Michigan

TEST FOR TEACHER CERTIFICATION

STUDY GUIDE

20 Earth/ Space Science

MI-SG-FLD020-04

TABLE OF CONTENTS

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National Evaluation Systems, P.O. Box 226, Amherst, MA 01004

PART 1: General Information About the MTTC Program and Test Preparation

The first section of the study guide is available in a separate PDF file. Click the link below to view or print this section.

General Information About the MTTC Program and Test Preparation

PART 2: Test Objectives and Sample Test Questions

INTRODUCTION

This section includes a list of the test objectives, immediately followed by sample test questions and an answer key for the field covered by this study guide.

Test Objectives

As noted, the test objectives are broad, conceptual statements that reflect the knowledge, skills, and understanding an entry-level teacher needs in order to teach effectively in a Michigan classroom. Each field's list of test objectives represents the **only** source of information about what a specific test will cover and, therefore, should be studied carefully.

The test objectives are organized into groups known as "subareas." These subareas define the major content areas of the test. You will find a list of subareas at the beginning of the test objective list. The percentages shown in the list of subareas indicate the approximate weighting of the subareas on the test.

Sample Multiple-Choice Test Questions

The sample multiple-choice test questions included in this section are designed to give the test-taker an introduction to the nature of the test questions included on the MTTC test for each field. The sample test questions represent the various types of test questions you may expect to see on an actual test; however, they are **not** designed to provide diagnostic information to help you identify specific areas of individual strengths and weaknesses or predict your performance on the test as a whole. Use the answer key that follows the sample test questions to check your answers.

To help you identify which test objective is being assessed, the objective statement to which the question corresponds is listed in the answer key. When you are finished with the sample test questions, you may wish to go back and review the entire list of test objectives and descriptive statements once again.

TEST OBJECTIVES

Subarea	Approximate Percentage of Questions on Test
Foundations of Scientific Inquiry	20%
Physical and Historical Geology	20%
Oceanography and Freshwater Systems	20%
Meteorology	20%
Astronomy	20%

FOUNDATIONS OF SCIENTIFIC INQUIRY

Demonstrate knowledge of principles and procedures for conducting scientific research.

Includes identifying procedures for conducting scientific investigations; developing valid experimental designs for collecting data and testing hypotheses; analyzing data; recognizing the limitations of scientific investigations; analyzing procedures used in setting up and conducting experiments in natural and laboratory settings; identifying experimental variables being held constant, being manipulated, and responding; applying methods for presenting data with graphs, tables, equations, and maps; and applying mathematics (e.g., statistics, algebra, trigonometry).

Apply knowledge of materials, methods, and equipment commonly used in earth/space science.

Includes recognizing the safe use of tools and materials (e.g., field equipment, chemicals, MSDS) related to earth/space science investigations conducted in laboratory and natural settings; identifying the tools, techniques, and procedures used in the observation, analysis, and prediction of natural phenomena in earth/space science (e.g., Geographic Information Systems, telescopes, computer models); identifying appropriate procedures for dealing with emergencies; applying procedures for selecting and using measurement devices (e.g., compasses, pH meters, scales); solving problems involving field and laboratory measurements; and applying procedures for interpreting and using maps and charts (e.g., topographic maps, geologic maps, astronomical charts).

Understand the nature and history of scientific thought and inquiry.

Includes recognizing the reliance of scientific investigations on empirical data, verifiable evidence, and logical reasoning; analyzing the cumulative process of developing scientific evidence in support of models and theories concerning earth/space science; recognizing the effects of personal and cultural bias on scientific investigations and the interpretation of data; and identifying major scientific ideas from societies and individuals of different periods and cultures.

Understand the relationship of earth/space science to contemporary, historical, technological, and societal issues.

Includes identifying how society influences the practice and development of earth/space science and how scientific developments and technological changes affect society; evaluating historical and contemporary controversies related to developments in earth/space science and applications of new technologies (e.g., energy production and use, space flight, overuse of marine resources, mining); identifying types and sources of pollution (e.g., water, air, soil); and analyzing the effects of pollution and conservation on the environment.

Demonstrate knowledge of the interrelationships among the life, physical, and earth/space sciences and among science, mathematics, and technology.

Includes analyzing the relationship of science and technology; identifying unifying themes and concepts that are common to the various scientific disciplines (e.g., classification, cause and effect, conservation of matter and energy) and that connect science, mathematics, and technology; and analyzing how common themes of science, mathematics, and technology (e.g., feedback, scale, systems) apply in real-world contexts.

PHYSICAL AND HISTORICAL GEOLOGY

Demonstrate knowledge of the structure, characteristics, and processes of the earth.

Includes analyzing the physical and chemical processes involved in the rock cycle that produce igneous, metamorphic, and sedimentary rocks; identifying the evidence for plate tectonics; describing the mechanisms that produce plate movements and crustal deformation (e.g., folding, faulting); interpreting geologic features (e.g., mountain ranges, rift valleys, wave-cut terraces) in terms of the tectonic processes by which they were formed; identifying different types of earth materials (e.g., minerals, rocks, soils) and the processes by which they are formed; describing the internal structure of the earth; and explaining the evidence upon which knowledge of the earth's internal structure is based (e.g., the earth's magnetic field, seismic waves, meteorites).

Understand the causes and consequences of volcanism and earthquakes.

Includes identifying the locations and characteristics of volcanoes and earthquakes; identifying the geologic processes responsible for different kinds of volcanism; analyzing the processes that produce earthquakes; recognizing the factors that influence the propagation (e.g., depth, ground composition) and destructive consequences of earthquakes; analyzing the methods used to monitor, measure, and predict earthquake activity and volcanism; and understanding the consequences of both (e.g., tsunamis, landslides).

Understand processes and consequences of weathering, erosion, and deposition.

Includes demonstrating knowledge of the integrated processes of weathering, erosion, and deposition, including the formation of karst topography; identifying the agents and effects of erosion and deposition; recognizing the processes and results of mass wasting; analyzing processes of soil formation under different conditions; identifying types and characteristics of continental and mountain glaciers and the associated glacial deposits; analyzing processes by which glaciers form, advance, and retreat; and analyzing the roles of weathering, erosion, and glaciation in shaping the Great Lakes region.

Demonstrate knowledge of the geologic time scale and the methods of relative and absolute dating.

Includes identifying the relative and absolute ages of important physical and biological events on the geologic time scale; recognizing the historical development and organization of the geologic time scale; identifying major evolutionary trends over the course of geologic time; recognizing factors that have affected life forms over geologic time (e.g., climate changes, plate tectonics); identifying the processes involved in fossil formation; analyzing the physical evidence for the age of the earth and biological evolution; and identifying the methods used in relative dating (e.g., crosscutting relations, superposition, index fossils) and absolute dating (e.g., radiometric dating, dendrochronology).

Understand the formation and use of geologic resources, and the relationship between the geosphere and human activities.

Includes identifying the types and characteristics of renewable (e.g., water, soils) and nonrenewable (e.g., fossil fuels, ores, minerals) geologic resources; analyzing factors that affect the availability and use of geologic resources (e.g., accessibility, environmental considerations, economics); identifying strategies for managing geologic resources (e.g., land-use planning, watershed protection, reclamation, recycling); and analyzing the types, sources, and effects of pollutants and ways of dealing with these problems (e.g., technological, ecological, cultural).

OCEANOGRAPHY AND FRESHWATER SYSTEMS

Demonstrate knowledge of the physical components and processes of the marine system.

Includes identifying the physical characteristics of ocean waters (e.g., salinity, chemical composition, thermal layering) and ocean basins (e.g., physiography, sediments, deep-ocean vents, atolls); identifying ocean zones (e.g., littoral, pelagic, benthic) in terms of their physical characteristics; recognizing the types of ocean currents and the connections between them; analyzing circulation patterns in the oceans and factors that influence these patterns (e.g., thermohaline gradients, wind systems, Coriolis effect); recognizing the causes and effects of waves (e.g., coastal erosion and deposition) and tides; recognizing the interrelationship between the marine environment and marine organisms; and recognizing the geologic processes that shape the ocean basins.

Understand the distribution of freshwater and the processes involved in the hydrologic cycle.

Includes recognizing factors that affect the distribution of freshwater resources; analyzing changes in the distribution of water over time (e.g., glaciers, fossil aquifers); analyzing the physical and chemical properties of water (e.g., structure, bonding, specific heat); explaining phase changes of water in terms of energy flow; analyzing the movement of water in the hydrologic cycle; and demonstrating knowledge of the movement of water in the Great Lakes system.

Apply knowledge of groundwater.

Includes using the hydrologic cycle to explain the movement and renewal of groundwater in different types of aquifers (e.g., confined, unconfined); describing the factors that affect the flow of groundwater through unconsolidated sediments and bedrock (e.g., porosity, grain-size distribution, fracturing, faulting); demonstrating knowledge of infiltration and recharge and the factors that affect them (e.g., soil type, surface geology, vegetation, urbanization); analyzing the interaction of groundwater with surface water; and identifying factors (e.g., pH, mineral content) that affect the quality and processing of groundwater used for human consumption.

Apply knowledge of freshwater systems.

Includes identifying the geological, chemical, and physical characteristics of watersheds, rivers (e.g., water chemistry, turbidity, flow rate), ponds, and lakes (e.g., thermocline, mass balance) and the interactions of rivers, ponds, and lakes; analyzing the processes that affect ponds and lakes (e.g., eutrophication, seasonal turnover); analyzing the effects of the aquatic environment (e.g., oxygen levels, pH) on aquatic organisms; and describing the physical characteristics of the Great Lakes (e.g., depth, size, drainage).

Understand the relationship between the hydrosphere and human activity.

Includes recognizing the characteristics and uses of renewable and nonrenewable marine and freshwater resources; identifying environmental issues related to the use of marine and freshwater resources; analyzing factors that affect the availability of local and global freshwater and marine resources; identifying the availability and uses of freshwater resources in the Great Lakes region; identifying types, sources, and effects of pollution, including invasive species, in freshwater and marine environments; analyzing strategies for preventing, monitoring, and cleaning up pollution problems in the hydrosphere; recognizing physical factors that affect the biological resources of the oceans; and identifying the tools and methods used to explore marine and freshwater systems.

METEOROLOGY

Understand the structure and characteristic features of the atmosphere and the atmospheric conditions and processes that affect weather and climate.

Includes identifying the relative positions and characteristics of the different layers of the atmosphere; recognizing the importance of different components of the atmosphere in regulating the earth's weather, including temperature, precipitation, and radiation budget; identifying the electromagnetic spectrum; analyzing the processes of radiation, convection, and conduction in the earth's atmosphere that affect weather and climate; explaining the formation of air masses; analyzing the interaction of ocean currents and continental glaciers over time; and recognizing factors that influence global and local wind patterns (e.g., Coriolis effect, distribution of land and water, convection, jet stream).

Understand the formation of clouds, precipitation, and condensation.

Includes recognizing the conditions and processes that produce condensation (e.g., presence of condensation nuclei, adiabatic cooling); identifying types and characteristics of clouds and analyzing the conditions and processes that produce them (e.g., water vapor, heat energy, atmospheric stability and instability); identifying types and characteristics of precipitation; and analyzing the conditions under which different types of precipitation form.

Understand the causes of different kinds of weather.

Includes explaining how various factors (e.g., pressure, temperature, winds) initiate different kinds of weather; identifying characteristics of air masses, fronts, cyclones and anticyclones, and analyzing how they affect weather; identifying characteristics of severe weather (e.g., floods, blizzards, hurricanes, tornadoes) and analyzing the processes responsible for its formation; applying knowledge of the jet stream to explain its effect on weather patterns; describing how regional weather is affected by large-scale patterns in the atmosphere (e.g., monsoons, the Bermuda high, the Pacific high, the Intertropical Convergence Zone); and analyzing the effects that the Great Lakes exert on regional and local weather (e.g., lake-effect precipitation, land and shore breezes, rainfall, shadow zones).

Apply knowledge of the earth's climate systems and analyze the factors that influence climate.

Includes analyzing the characteristics and distribution of different climates; analyzing factors that affect climate (e.g., temperature, amount of precipitation); describing climate changes that have occurred during the history of the earth (e.g., ice age); identifying the causes of climate changes (e.g., orbital variations, changes in the composition and circulation of the atmosphere, plate tectonics); analyzing the conditions associated with the different phases of the El Niño/Southern Oscillation (ENSO) climate phenomenon; and applying knowledge of the conditions associated with the different phases of the ENSO climate phenomenon to explain its effects on global weather patterns.

Understand the relationship between the atmosphere and human activity.

Includes identifying the evidence used in the study of climate change (e.g., chemical analysis of ice cores, oxygen isotope analysis, sedimentary deposits, pollen diagrams); recognizing the causes and effects of human-induced changes in local and global climate systems (e.g., deforestation and overgrazing can lead to desertification, fossil fuel use alters atmospheric chemistry); recognizing the possible causes and risks of global climate change; identifying types, sources, and effects of atmospheric pollution (e.g., atmospheric deposition, greenhouse gases, smog, ozone pollution in the troposphere); evaluating techniques and procedures for reducing air pollution; and relating ozone layer destruction and the amount of ultraviolet radiation reaching the earth's surface.

ASTRONOMY

Understand the characteristics of the sun-earth-moon system.

Includes identifying the motions of the earth and moon; describing the history of the sun-earth-moon system (e.g., changes in orbit and rotation over time); recognizing the effects of the gravitational fields of the sun and moon on tides; identifying the effects solar energy has on the earth (e.g., solar cycle, cycling of energy, atmospheric phenomena, health effects); and analyzing the effects of the earth's motion and orientation on physical phenomena (e.g., the diurnal cycle, seasons, phases of the moon, eclipses).

Recognize the components of the solar system.

Includes identifying the characteristics of the different types of objects in the solar system (e.g., comets, asteroids, planets, moons) and their locations; recognizing the physical laws controlling the motions of objects in the solar system; analyzing apparent motions of objects in the solar system as viewed from the earth (e.g., retrograde motion of Mars); and explaining current scientific theories on the origin and development of the solar system.

Understand stellar evolution and the formation of the universe.

Includes analyzing the evolution of stars (e.g., H-R diagrams, production of elements); identifying characteristics of different types of stars (e.g., white dwarfs, neutron stars, binary stars) and stellar phenomena (e.g., supernovae, black holes, star clusters); analyzing evidence for the layered composition, temperature, and motion of stars; recognizing factors that affect the absolute and apparent magnitude of stars; identifying types and characteristics of galaxies, including the Milky Way; and recognizing scientific theories and evidence relating to the origin of the universe (e.g., big bang theory, inflationary models, dark matter).

Demonstrate knowledge of the history of astronomy.

Includes recognizing major events in the history of astronomy and space exploration; identifying the ideas and accomplishments of individuals (e.g., Galileo, Copernicus, Kepler) involved in the history of astronomy; and recognizing the technology used to advance knowledge of space (e.g., radio telescopes, infrared telescopes, optical telescopes, manned space craft, space probes).

SAMPLE MULTIPLE-CHOICE TEST QUESTIONS

1. Geographic Information Systems (GIS) are used in the study of the earth and space sciences primarily to:

   A. determine an observer's precise location on the earth using satellite data.

   B. examine and display spatial relationships between related data sets.

   C. gather data from the earth's surface using remote sensing techniques.

   D. analyze maps made by cartographers prior to computerization of mapping.

2. Use the passage below to answer the question that follows.

   The theory of catastrophism, developed in the seventeenth century, stated that the earth's landscape was formed by catastrophic events. Supporters of the theory thought the Noachian flood described in the Bible was the most recent of these events, and that different layers of rock represented different precipitates that formed as the ocean receded.

   The articulation of the theory of catastrophism helped advance the development of scientific knowledge because it:

   A. promoted research into the structural differences and properties of different rock types.

   B. supplied a unifying theory that made a coherent whole from scientific and biblical knowledge.

   C. defined the scope of scientific inquiry by distinguishing between the knowable and the unknowable.

   D. provided a hypothesis that could be validated or rejected as researchers collected and analyzed new data.

3. Lining of sanitary landfills with a clay barrier is most useful for which of the following purposes?

   A. to reduce the surfacing of methane and other gases

   B. to minimize bacterial interaction with the waste

   C. to speed the rate of biodegradation of waste

   D. to prevent leachate from migrating away from the waste site

4. Mathematics is understood to be the language of science primarily because it:

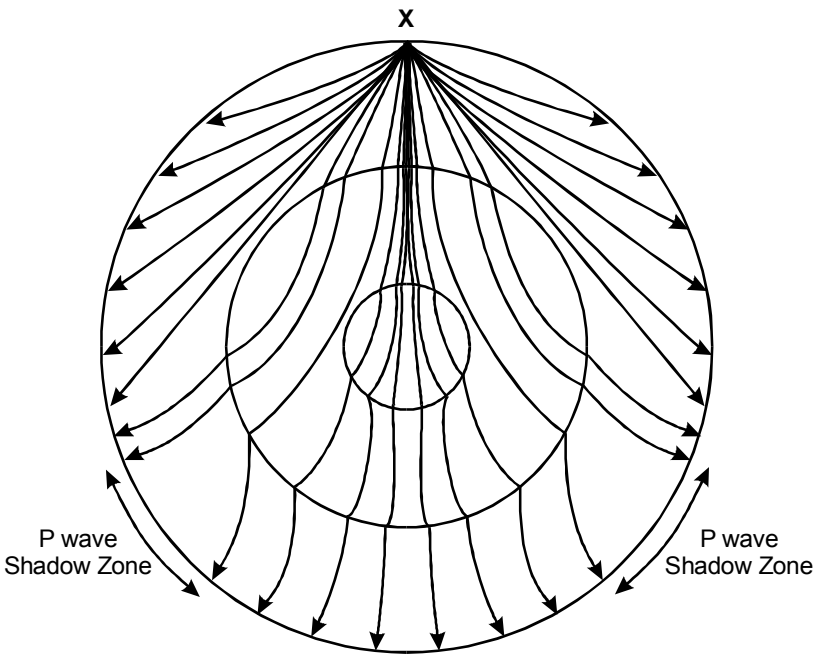
   A. has no cultural bias associated with its practice.

   B. describes predictable and testable relationships.

   C. reduces the uncertainty associated with chaotic systems.

   D. relies on the same processes as science.

5. Use the information below to answer the question that follows.



The diagram above shows the earth's crust and the boundaries of the earth's outer and inner cores. Propagation pathways of P waves recorded after an earthquake located at position X are shown as lines radiating out from position X. Which of the following best explains the P wave shadow zones indicated on the diagram?

A. the reflection of seismic waves
as they encounter the differing densities of the inner and outer cores

B. the variable absorption of seismic waves as they pass through the mantle and the outer and inner cores

C. the refraction of seismic waves
as they cross boundaries between materials with different densities

D. the differing speed of seismic waves moving into the increasingly dense materials of the outer and inner cores

6. Which of the following best describes the geologic event that produced the flat, rich agricultural lands surrounding Saginaw Bay along the east shore of Michigan's Lower Peninsula?

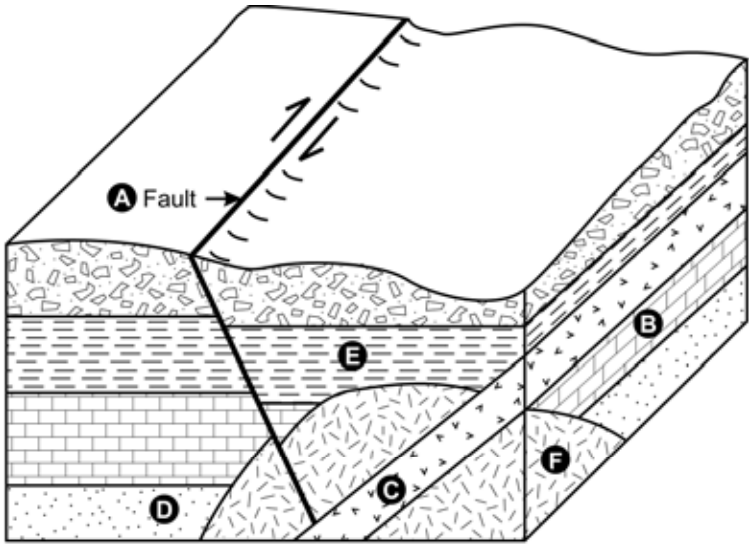
   A. weathering of glacial till

   B. deposition of wind blown fine sand and silt

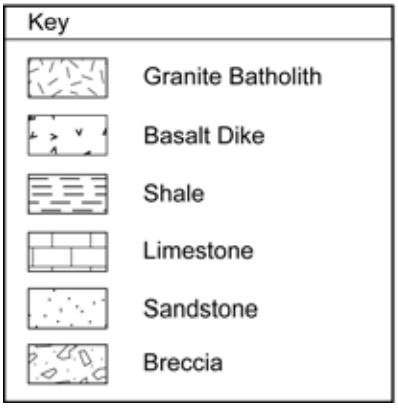
   C. isostatic uplift of a former lake bed

   D. erosion of underlying Precambrian shale strata

7. Use the block diagram below to answer the question that follows.



No overturned strata. Not to scale.



In the geologic block diagram shown above some of the strata are labeled with the letters B, C, D, E, and F. The fault is labeled as A. Which of the following best reflects the sequence of deposits from oldest to most recent and the timing of faulting?

A. E, B, D, F, A, C

B. D, B, E, F, A, C

C. F, D, B, E, A, C

D. D, B, E, A, F, C

8. The cation-exchange capacity of a particular type of soil is an important characteristic of the soil. This is primarily because the cation-exchange capacity of a soil:

   A. affects the rate of nutrient leaching from the topsoil.

   B. regulates the release of nutrients from the surface litter.

   C. accelerates the breakdown of minerals into available nutrients.

   D. determines the nutrients that are available to soil microorganisms.

9. Which of the following best describes the pelagic zone of the marine environment?

   A. upper layers of the open ocean where photosynthesis can occur

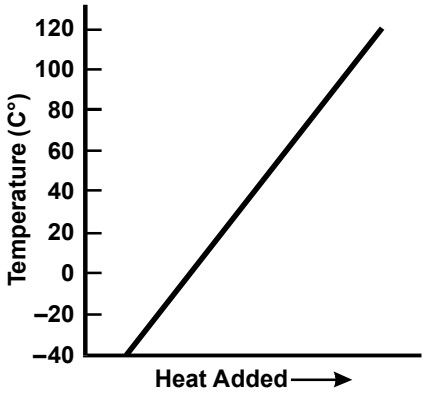
   B. ocean-bottom surfaces with enough sunlight to support photosynthesis

   C. open oceans regardless of their depth or location

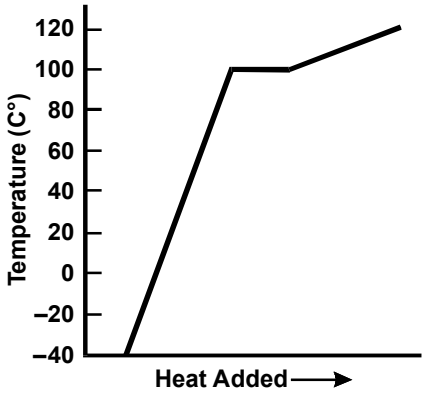
   D. ocean-bottom surfaces regardless of their location or topography

10. A sample of ice at –40º C is heated in an open vessel. Which of the following charts best represents the relationship between heat added and the temperature of the sample?

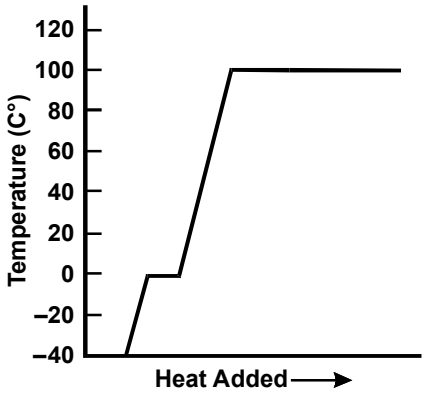
A.



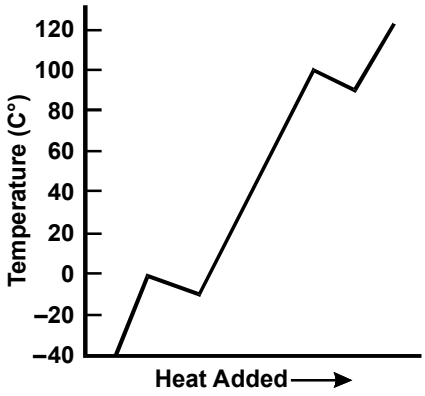
B.



C.



D.



11. A community gets its water from aquifers located in limestone strata. Which of the following is likely to characterize the water derived from these aquifers?

    A. exceptional clarity due to effective filtration

    B. high levels of dissolved calcium carbonate

    C. cloudiness due to the presence of organic solids

    D. strong odor and flavor of sulfur

12. Following the completion of the Aswan High Dam on the Nile River in Egypt, the annual harvest of marine fish species decreased in the region surrounding the Nile Delta. The decrease in fish stocks in this part of the Mediterranean Sea was most likely related to a change in:

    A. dissolved oxygen levels.

    B. salt concentration.

    C. water clarity.

    D. nutrient availability.

13. Which of the following is a necessary condition for condensation to occur in the atmosphere?

    A. a rapid increase in the concentration of water vapor

    B. the presence of microscopic particles

    C. a relative humidity slightly over 100 percent

    D. the existence of significant contrasts in temperature across the region

14. Which of the following best explains why hurricanes typically do not form on the equator?

    A. The Coriolis force, which is critical in supporting large-scale rotation in developing hurricanes, is zero at the equator.

    B. The upper-level winds on the equator are strongest during the summer season, disrupting the vertical growth of tropical storms.

    C. The sinking of convergent air flows that meet at the equator creates a high pressure zone not conducive to hurricane growth.

    D. Upwelling currents keep ocean surface temperatures at the equator below 80 degrees, which is too cool to support hurricane development.

15. Scientists now realize that the El Niño/ Southern Oscillation (ENSO) phenomenon affects climates worldwide. Which of the following best describes a predictable climate change in Michigan during a year with a strong El Niño pattern?

    A. below-average summer and fall temperatures

    B. above-average fall and winter precipitation

    C. below-average winter and spring precipitation

    D. above-average fall and winter temperatures

16. Since 1977, scrubbers have been required for the exhaust fumes of all new fossil-fuel-burning power plants and smelters. These devices are used to reduce emissions of:

    A. carbon dioxide.

    B. lead and other heavy metals.

    C. sulfur dioxide.

    D. volatile organic compounds.

17. Which of the following best explains why typical sunrises and sunsets are often characterized by red-, yellow-, and orange-colored skies?

    A. The relative humidity tends to be higher in the atmosphere at those times of day, and water vapor preferentially absorbs visible light in the blue region of the spectrum.

    B. The low angle of the sun results in the light passing through a thicker atmosphere, and longer wavelengths are more likely to penetrate without being scattered.

    C. The higher concentration of particulate matter in the atmosphere at those times of day is more likely to scatter longer wavelengths across the sky than shorter wavelengths.

    D. The greater distance the sun's light travels to reach the earth results in the Doppler effect, shifting incident light toward the longer wavelengths of the electromagnetic spectrum.

18. Over the course of several thousand years, the position of Polaris, the North Star, in the night sky has changed. This phenomenon is due to:

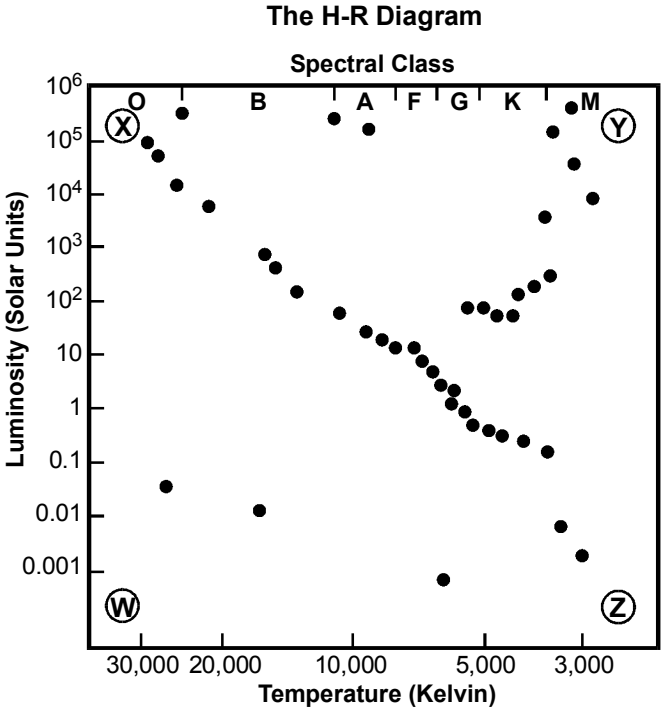
    A. the continuous rotation of the solar system.

    B. changes in the angle of the earth's orbital plane to the solar system.

    C. the continuous revolution of the Milky Way galaxy.

    D. changes in the orientation of the earth's rotational axis.

19. Use the information below to answer the question that follows.



In the H-R diagram above, stars are plotted as dots based on their luminosity and spectral class or temperature. Near which of the following regions of the H-R diagram would a red giant most likely be located?

A. near the W

B. near the X

C. near the Y

D. near the Z

20. Which of the following historical accomplishments provided the first convincing evidence that the earth and other planets orbited the sun?

    A. Copernicus's explanation for the retrograde motion of Mars

    B. Galileo's observation that Venus went through phases like the moon

    C. Aristotle's careful observations of planetary motions

    D. Tycho Brahe's observation that stars were outside the sphere of planets

ANSWER KEY FOR THE SAMPLE MULTIPLE-CHOICE TEST QUESTIONS

Item Number	Correct Response	Objective
1.	**B**	Apply knowledge of materials, methods, and equipment commonly used in earth/space science.
2.	**D**	Understand the nature and history of scientific thought and inquiry.
3.	**D**	Understand the relationship of earth/space science to contemporary, historical, technological, and societal issues.
4.	**B**	Demonstrate knowledge of the interrelationships among the life, physical, and earth/space sciences and among science, mathematics, and technology.
5.	**C**	Demonstrate knowledge of the structure, characteristics, and processes of the earth.
6.	**C**	Understand processes and consequences of weathering, erosion, and deposition.
7.	**B**	Demonstrate knowledge of the geologic time scale and the methods of relative and absolute dating.
8.	**A**	Understand the formation and use of geologic resources, and the relationship between the geosphere and human activities.
9.	**C**	Demonstrate knowledge of the physical components and processes of the marine system.
10.	**C**	Understand the distribution of freshwater and the processes involved in the hydrologic cycle.
11.	**B**	Apply knowledge of groundwater.
12.	**D**	Understand the relationship between the hydrosphere and human activity.
13.	**B**	Understand the formation of clouds, precipitation, and condensation.
14.	**A**	Understand the causes of different kinds of weather.
15.	**D**	Apply knowledge of the earth's climate systems and analyze the factors that influence climate.
16.	**C**	Understand the relationship between the atmosphere and human activity.
17.	**B**	Understand the characteristics of the sun-earth-moon system.
18.	**D**	Recognize the components of the solar system.
19.	**C**	Understand stellar evolution and the formation of the universe.
20.	**B**	Demonstrate knowledge of the history of astronomy.