Michigan

TEST FOR TEACHER CERTIFICATION

STUDY GUIDE

93 Integrated Science (Elementary)

MI-SG-FLD093-02

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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	25%
Life Science	25%
Earth/Space Science	25%
Physical Science	25%

Candidates for the elementary integrated science endorsement must have an understanding of the common themes and connections among the various scientific disciplines. Although these test objectives contain separate subareas for the life, earth/space, and physical sciences, the teacher candidate should be prepared to analyze some scientific problems and phenomena from the perspective of two or more of these disciplines and to understand the integrated nature of all scientific inquiry.

FOUNDATIONS OF SCIENTIFIC INQUIRY

Understand the principles and procedures for conducting scientific research.

Includes developing valid experimental designs for collecting data and testing hypotheses; recognizing the role of control groups in experiments; understanding procedures for collecting and interpreting data to minimize bias; identifying procedures used in setting up and conducting scientific investigations in natural and laboratory settings; selecting and using simple measurement devices (e.g., rulers, balance scales, graduated cylinders, thermometers); solving problems involving measurement; recognizing variables being held constant, being manipulated, and responding; identifying how best to present data, ideas, and relationships (e.g., graphs, tables, equations, maps, models, analogies); evaluating simple descriptive statistics; interpreting data presented in different formats; evaluating the validity of conclusions; and assessing the reliability of sources of information.

Apply knowledge of methods and equipment used in scientific investigations.

Includes identifying procedures for the safe use and storage of equipment and materials (e.g., chemicals, biohazards, heat sources) related to scientific investigations; and understanding the practices and requirements related to the humane treatment of animals.

Understand the nature and history of scientific thought and inquiry.

Includes being aware of the reliance of scientific investigations on empirical data, verifiable evidence, and logical reasoning; recognizing the effect of researcher bias on scientific investigations and the interpretation of data; identifying major scientific ideas developed by individuals from different periods and cultures; and analyzing the dynamic nature of scientific knowledge, including ways in which scientific knowledge is acquired and modified.

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

Includes recognizing the differences between science and technology; identifying how society influences the practice of science; analyzing the issues related to scientific and technological changes; assessing the effects of science and technology on society and recognizing ethical issues (e.g., controversies surrounding cloning, genetically modified foods, energy use); analyzing the effects of pollution and conservation on the environment; and evaluating the credibility of scientific claims made in various forums (e.g., the popular media, professional journals, advertising).

Understand interrelationships among the life, physical, and earth/space sciences and among science, mathematics, and technology.

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

LIFE SCIENCE

Understand cell structure and function.

Includes identifying the principles of cell theory; describing basic cell structures and their functions; applying knowledge of the processes of mitosis and meiosis; recognizing the steps involved in protein synthesis; comparing and contrasting animal cells and plant cells; and analyzing the relationship between structure and function of specialized cells.

Understand the organization, characteristics, and functions of living things.

Includes applying knowledge of systems for classifying organisms; analyzing the development of multicellular organisms by cell growth and division; describing the life cycles and reproductive strategies of common organisms; comparing sexual and asexual reproduction; recognizing the basic characteristics and products of photosynthesis and cellular respiration; identifying homeostatic and metabolic processes; recognizing levels of biological organization and interactions between the levels (e.g., cells, tissues, organs, systems); and analyzing the functions of specialized structures (e.g., bark, fur) and systems (e.g., vascular, skeletal) found in plants and animals.

Understand concepts of heredity and modern genetics.

Includes recognizing how characteristics are passed from one generation to the next (e.g., Mendelian genetics, molecular basis of inheritance); analyzing patterns of inherited traits; identifying the influence of environmental factors on the inheritance of characteristics (e.g., natural selection, mutations); and recognizing characteristics and applications of modern genetics (e.g., genetic engineering, DNA fingerprinting).

Understand evolutionary change of life on Earth.

Includes recognizing theories and processes associated with the origin and evolution of life; evaluating scientific evidence for these theories and processes (e.g., fossil record, genetics, speciation, extinction); identifying methods used to investigate evolution; and evaluating the roles of variation, natural selection, and adaptation in producing species diversity.

Understand characteristics of ecological systems.

Includes analyzing biotic and abiotic factors that affect populations, communities, ecosystems, and biomes; identifying strategies used by organisms to obtain basic requirements for life (e.g., nutrients, shelter, oxygen, water); identifying factors that affect population dynamics; analyzing interrelationships among organisms, including humans, in ecosystems; identifying biogeochemical cycles; analyzing energy transfers in food webs and food chains; applying knowledge of the process of ecological succession; analyzing responses of ecosystems to changes in the environment; and analyzing issues related to the availability, management, and use of renewable and nonrenewable resources.

Understand characteristics of human biology.

Includes applying knowledge of anatomical structures and physiological functions; identifying causes and characteristics of common diseases and methods of prevention and treatment; demonstrating knowledge of human reproduction and growth; analyzing the role of environmental factors, nutrition, and fitness in maintaining health; and identifying factors that affect human population growth and diversity.

EARTH/SPACE SCIENCE

Understand characteristics of the lithosphere and the history and processes of the changing earth.

Includes evaluating theories of the earth's origin; identifying methods of determining the age of the earth; describing processes of structural change in the earth's crust (e.g., mountain building, seafloor spreading, weathering, erosion); evaluating the theory of plate tectonics and evidence that supports this theory; recognizing the structure and composition of the earth and its layers; applying knowledge of the rock cycle; analyzing the processes of rock, mineral, and soil formation; describing the effects of natural phenomena (e.g., volcanism, meteor impacts, glaciation) on the earth and biosphere; identifying important topographical features of the earth and their characteristics; and reading topographic and geologic maps.

Understand characteristics of the hydrosphere.

Includes recognizing the physical, chemical, and biological characteristics of oceans, lakes (including the Great Lakes), streams, and ground water; analyzing how ocean currents and temperature affect climate and the biosphere; using the water cycle to explain the movement and renewal of ground water and of water in oceans, rivers, lakes, and watersheds; analyzing the role of phase changes in the hydrologic cycle; describing how human activities affect the hydrosphere; and identifying how energy from the sun drives the hydrologic cycle.

Understand the earth's atmosphere, weather, and climate.

Includes identifying the structure and characteristics of the atmosphere; analyzing the processes and causes of atmospheric convection, cloud formation, and precipitation; identifying the characteristics of low- and high-pressure systems and the movement of air in the atmosphere; evaluating the climatological evidence and mechanisms implicated in global warming and depletion of ozone in the upper atmosphere; identifying equipment and techniques used to monitor the weather; interpreting meteorological and climatological information; applying knowledge of techniques used to predict the weather and climatic change; and explaining appropriate safety precautions during severe weather.

Understand features of the universe and the methods of astronomy.

Includes comparing and contrasting components of our solar system; analyzing interactions and movements of the earth, moon, and sun (e.g., seasonal changes, moon phases, eclipses, tides); identifying components of the solar system and universe (e.g., stars, comets, asteroids, galaxies) and their characteristics; and recognizing theories of the origin and evolution of the solar system and universe.

PHYSICAL SCIENCE

Understand the chemical properties of matter.

Includes using models of atomic structure to explain chemical behavior; relating atomic structure to the structure and organization of the periodic table; differentiating among elements, compounds, and mixtures; and interpreting chemical symbols, formulas, and expressions.

Understand the nature of chemical changes in matter.

Includes analyzing common chemical changes (e.g., acid-base reactions, redox reactions) in terms of properties of reactants and products; recognizing types of chemical bonds, their characteristics, and their effects on the properties of matter; balancing equations; and identifying factors that affect rates of reaction and chemical equilibrium.

Understand the physical properties of matter and the nature of physical changes.

Includes applying knowledge of the physical characteristics of matter (e.g., density, mass, atomic structure); relating the properties of materials to their usefulness; understanding the difference between weight and mass; applying knowledge of the characteristics of the states of matter; explaining what happens at the molecular level during changes of state; identifying the changes in energy that occur during changes of state; identifying physical properties of common materials (e.g., metals, nonmetals, water); and identifying the physical properties of mixtures and solutions and methods for their separation.

Apply knowledge of the ideal gas laws and the kinetic molecular model to explain observable phenomena.

Includes using the kinetic molecular model to explain the properties and behaviors of solids, liquids, and gases; applying knowledge of the behavior of ideal gases, including the interrelationships among pressure, temperature, and volume in gases; and solving problems involving equilibrium in gaseous systems.

Understand the basic concepts of mechanics as applied in real-world contexts.

Includes identifying and applying the concepts of force, work, and power; solving problems involving motion of an object using the concepts of speed, velocity, acceleration, inertia, momentum, and mass; and describing the types, characteristics, and uses of simple machines.

Apply knowledge of electricity, magnets, and electromagnetism.

Includes applying knowledge of the generation, properties, uses, and safety of current and static electricity; interpreting electric circuit diagrams; applying knowledge of the characteristics of magnets and magnetic fields; identifying and applying the principles of electromagnetism; and describing the characteristics of the flow of charges and simple electric circuits.

Understand the basic concepts of energy and thermodynamics.

Includes identifying different forms and uses of energy (e.g., mechanical, radiant, sound, thermal, electrical, nuclear); applying knowledge of energy transfer, conversion, and conservation; analyzing the relationship between kinetic and potential energy; differentiating between temperature and heat energy; describing methods of heat energy transfer (i.e., convection, conduction, radiation); and recognizing the laws of thermodynamics and their application in physical systems.

Understand the characteristics and behavior of waves, vibrations, and optics.

Includes analyzing types and characteristics (e.g., frequency, amplitude) of waves and oscillations; relating these characteristics to perceived phenomena (e.g., color, pitch, loudness); recognizing how wave interactions (e.g., superposition, interference) affect the character and propagation of waves; describing the properties and behavior of sound and light waves in various media (e.g., refraction, reflection); applying knowledge of phenomena related to sound and light (e.g., echoes, shadows, Doppler effect); and describing characteristics and properties of the color spectrum.

SAMPLE MULTIPLE-CHOICE TEST QUESTIONS

1. A scientist hypothesizes that polychlorinated biphenyls (PCBs) in the water cause neural developmental abnormalities in salmon. Which of the following experimental designs is most appropriate to test this hypothesis?

   A. Test for the presence of PCBs in the fatty tissue of salmon with neural defects as compared to salmon with normal neural development.

   B. Examine several generations of an isolated population of PCB-contaminated salmon for neural defects.

   C. Compare frequency of neural defects among salmon embryos when half of the group is exposed to PCBs and the other half is not.

   D. Compare frequency of neural defects in salmon from PCB-contaminated waters to frequency of neural defects in salmon from PCB-free waters.

2. During the nineteenth century, scientists developed several principles to describe cells. These principles developed into cell theory. Which of the following are fundamental principles of cell theory?

   A. Cells are the basic living unit of organization and arise from pre-existing cells.

   B. Cells have specialized structures, and cell function is different in plant and animal cells.

   C. Cells replicate through a process of cell division and can only be small due to physical limitations.

   D. Organisms grow through an increase in the number of cells and all cells are bounded by individual cell walls.

Use the passage below to answer the two questions that follow.

The dwarf lake iris only grows around Lakes Huron and Michigan, and in Michigan, it is found exclusively on the north shores of these lakes. The perennial grows low to the ground and has shallow, creeping rhizomes that produce new fans of leaves at their nodes. In semi-open habitats having partial sun, the dwarf lake iris blooms, producing small blue, lilac, or white flowers. Depending on environmental conditions, seeds are sometimes produced. The seeds are in rounded capsules approximately one-half inch long and are dispersed by ants. Throughout its current range, the dwarf lake iris is threatened as a result of residential development near shorelines and over-collecting of the popular wildflower.

3. Which of the following conclusions about the dwarf lake iris can be drawn from the passage?

   A. The plant will go extinct if not protected by law.

   B. Dwarf lake irises can reproduce both sexually and asexually.

   C. The plant produces seeds whenever it flowers.

   D. The dwarf lake iris cannot survive in forested areas.

4. In 1988, the dwarf lake iris was added to the U.S. List of Endangered and Threatened Wildlife and Plants. In which of the following ways will this help preserve the dwarf lake iris?

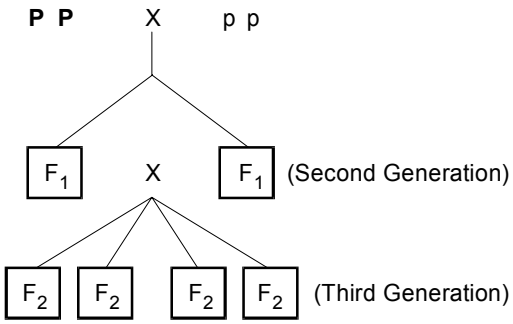
   A. by designating dwarf lake iris habitat as undevelopable

   B. by mandating limits on the use of lawn chemicals on private land where the dwarf lake iris grows

   C. by providing programs and funding to help protect and restore the species

   D. by supporting research to identify ways of improving the species' survival in altered habitats

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



A pea plant that is homozygous dominant for red flowers (PP) is crossed with a pea plant that is homozygous recessive for white flowers (pp). The offspring of that cross (the F_1 generation) are then crossed to create a third generation of pea plants (the F_2 generation). What will the phenotypic ratio of red-flower plants to white-flower plants be in the F_2 generation?

A. 2:2

B. 3:1

C. 4:0

D. 1:3

6. Which of the following sequences best represents an evolutionary progression of animals accepted by most biologists?

A. amphibians → fish → marine invertebrates → reptiles → mammals

B. marine invertebrates → fish → reptiles → amphibians → mammals

C. amphibians → reptiles → marine invertebrates → fish → mammals

D. marine invertebrates → fish → amphibians → mammals

Use the passage below to answer the three questions that follow.

In 1869, Russian chemist Dmitry Mendeleyev took the 55 known elements and arranged them in rows according to increasing weight and in columns according to similar chemical properties. This method created a table with gaps in the sequence of elements, a fact which caused his contemporaries to ridicule him. Mendeleyev, however, insisted the missing elements existed but had yet to be discovered. Within twenty years, three elements were discovered that matched the properties that Mendeleyev's table had predicted. Gradually, the table of elements became the framework for much of chemical theory and has developed into the periodic table used today.

7. The development of Mendeleyev's Table of the Elements best illustrates how:

   A. scientific bias can cause researchers to assume the existence of something even though no proof exists.

   B. circumstance and chance play a significant role in discovering new scientific knowledge.

   C. scientific methods can be used to discover new knowledge by suggesting a direction for experimentation.

   D. empirical data and evidence are the only driving forces behind discovering new scientific knowledge.

8. Mendeleyev's development of the Table of the Elements reflects which of the following concepts fundamental to math, science, and technology?

   A. The chaos present in nature can be organized into systems using logic.

   B. Properties of matter derive from energy levels on the atomic scale.

   C. Patterns in large-scale phenomena also occur in small-scale phenomena.

   D. Data can be classified into logical systems that provide new insights.

9. Elements in the same group of the periodic table have similar chemical properties because all elements in the group have the same number of:

   A. protons.

   B. neutrons.

   C. valence electrons.

   D. atomic orbitals.

10. The erosion of limestone would have the greatest effect on which of the following biogeochemical cycles?

    A. the carbon cycle

    B. the water cycle

    C. the nitrogen cycle

    D. the oxygen cycle

11. Which of the following common diseases or disorders is caused by the dysfunction of the pancreas?

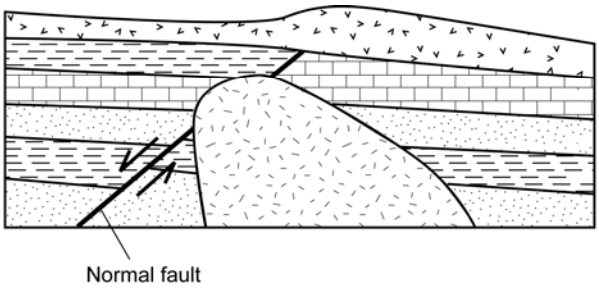
    A. diabetes

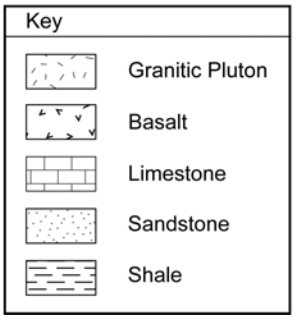
    B. cancer

    C. artherosclerosis

    D. hypertension

12. Use the diagram below to answer the question that follows.





Which of the following conclusions can be drawn about the geological structures labeled in the diagram?

A. The limestone stratum is older than the sandstone strata.

B. The granitic pluton is younger than the basalt.

C. The normal fault is older than the granitic pluton.

D. The limestone stratum is younger than the normal fault.

13. The high plains aquifer that stretches from Texas to South Dakota contains vast reserves of ground water. During the last fifty years, however, the water table in this aquifer has dropped dramatically. Which of the following is the most likely explanation for the depletion of this aquifer?

    A. Precipitation in the region is not sufficient to compensate for the withdrawal of water by farmers and communities.

    B. Rainfall throughout the region has been much lower on average than during the first half of the twentieth century.

    C. Cool, wet conditions that existed millions of years ago filled the aquifer and now most precipitation leaves the region as runoff.

    D. Changes in the ability of the soil to absorb water caused by agricultural development have increased surface water loss through evaporation.

14. A climatologist reports that the surface temperature of a region of the tropical Pacific Ocean has warmed by several degrees. Which of the following is the most direct consequence of this change in water temperature?

    A. an increase in the mixing of ocean layers

    B. a decrease in the density of ocean water

    C. an increase in the evaporation of ocean water

    D. a decrease in the convection of air overlying the ocean

15. The northern and southern lights, known respectively as the aurora borealis and the aurora australis, are caused by:

    A. the interaction of high energy particles from the sun with the earth's magnetic field.

    B. the ionization of gases from the troposphere as they enter regions of extreme cold in the thermosphere.

    C. the ignition of volatile gases in the ionosphere by ultraviolet radiation from the sun.

    D. the reflection of visible light from the sun off dust particles in the upper atmosphere.

16. Which of the following most accurately describes the evaporation of lake water when exposed to sunlight?

    A. Heating of the air above the water decreases the relative humidity, allowing increased diffusion of water vapor from the surface of the lake.

    B. Solar radiation hitting the lake decreases the surface tension of the water, allowing molecules at the surface to break away as water vapor.

    C. Solar radiation striking the water separates hydrogen atoms from oxygen atoms, creating two gases that diffuse from the water in microscopic bubbles.

    D. The sun's energy increases motion of the water molecules, allowing some molecules to overcome the attractive forces of the surface molecules and escape as gas.

17. Which of the following is best explained by the kinetic molecular model?

    A. why water in its solid phase exists at a lower temperature than liquid water

    B. why water takes up more space as it freezes than it does as a liquid

    C. why the molecular mass of water is equal to the sum of the atomic masses of its component atoms

    D. why hydrogen and oxygen bond to create water molecules

18. A child is sledding rapidly down a hill. The sled hits a bare spot in the snow and slows dramatically. Which of the following best explains why the child slides forward on the sled when the sled suddenly slows?

    A. The acceleration of an object is inversely proportional to its mass.

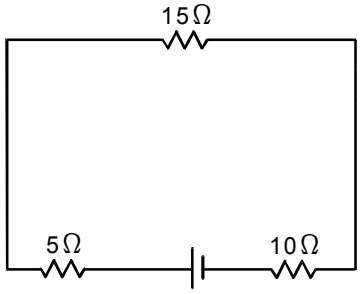
    B. For every action there is an equal and opposite reaction.

    C. The force acting on an object is equal to its mass times its rate of acceleration.

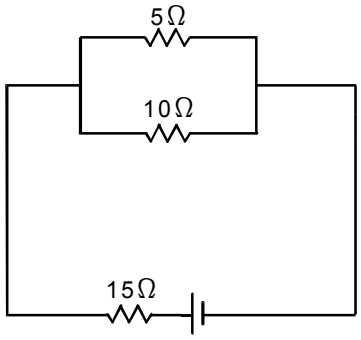
    D. An object in motion continues in motion unless that object experiences a net external force.

19. An electric circuit has a 5Ω and a 10Ω resistor connected in series. A 15Ω resistor is added parallel to those resistors. Which of the following diagrams best represents the arrangement of the circuit?

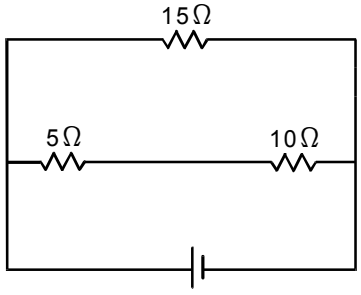
A.



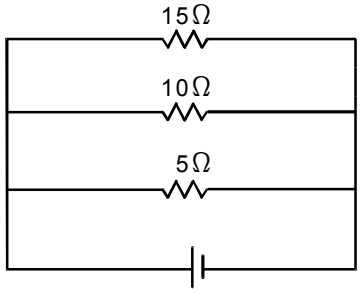
B.



C.



D.



20. Which of the following properties of a light wave is most closely associated with the physiological sensation of brightness?

A. frequency

B. speed

C. wavelength

D. amplitude

ANSWER KEY FOR THE SAMPLE MULTIPLE-CHOICE TEST QUESTIONS

Item Number	Correct Response	Objective
1.	**C**	Understand the principles and procedures for conducting scientific research.
2.	**A**	Understand cell structure and function.
3.	**B**	Understand the organization, characteristics, and functions of living things.
4.	**C**	Understand the relationship of science to contemporary, historical, technological, and societal issues.
5.	**B**	Understand concepts of heredity and modern genetics.
6.	**D**	Understand evolutionary change of life on Earth.
7.	**C**	Understand the nature and history of scientific thought and inquiry.
8.	**D**	Understand interrelationships among the life, physical, and earth/space sciences and among science, mathematics, and technology.
9.	**C**	Understand the chemical properties of matter.
10.	**A**	Understand characteristics of ecological systems.
11.	**A**	Understand characteristics of human biology.
12.	**C**	Understand characteristics of the lithosphere and the history and processes of the changing earth.
13.	**A**	Understand characteristics of the hydrosphere.
14.	**C**	Understand the earth's atmosphere, weather, and climate.
15.	**A**	Understand features of the universe and the methods of astronomy.
16.	**D**	Understand the physical properties of matter and the nature of physical changes.
17.	**A**	Apply knowledge of the ideal gas laws and the kinetic molecular model to explain observable phenomena.
18.	**D**	Understand the basic concepts of mechanics as applied in real-world contexts.
19.	**C**	Apply knowledge of electricity, magnets, and electromagnetism.
20.	**D**	Understand the characteristics and behavior of waves, vibrations, and optics.