

# **MICHIGAN TEST FOR TEACHER CERTIFICATION (MTTC)**

## **TEST OBJECTIVES FIELD 094: INTEGRATED SCIENCE (SECONDARY)**

<b>Subarea</b>	<b>Approximate Percentage of Questions on Test</b>
Constructing and Reflecting on Scientific Knowledge	25%
Life Sciences	25%
Earth/Space Sciences	25%
Physical Sciences	25%

Candidates for the secondary 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.

### **I. CONSTRUCTING AND REFLECTING ON SCIENTIFIC KNOWLEDGE**

**001 Understand and apply the principles and procedures for conducting scientific research.**

Includes formulating research questions and designing experiments; developing valid experimental designs for collecting and analyzing 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; recognizing independent and dependent variables and analyzing the role of each in experimental design; identifying how best to present data with graphs, tables, equations, and maps; using and evaluating simple descriptive statistics; interpreting data presented in different formats; evaluating the validity of conclusions; and assessing the reliability of sources of information.

**002 Apply knowledge of methods and equipment used in scientific investigations.**

Includes identifying and implementing procedures for the safe use, storage, and disposal of equipment and materials related to scientific investigations; understanding the practices and requirements related to the humane treatment of animals; applying procedures for selecting and using simple standard and metric measurement devices (e.g., rulers, balances, scales, thermometers); and solving problems involving measurement.

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**FIELD 094: INTEGRATED SCIENCE (SECONDARY)**

**003 Understand the nature and history of scientific thought and inquiry.**

Includes demonstrating knowledge 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 recognizing the dynamic nature of scientific knowledge, including ways in which scientific knowledge and theory are acquired and modified.

**004 Understand the relationship of science and technology to contemporary, historical, and societal issues.**

Includes recognizing the relationships and 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; recognizing ethical issues (e.g., cloning, genetically modified foods, energy use) related to science and technology; 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).

**005 Understand interrelationships among the life, physical, and earth/space sciences and their connections to 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, entropy); 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.

**II. LIFE SCIENCES**

**006 Understand cell structure and function.**

Includes describing the principles of cell theory; applying knowledge of basic cell structures to explain their functions; describing the processes of mitosis and meiosis; recognizing the steps involved in protein synthesis; comparing animal cells and plant cells; recognizing the roles of biomolecules in cell structure; and analyzing the relationship between a cell's structure and its function.

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

Includes recognizing the characteristics that differentiate living and nonliving things; 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; analyzing the processes and products of photosynthesis and cellular respiration; identifying homeostatic and metabolic processes; recognizing levels of biological organization (e.g., cells, tissues, organs, systems) and analyzing interactions between the levels; and analyzing the functions of specialized structures (e.g., bark, fur) and systems (e.g., vascular, skeletal) found in plants and animals.

**008 Understand characteristics of human biology.**

Includes demonstrating knowledge of anatomical structures and physiological functions; recognizing common causes (e.g., immunologic, microbiologic, genetic) and characteristics of diseases and methods of prevention; demonstrating knowledge of human reproduction and growth; analyzing the effects of environmental factors, nutrition, and fitness on health; and identifying factors that affect human population growth and diversity.

**009 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); predicting the inheritance of traits; analyzing the influence of environmental factors (e.g., nutrition, pollution, climate change) and how they affect natural selection and mutation; and recognizing characteristics and applications of modern genetics (e.g., genetic engineering, DNA fingerprinting).

**010 Understand evolutionary change of life on Earth.**

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

**011 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); analyzing factors that affect population dynamics; analyzing interrelationships among and effects of organisms, including humans, on ecosystems; relating biogeochemical cycles to the functioning of ecosystems; 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 (e.g., agriculture, land use, waste disposal); and analyzing issues related to the availability, management, and use of renewable and nonrenewable resources.

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**III. EARTH/SPACE SCIENCES**

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

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

**013 Understand characteristics of the hydrosphere.**

Includes demonstrating knowledge of the physical, chemical, and biological characteristics of oceans, lakes, streams, and ground water; describing how ocean currents and temperature affect climate and the biosphere; using knowledge of the water cycle to explain watersheds and the movement and renewal of ground water; describing the role of phase changes in the hydrologic cycle; and recognizing how energy from the sun drives the hydrologic cycle.

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

Includes recognizing and describing the structure and characteristics of the atmosphere; describing the processes and causes of atmospheric convection, cloud formation, and precipitation; applying knowledge of the characteristics of low- and high-pressure systems to explain the movement of air in the atmosphere and weather phenomena; 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; and applying knowledge of meteorologic techniques to predict the weather and climatic change.

**015 Understand features of the universe and the methods of astronomy.**

Includes identifying the structure and components of the solar system; describing the planets and their characteristics; understanding interactions and movements of the earth, moon, and sun and applying this knowledge to explain seasonal changes, moon phases, eclipses, and tides; identifying other components of the universe (e.g., stars, galaxies) and their characteristics; and comparing theories and evaluating evidence of the origin and evolution of the universe, stars, and the solar system.

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**IV. PHYSICAL SCIENCES**

**016 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; interpreting chemical symbols, formulas, and expressions; and identifying the molecular structures of various types of organic compounds (e.g., polymers, heterocyclic compounds, aromatic and aliphatic hydrocarbons).

**017 Understand the nature of chemical changes in matter.**

Includes analyzing common chemical changes (e.g., acid-base reactions, redox reactions, aliphatic and alicyclic 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; demonstrating understanding of the mole concept; analyzing factors that affect rates of reaction and chemical equilibrium; and identifying organic functional groups (e.g., alcohols, ethers, amines).

**018 Understand the physical properties of matter, the ideal gas laws, and the nature of physical changes in terms of molecular behavior.**

Includes demonstrating knowledge of the physical characteristics of matter (e.g., density, mass, atomic structure); understanding the difference between weight and mass; applying knowledge of the characteristics of the states of matter; describing what happens at the molecular level during changes of state; identifying the changes in energy that occur during changes of state; demonstrating knowledge of the physical properties of common materials (e.g., metals, nonmetals, water); relating the structure of a crystalline solid to its physical properties (e.g., melting point, conductivity, solubility); comparing the physical properties of mixtures and solutions; and demonstrating knowledge of the behavior of ideal gases, including the relationships among pressure, temperature, and volume.

**019 Understand and apply the concepts of mechanics.**

Includes analyzing motions in terms of concepts of displacement, velocity, and acceleration; recognizing how force and motion are related; applying the laws of motion to various situations; understanding the concepts of inertial mass and momentum; and describing the types and uses of simple machines and explaining their principles of operation.

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**020 Understand and apply the concepts of electricity and magnetism.**

Includes relating the phenomenon of electrostatic charge to the atomic structure of matter; describing the electrostatic forces between charges; describing electric current and conduction in terms of flow of charge; analyzing electric circuits in terms of concepts of potential difference, current, and resistance; recognizing that magnetic fields are produced by both magnets and electric currents; understanding that electric current can be produced from magnetic field changes; and describing technological applications of electromagnetism.

**021 Understand and apply the basic concepts of energy and thermodynamics.**

Includes describing the concept of work and understanding its relationship to energy; identifying different forms of energy (e.g., kinetic, potential, thermal); understanding that energy may transform from one form to another, but that total energy is conserved; discriminating between heat and temperature; describing modes of heat transfer (i.e., convection, conduction, radiation); and demonstrating understanding of the first and second laws of thermodynamics and relating them to the conversion of mechanical to thermal energy and vice versa, including the basic idea of entropy.

**022 Understand the characteristics of waves and vibrations and the properties of light and sound.**

Includes identifying characteristics of waves and oscillations (e.g., amplitude, frequency, period) and relating these to perceived properties of sound and light (e.g., loudness, pitch, intensity, color); describing types of wave (e.g., transverse, longitudinal); applying the concept of light rays to the formation of shadows in various situations; demonstrating knowledge of the law of reflection and its application to the formation of images in mirrors; describing refraction of an interface and by lenses; and recognizing characteristics and properties of the electromagnetic spectrum, including visible light.