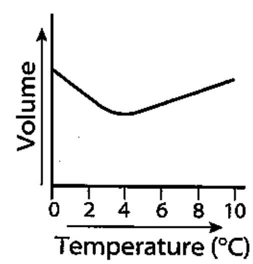
Liquid	Volume (mL)	Mass (g)
A	500	400
B	500	500
C	500	600

24 What is the density of liquid A? [1]

25 If half of liquid B is removed from its container, what will the density of the remaining liquid be in relationship to the original density? [1]

26 The accepted mass for liquid C is 600 g, but a student measures the mass as 612 g. What is the percent deviation (percent of error) of the student's measurement? [1]

27 The following graph shows the volume of liquid B as the temperature changes from 0°C to 10°C. According to the graph, at what temperature is the density of liquid B the greatest? [1]

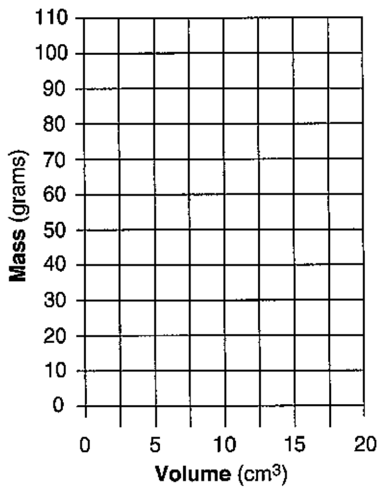


28 Liquid A is NOT water. Some of liquid A is frozen into a solid block and placed in a container of liquid A. What will probably happen to the location of the solid block in relationship to the liquid? [1]

29 Mount St. Helens erupted in 1980, depositing volcanic ash over much of the countryside. Why is it important for scientists to try to predict volcanic eruptions? [1]

Base your answers to questions 30 and 31 on the data table below, which shows the volume and mass of three different samples, *A*, *B*, and *C*, of the mineral pyrite.

Pyrite		
Sample	Volume (cm^3)	Mass (g)
A	2.5	12.5
B	6.0	30.0
C	20.0	100.0



30 On the grid provided above, plot the data (volume and mass) for the three samples of pyrite and connect the points with a line. [2]

31 State the mass of a 10.0-cm^3 sample of pyrite. [1]

Part C

The following fictional article describes an oil spill that resulted from an earthquake in Saudi Arabia. Use your knowledge of earth science and the information in the article to answer questions 32 through 36.

An earthquake in Saudi Arabia caused a break in an oil pipeline that connected oil wells to shipping facilities in the Persian Gulf. A total of 120,000 gallons of crude oil (density 0.86 g/cm^3) spilled onto the desert soil. At first it was thought that 50,000 gallons eventually flowed into a reservoir that supplies drinking water to several communities. Later it was learned that only 35,000 gallons had flowed into the reservoir.

The cleanup crews removed the crude oil from the reservoir in a little over a week. It took much longer to remove the crude oil from the sandy desert soil. After two weeks of continuous effort, only 5000 gallons of oil had been removed. This area of the desert is irrigated and used for growing crops, most of which were killed by the crude oil. It is not yet known if all the oil can be removed from the soil and if crops will grow in the region again.

32 Which physical property of the crude oil allowed it to be easily cleaned up from the water reservoir? [1]

33 Why is the earthquake in the article considered to be a natural disaster? [1]

34 Calculate the percent deviation of the first estimate of the amount of crude oil in the reservoir compared to the actual amount. Be sure to show ALL work including writing the equation, substituting values, and indicating the answer. [2]

35 What was the rate of crude oil recovery from the soil in gallons per day for the two-week period described in the article? Be sure to show ALL work including writing the equation, substituting values, and indicating the answer. [2]

36 Explain why the crude oil in the soil would be considered pollution. Be sure to use the term *concentration* in your answer. [1]

---

37 A hurricane traveled 2,600 kilometers during a 4-day period. Calculate the average rate of daily movement of a hurricane following the directions below.

(a) Write the equation used to determine the rate of change.

(b) Substitute data into the equation. [1]

(c) Calculate the rate and label it with the proper units. [1]

38 The students decided to measure the speed of the stream by floating apples down a straight section of the stream. Describe the steps the students must take to determine the stream's surface rate of movement (speed) by using a stopwatch, a 10-foot rope, and several apples. Include the equation for calculating rate. [3]