MICHIGAN TEST FOR TEACHER CERTIFICATION (MTTC)

TEST OBJECTIVES
FIELD 093: INTEGRATED SCIENCE (ELEMENTARY)

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.

I. FOUNDATIONS OF SCIENTIFIC INQUIRY

001 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.

002 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.

003 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.

004 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).

005 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.

II. LIFE SCIENCE

006 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.

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007 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.

008 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).

009 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.

010 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.

011 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.

III. EARTH/SPACE SCIENCE

012 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.

013 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.

014 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.

015 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.

IV. PHYSICAL SCIENCE

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; and interpreting chemical symbols, formulas, and expressions.

017 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.

018 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.

019 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.

020 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.

021 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.

022 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.

023 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.