CHAPTER 6

History and Nature of Science

> Science investigates; religion interprets. Science gives man knowledge, which is power; religion gives man wisdom, which is control.
>
> ~ Martin Luther King, Jr.

Science as a Human Endeavor

Characteristics of Scientists

How do scientists differ from the rest of us? This is an interesting question. The answer may be that scientists simply spend more time doing science than most people. That fact is certainly true. But do scientists have interests that differ very much from most people's interests?

Here are some characteristics of scientists:

- Scientists tend to be curious about the world.
- Some scientists prefer to work alone. Others prefer to work with other people, sometimes in groups of several hundred people.
- Scientists take pride in their work.
- Scientists like to tell other people about their work.
- Scientists are influenced by their own personal beliefs, values, and religion.
- The work of scientists is often influenced by the needs of society.
- The work of scientists is often limited by a lack of funding (money).

Do these characteristics sound familiar? If so, you may be more of a scientist than you think! Do you wonder why the sky is blue, why birds sing, or what walking on the Moon feels like? Do you think of yourself as an idea person or as an inventor? If you answer yes to any of these questions, you are thinking like a scientist. Remember, being a scientist does not mean you must do science for a living. Plenty of people consider science as a hobby instead of a career.

Science is truly a human endeavor. Science involves people like you: people who ask questions; people who want to know. The following statements were made by renowned scientists regarding their desire to know more about the natural world:

> I can live with doubt and uncertainty. I think it's much more interesting to live not knowing than to have answers that might be wrong.
>
> ~ Richard Feynman (1918–1988), Recipient of the 1965 Nobel Prize in physics

> My goal is simple. It is a complete understanding of the universe, why it is as it is and why it exists at all.
>
> ~ Stephen Hawking (1942–), British theoretical physicist and mathematician

> The world of learning is so broad, and the human soul is so limited in power! We reach forth and strain every nerve, but we seize only a bit of the curtain that hides the infinite from us.
>
> ~ Maria Mitchell (1818–1889), American astronomer

The Hopes and Dreams of Scientists

Over the centuries, scientists have had very high hopes for science. But the search for knowledge has often ended sadly, with the discoveries of science being used for destructive purposes. Over the years, many scientists have spoken directly of both their hopes for and their disappointments regarding science.

> Science is triumphant with far-reaching success, but its triumph is somehow clouded by growing difficulties in providing for the simple necessities of human life on Earth.
>
> ~ Barry Commoner (1917–), American biologist, ecologist, and educator

> Why does this magnificent applied science, which saves work and makes life easier, bring us so little happiness? The simple answer runs: Because we have not yet learned to make sensible use of it.
>
> ~ Albert Einstein (1879–1955), German-born American physicist and Nobel prize-winner

In recent times, modern science has developed to give mankind, for the first time in the history of the human race, a way of securing a more abundant life, which does not simply consist in taking away from someone else.

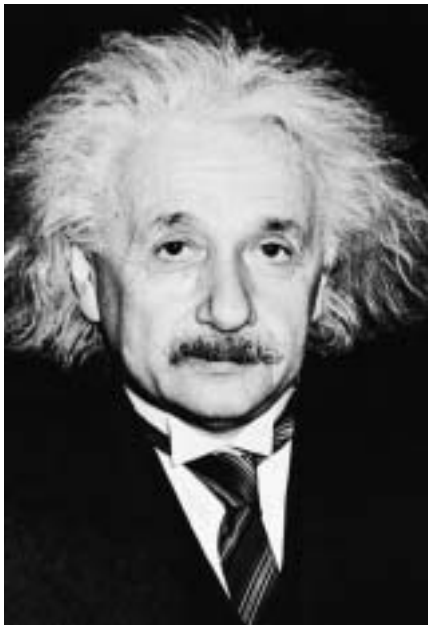
~ Karl Taylor Compton (1887–1954), American physicist

Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world. Science is the highest personification of a nation because that nation will remain the first which carries further the works of thought and intelligence.

~ Louis Pasteur (1822–1895), French chemist, biologist, and founder of microbiology

Perhaps the hope of all scientists for a better future is best expressed in the words of Dimitry Mendeleyev (1834–1907), a Russian chemist, who said:

There will come a time, when the world will be filled with one science, one truth, one industry, one brotherhood, one friendship with nature. . . . This is my belief.



Albert Einstein

Louis Pasteur

Dimitry Mendeleyev

Thinking About Science

Directions: Look at the following cartoon and answer each question below.

1. What point do you think the cartoonist is trying to make about modern conveniences provided by advances in science and technology?

_____

_____

2. Name two modern consumer products that you wish had not been invented. Give a brief reason why you do not like these products

_____

_____

_____

GED PRACTICE

Directions: Choose the one best answer to each question.

Questions 1–3 refer to the information on pages 139–141.

1. Which of the following words or phrases does not describe the personality of a good scientist?

(1) curious
(2) proud of his or her work
(3) willing to share ideas
(4) secretive
(5) honest

2. Which of the following types of scientific research is a result of the sad reality of modern life?

(1) medical research
(2) research on the intelligence of apes
(3) weapons research
(4) research on physical activity
(5) research on nutrition

3. What is one thing scientists have very little control over?

(1) the number of hours they work
(2) the type of work they do
(3) how they choose to share information with other scientists
(4) how they report scientific discoveries to the general public
(5) how scientific discoveries are used by society

Questions 4 and 5 refer to the following warning label.

SURGEON GENERAL'S WARNING:

Quitting Smoking Now Greatly Reduces Serious Risks to Your Health

4. A scientist supports placing this warning label on all tobacco products. What concern is this scientist responding to?

(1) house fire danger
(2) restrictions on personal freedom
(3) level of government taxation
(4) tobacco company profits
(5) community health

5. A scientist claims that there is no medical evidence to support this label. Which concern probably plays no role in this scientist's thinking?

(1) scientific accuracy
(2) job security
(3) tobacco company profits
(4) tobacco company image
(5) maintaining a variety of popular tobacco brands

Answers are on page 441.

Historical Perspectives

The Science of Primitive People

As used here, primitive people are those who lived between 100,000 years ago and about 5,000 years ago. These are people who did not leave a written record of their lives or thoughts. What we know about how primitive people interpreted the world comes from cave drawings and legends that passed from generation to generation.

Most likely, primitive people questioned their world much as we question ours. They are likely to have answered those questions in ways that were meaningful to them, much as we do today. The difference between their interpretation of the world and ours is this: primitive people most likely formed beliefs based on a range of emotions rather than on a detailed study of the natural world. Some of those beliefs are listed below:

- The belief that spirits or souls were the givers and maintainers of life
- The belief that fire had a religious importance and may have been a divine gift
- The belief that demons caused natural disasters, such as violent storms, forest fires, earthquakes, and volcanic eruptions
- The belief that evil spirits caused disease

Primitive people did not separate the properties of the world from the personalities of spiritual beings. In this way of thinking, causes and effects were simply a demonstration of the will of spiritual beings.

As you can see, the science of primitive people was very unlike our science today. While primitive people may have feared or worshipped a full moon, we flew to that moon, walked on it, and brought part of it to Earth.

The Science of Aristotle

Between 600–200 B.C., the country of Greece rose as the center of learning of Western civilization. One of the great thinkers of this period was Aristotle (384–322 B.C.), whose science dominated Western thinking for 1,800 years, until the beginning of the Renaissance in the fourteenth century.

Aristotle helped organize an accumulating body of observations. He believed these observations held the key to understanding the processes of Earth and its life forms. Aristotle believed in cause and effect. He believed that to understand an effect you must first understand its causes and the purposes of those causes. With this belief as a starting point, Aristotle proposed the following scientific theories:

- The world is composed of individuals occurring in a fixed number.
- Each individual grows according to a pattern.
- Each individual seeks self-realization (maturity) as a goal.
- Earth is the center of the universe.

- All things are made of the same four elements: earth, air, fire, and water.
- Life forms do not change over time. (Evolution does not occur.)
- All thinking and all knowledge come from experience.
- All motion of objects on Earth is in a straight line. Objects in motion move downward, toward the center of Earth. The purpose of their movement is to go to their natural resting place.
- Fire moves upward, toward its natural resting place in heaven.
- The heavens move in a circle around Earth.

Unlike the science of primitive people, the science of Aristotle was based on a detailed study of the natural world. Aristotle did not turn to spiritual beings to account for all things that happen. Instead, he tried to logically connect those things that he saw. The science of Aristotle is truly the infant of modern science today.

The Science of the Renaissance

The Renaissance is a period of great intellectual growth and achievement that began in the fourteenth century and extended into the seventeenth century. Between the time of Aristotle and the beginning of the Renaissance, little progress was made in scientific thinking. This was soon to change. The Renaissance brought with it a spirit of curiosity and experimentation unseen since the time of Aristotle.

One of the first great achievements of the Renaissance was to move away from the idea that the universe centers on human beings. In the Renaissance way of thinking, humans were part of a universe that included Earth.

A second important change in thinking also occurred. Renaissance scientists rejected the idea that there was a hidden purpose behind everything. A rock didn't fall to the ground to move toward its natural resting place. A rock fell to the ground because of gravity. People of the Renaissance understood that gravity is a property of matter, that it is a force between two objects. Today, we can measure the effects of gravity, and we can make predictions based on our discoveries. But for the people of the Renaissance to realize that Earth and its life forms have properties that can be studied and understood is arguably the single greatest achievement of the Renaissance.

The following are a few important discoveries from the Renaissance that totally changed the way scientists viewed the world:

- Andreas Vesalius (1514–1564), a Belgian doctor, did detailed studies of the human body by cutting open corpses. His work corrected misconceptions that had prevailed since the time of Aristotle. The work of Vesalius began the modern study of anatomy.
- Christopher Columbus (1451–1506), an Italian sailor for Spain, made use of inventions and discoveries about navigation and sailed west from Spain on a quest to sail to Asia. Columbus paved the way for navigators to discover that Earth is not flat.

- Johannes Gutenberg (1390–1468), a German printer, is credited with inventing the first movable-type printing press in 1450. Movable type led to printed books and the spreading of knowledge.
- Nicolaus Copernicus (1473–1543), a Polish astronomer, proposed that the Sun is at the center of the universe and that Earth rotates once daily on its axis. (This was a revolutionary idea at that time. Today we know that the Sun is at the center of our solar system, not the center of the universe.)
- Galileo Galilei (1564–1642), an Italian physicist and astronomer, first pointed a telescope toward the heavens and made many remarkable discoveries: mountains and valleys on the Moon, dark spots on the Sun, and moons circling the planet Jupiter.
- Leonardo da Vinci (1452–1519), an Italian artist and scientist, did studies in optics, anatomy, and hydraulics that led to modern studies in each of these fields. He invented an underwater diving suit and drew pictures of "flying devices," anticipating the later invention of airplanes.

The work of Renaissance scientists paved the way for the discoveries and inventions that followed. The Renaissance, as its name means, was a rebirth, a revival of the human intellect.

The Science of Today

Between the Renaissance and today, science has come an incredible distance. Along with discoveries and inventions has come the scientific method. One main feature of the scientific method is the following: scientists attempt to look at the natural world objectively. This means that scientists try to see things as they are, without letting values or beliefs cloud their view. This is quite unlike the science of primitive people and even the science of the Renaissance.

Scientific knowledge today is based on explanations that are affirmed by experiments. The goal of science is to answer questions about our world by creating the best possible explanation that agrees with experimental results.

For an explanation to be considered scientific, the explanation must fulfill the following requirements:

- Be logically consistent with known facts
- Be capable of being confirmed by experiment and observation
- Be a basis from which accurate predictions can be made
- Be open to criticism and revision as more information becomes available

To make findings available to others, scientists report all experimental results and the procedures used to acquire those results. In this way, other scientists can redo experiments to see if they get the same results. Scientists often check the work of other scientists in this way.

The Role of Personal Beliefs

From the time of primitive people to the present, personal beliefs, particularly religious beliefs, have played a role in science. When science was in its infancy, scientific discoveries often were in disagreement with religious teachings. When that happened, religious beliefs were usually considered correct and further scientific inquiry was stopped.

Today, science and religion have come a long way from those earlier times. Now the questions of science do not overlap questions of faith.

- Science deals with questions of the natural world, questions for which experiments can be performed. For example, "Is there life on Mars?"
- Faith deals primarily with questions of values, questions for which science cannot give answers. For example, "Should we do medical experiments on chimpanzees?"

As we begin the twenty-first century, we need to realize that the most difficult questions ahead of us will be questions of values, not science. Each of us must accept a personal challenge and ask ourselves, "What do I want the human race to become as a species?" Science will give us many possible choices, but it will not provide an answer to this question.

Thinking About Science

Directions: Write the name of the scientific philosophy or philosophies (primitive, Aristotelian, Renaissance, or modern) that developed each concept listed below.

_____ **1.** Earth is the center of the universe.

_____ **2.** Explanations must be backed up by experimental results.

_____ **3.** Fire and all other natural elements are gifts of the gods.

_____ **4.** Planets are circled by smaller bodies called moons.

_____ **5.** Every living thing is a combination of earth, air, fire, and water.

Answers are on page 441.

GED PRACTICE

Directions: Choose the one best answer to each question.

Questions 1 and 2 refer to the information on pages 145–147.

1. Seen from Earth, what is the main difference most likely noticed by early observers of the Moon and the Sun?

(1) The Sun looks much larger than the full Moon.
(2) The Sun is not the same color as the bright part of the Moon.
(3) The Sun is at a greater distance from Earth than is the Moon.
(4) The Sun has a higher temperature than the Moon has.
(5) The Moon goes through phases while the Sun does not.

2. Before the rise of modern science, what was the main objection to the idea that Earth is not the center of the universe?

(1) an objection based on scientific theory
(2) an objection based on economics
(3) an objection based on a poll of voters
(4) an objection based on religion
(5) an objection based on evidence

Questions 3–5 refer to the following passage.

Thales, a sixth century B.C. Greek philosopher, is often given credit as being the father of scientific thought. Thales taught that water is the original principle of all things. Thales said that everything comes from water and everything returns to water.

Before the time of Thales, explanations of the universe were based on myths. Thales was the first philosopher who based explanations on physical properties of Earth that were observable.

3. What feature of Thales's approach to science became a major part of the modern scientific method ?

(1) the importance of mathematics
(2) the importance of patience
(3) the importance of sharing ideas
(4) the importance of reproducibility
(5) the importance of observation

4. Which of the following is the least likely reason that Thales chose water as the original principle?

(1) Deep water appears blue, like the sky.
(2) Water quenches human thirst.
(3) Water is needed to grow crops.
(4) Water is involved in childbirth.
(5) Water can be used to both cool a fever and warm a chilled person.

5. Which additional fact, unknown to Thales, could he have used to support his theory that water is the original principle?

(1) Mountains and valleys are found along the ocean floor.
(2) Fresh water can be formed by evaporating ocean water.
(3) Many ocean fish cannot live in fresh water.
(4) Between 50 and 90 percent of the weight of all living organisms is water.
(5) The boiling temperature of water decreases as altitude increases.

Answers are on page 441.

Milestones in Modern Science

Scientific understanding usually proceeds in little bits and pieces, much like a huge jigsaw puzzle being put together. Yet, every once in a while, an idea occurs or a discovery is made that gives us a huge jump in our understanding. Many such milestones in science have occurred during the last two hundred years. Here we will briefly mention a few of these major discoveries. You will learn more about them in the remaining chapters of this book.

Evolution of Earth

For most of recorded history, Earth was believed to be the center of the universe, perfect in its creation and unchanging.

Modern science changed that view. Earth is now understood to be just one of many similar planets circling one of hundreds of billions of stars. Earth is not the center of anything; Earth is not perfect; and Earth is not unchanging. Earth is a cooling ball of fiery liquid that once looked similar to the Sun.

Not far below Earth's surface is an ocean of hot metal. Floating on this liquid core are tectonic plates—individual pieces of land that make up Earth's surface. Volcanoes are points where this fiery liquid gushes up through the surface of the tectonic plates. Earthquakes result when the tectonic plates rub against each other.

The movement of tectonic plates constantly changes the features of Earth's surface. At one time, 100 million years ago or so, all the continents likely sat side by side and formed a single large landmass.

Evolution of Species

The publication in 1859 of the book *On the Origin of Species by Means of Natural Selection* by Charles Darwin was truly a turning point in scientific understanding. This book is often called "the book that shook the world."

Charles Darwin proposed a theory that stands today as a central principle in life science. Darwin proposed that species, or particular types of life forms, evolve, or change over time. Each species undergoes slight variations that can be passed on to offspring. Furthermore, Darwin said that all similar organisms that exist today may have descended from a common ancestor.

Darwin suggested that humans today may not look like humans did thousands of years ago. He also suggested that humans and monkeys may have evolved from a common ancestor. Both of these ideas shocked his readers, especially religious leaders. Such a theory, they argued, would rob human beings of their special place in the story of creation. In Darwin's theory, humans are just one of many animals in a constant struggle for survival.

Even scientists had trouble accepting Darwin's theory. The scientists of his day did not see how variations could occur in any species. And, even if variations did occur, there was no way for a variation to be passed to offspring. These scientific objections to Darwin's theory were answered and supported by the theory of genetics a few years later.

Structure of Matter

For thousands of years, people have wondered about the structure of matter. Often, the following question, or one like it, would be asked:

> Suppose you take a piece of gold and divide it into smaller and smaller pieces. What does the smallest possible piece of gold look like?

Experiments performed in the nineteenth and twentieth centuries finally answered this question. Scientists discovered that all matter, including all life forms, is made of about one hundred different elements. Some substances, such as gold, are made of a single element. Other substances, such as water, are made of more than one element. Water is made of two elements: hydrogen and oxygen.

The smallest piece of an element that has properties of that element is an atom. An atom is very, very small. It would take many billions of atoms placed side by side to cross this page. The smallest possible piece of gold is a single gold atom. The smallest piece of water is a single water molecule. A water molecule contains two hydrogen atoms and one oxygen atom. If a water molecule were broken down into the two elements that make it up, the water molecule would disappear. In its place would be separated hydrogen and oxygen atoms.

Living organisms are made of the same elements that make up Earth itself. A living organism is mainly made of three elements: hydrogen, oxygen, and carbon.

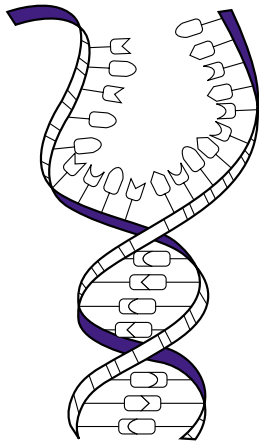
The Molecular Basis of Heredity

Following the publication of Darwin's theory came increased interest in biological inheritance. How are physical, biochemical, and behavioral traits passed from parent to offspring? Furthermore, how do individual cells of an organism know what to be?

While earlier scientists discovered the basic laws of heredity, the molecular structure of genes and chromosomes was not discovered until the early 1950s. According to the laws of heredity, every organism has a set of coded instructions. These instructions can be passed to offspring. A newborn whale's set of instructions, for example, contains a code that causes the whale to look like its parents. The code also tells the whale how to swim at the moment of birth. The whale isn't taught to swim. The whale's coded instructions make swimming part of its nature.

A complete set of coded instructions is in every cell of every organism. These instructions are contained in special molecules called DNA, or deoxyribonucleic acid. Each cell in an organism has the same DNA found in each other cell. A human skin cell contains a complete set of instructions for that person. So does a heart cell, a blood cell, and a muscle cell. Instructions in an individual cell also tell the cell its function.

DNA



DNA is a molecule organized in a double helix shape. When a cell divides, its DNA splits into two parts, each part then forming a new DNA molecule that is identical to the original.

Organisms differ from other organisms because of chemical and structural differences in DNA. Human DNA is different from frog DNA and from monkey DNA. However, human DNA is more closely related to monkey DNA than to frog DNA.

Physical or behavioral variations in an organism are due to mutations, or changes, occurring in the DNA contained in a reproductive cell. A variation in this DNA can be passed along to offspring.

The theory of the molecular basis of heredity explains how both physical characteristics and behavior patterns are inherited. Also, an understanding of DNA is giving scientists a better understanding of how cells work. This understanding is showing great promise in the fight against inherited diseases such as sickle-cell anemia.

Thinking About Science

Directions: Briefly describe what is meant by each phrase below.

1. evolution of Earth: _____

2. evolution of species: _____

3. atomic theory of matter: _____

4. molecular basis of heredity: _____

Answers are on page 441.

GED PRACTICE

Directions: Choose the one best answer to each question.

Question 1 refers to the following passage.

Before Darwin published his theory of evolution, Jean Lamarck, a French biologist, proposed a different theory on how species evolved. According to Lamarck, an individual organism could acquire certain traits by its own efforts. Lamarck believed that these traits would then be inherited by all of the organism's future offspring.

Lamarck's most famous example was a giraffe. He claimed that giraffes once had short legs and short necks. But then, as they strained to reach leaves high in trees, giraffes stretched their necks and legs a little bit at a time. In this way the bodies of giraffes changed shape. When each "stretched" giraffe reproduced, its offspring were born with long necks and long legs!

Scientists today do not accept Lamarck's theory. Although organisms can adapt their own bodies to their environment, they cannot pass these changes to offspring.

1. According to Lamarck, which of the following factors most influenced a change in shape in giraffes?

(1) a lack of natural predators
(2) an abundance of vegetation close to the ground
(3) the great depth of rivers during frequent floods
(4) a lack of vegetation close to the ground
(5) the need to be larger than natural predators

2. Which example supports Lamarck's theory but would not be considered an inherited trait by modern geneticists?

(1) a tree frog passed on its green color to its offspring
(2) a sheep passed on its thick wool to its offspring
(3) a mother dyed her brown hair red and passed this trait onto her child
(4) a bird passed on its ability to fly to its offspring
(5) a polar bear passed on its white fur to its offspring

Answers are on page 441.

GED PRACTICE

History and Nature of Science Review

Directions: Choose the one best answer to each question.

Questions 1 and 2 refer to the following passage.

Before Darwin published his theory of evolution, most scientists believed that Earth had experienced several separate creations of animal and plant life. Each creation followed a sudden catastrophe that destroyed much or all life on Earth. Many scientists believed that the most recent catastrophe was Noah's flood, spoken of in the Christian Bible. In the view of scientists who believed the *catastrophe theory of species change*, species were created individually. Then, once created, a species did not change.

According to the catastrophe theory, fossils are the only reminder of any species that is now extinct.

1. Which idea would be rejected by scientists who believed the catastrophe theory of species change?

(1) Natural catastrophes can eliminate many species from Earth.
(2) A worldwide flood could be a major natural catastrophe.
(3) Fossils are traces of organisms that may now be extinct.
(4) Living species do not change characteristics over time.
(5) Living species are related to species that are now extinct.

2. In the biblical story, Noah takes a certain number of species on a boat (ark) to protect them from the flood. According to the catastrophe theory, what happened to the species on Noah's ark?

(1) Each species evolved into a new species.
(2) Their descendants are unchanged today.
(3) Their descendants live only on islands.
(4) Their descendants live only in the ocean.
(5) Each species became extinct.

Questions 3 and 4 refer to the following passage.

Following publication of Darwin's theory of evolution, a search took place for a fossil that could prove the existence of an evolutionary ancestor of both humans and apes. No one knew if this ancestor, called the *missing link*, even existed.

Then, in 1912 near Piltdown, England, an ape-like fossil was found that seemed to confirm the existence of the missing link. The scientific community was astounded. Charles Dawson, an amateur naturalist gained instant fame from his discovery.

It wasn't until 1953 that Piltdown man, as the fossil came to be known, was proved to be a fake. Dating techniques, which only became available in 1953, showed the skull bones to be only several hundred years old rather than the million or more years that a genuine missing-link fossil would be.

The fossil was made of the cranium of a human and the jaw of an ape. The pieces of skull had been stained and sanded to give them a very aged appearance.

3. What is meant by the words *missing link*?

(1) an ape's skull with human features
(2) a common ancestor of all apes
(3) a common ancestor of humans and apes
(4) a fossil of a human that is more than one million years old
(5) a fossil of a human that is older than any known fossil of an ape

4. For what reason did the Piltdown man hoax go undiscovered for many years?

(1) inadequate dating techniques
(2) lack of confirming evidence
(3) lack of interest by scientists
(4) secrecy regarding the discovery
(5) existence of confirming evidence

Questions 5 and 6 refer to the following passage.

Albert Einstein (1879–1955), a German-born American physicist, is one of the most famous scientists of all time. In 1905 Einstein published his *theory of relativity*. Einstein concluded that mass is a form of energy and that there is an equivalence between mass and energy. This relationship is expressed by what is perhaps the most well-known equation: $E = mc^2$ (energy = mass times the square of the speed of light).

Einstein's equation states that mass (matter) and energy can be changed into one another. For the first time, it was realized that atoms themselves can be turned into pure energy. This is very unlike chemical energy in which matter changes from one form to another but is not destroyed in the process. The idea that matter can disappear in a burst of energy was an astonishing discovery.

The amount of energy released by matter is far greater than energy released by any other energy source. Einstein's insight made possible the understanding of energy processes on our Sun and on stars, and led to the development of atomic bombs and of nuclear power plants.

5. How does a nuclear power plant differ from a fossil-fuel plant?

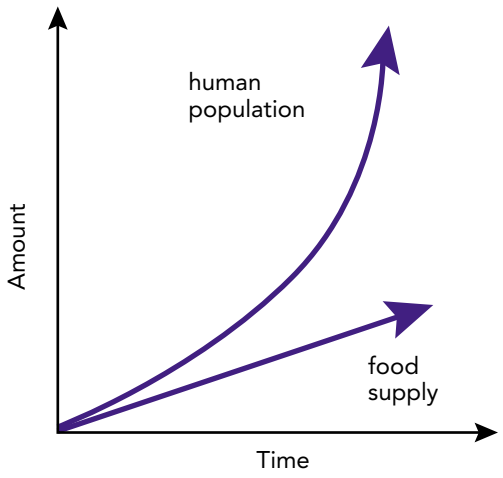
(1) how energy is released
(2) production of electricity
(3) cost of energy produced
(4) need for safety regulations
(5) use of human workers

6. Which of the following can you conclude from information given in the passage?

(1) Solar energy is decreasing each year.
(2) Solar energy in unlimited.
(3) The mass of the Sun remains constant.
(4) The mass of the Sun is decreasing.
(5) The mass of the Sun is increasing.

Questions 7 and 8 refer to the following diagram.

Thomas Malthus (1766–1834) proposed a theory that is represented by the graph below.



7. What is the best summary of the theory proposed by Malthus?

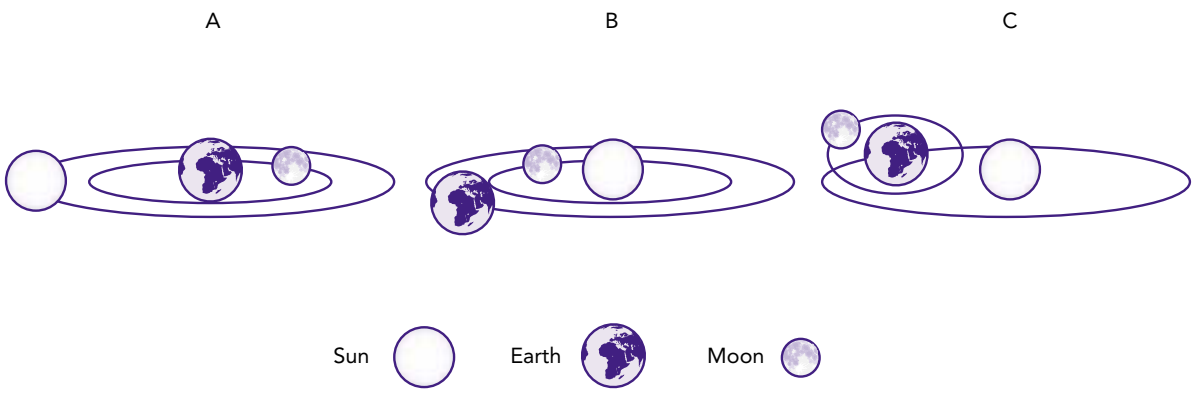
(1) Human population increases less rapidly than the available food supply.
(2) Human population increases more rapidly than the available food supply.
(3) Human population growth and food supply are not related to one another.
(4) An increase in human population growth leads to an increase in food supply.
(5) An increase in food supply leads to an increase in human population growth.

8. What does the graph imply will eventually occur in countries that have a very high growth rate?

(1) a high rate of disease
(2) overcrowding in major cities
(3) mass starvation
(4) air pollution in urban areas
(5) extinction of the human race

Questions 9 and 10 refer to the following diagram.

THREE MODELS OF THE EARTH, MOON, AND SUN



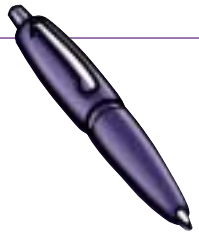
9. Which model of the Earth, Moon, and Sun would Aristotle and other scientists of his time most likely have thought correct?

(1) A
(2) B
(3) C
(4) either A or B
(5) either B or C

10. Which model of the Earth, Moon, and Sun do scientists today believe to be correct?

(1) A
(2) B
(3) C
(4) both A and B
(5) both B and C

Answers are on page 441.



Themes in Science Writing Activities

The following topics will give you extra practice in thinking and writing about themes in science.

Directions: Choose one of the topics below and write a well-developed essay (approximately 250 words). You may wish to plan your essay before you write. Pay attention to your organization, development, and control of sentence structure, punctuation, grammar, word choice, and spelling. After you finish writing your essay, reread what you have written and make any changes that will improve your essay.

TOPIC 1

New developments in science often lead to new developments in technology and vice versa. Sometimes these developments in technology can have a major impact on human life. In your opinion what is the single greatest technological milestone of the last century?

In your essay describe what you believe to be the greatest technological milestone. Give examples to support your belief.

TOPIC 2

Albert Einstein once said, "The problems that exist in the world today cannot be solved by the level of thinking that created them." Do you think that scientific advancement has created more problems that it has solved?

In your essay state whether you believe science has created more problems than it has solved. Give specific reasons to support your belief.

TOPIC 3

Within the next five to ten years, the cloning of valued animals, such as livestock, endangered species, and domestic pets, may be a common occurrence. In fact, some companies are now preserving genetic material from these animals for future use. Would you ever consider cloning a valued animal?

In your essay present your views regarding the cloning of valued animals. Give specific examples to support your opinion.