

Table of Contents

SUBAREA I. SCIENTIFIC INQUIRY

Competency 1.0 Understand types and uses of natural resources, the effects of human activities on the environment, and the need to preserve the environmental integrity of the Earth’s ecosystems 1

Skill 1.1 Understand the classification, uses, and importance of natural resources and methods of locating and obtaining natural resources 1

Skill 1.2 Identify the positive and negative effects of human activities on Earth’s environment (e.g., reclamation of strip mines, ocean dumping) 5

Skill 1.3 Describe strategies for dealing with environmental problems..... 12

Competency 2.0 Understand the nature of scientific inquiry, the role of observation and experimentation in science, and the relationships between Earth science, technology, and other fields of knowledge..... 15

Skill 2.1 Identify the processing by which new scientific knowledge and hypotheses are generated and rejected 15

Skill 2.2 Understand ethical issues related to Earth science (e.g., accurately reporting experimental results 18

Skill 2.3 Evaluate the appropriateness of a specified experimental design to test a given hypothesis in Earth science 18

Skill 2.4 Understand the role of communication among scientists in promoting scientific progress. 19

Skill 2.5 Identify the similarities and differences between science and technology (e.g., science as investigating the natural world, technology as solving human adaptation problems) 20

Competency 3.0 Understand the processes of gathering, organizing, reporting, and interpreting scientific data in the context of Earth science investigations. 23

Skill 3.1 Evaluate the appropriateness of a given method or procedure for collecting data for a specified purpose 23

TEACHER CERTIFICATION STUDY GUIDE

Skill 3.2	Organize and report given experimental data using appropriate and effective graphic representation (e.g., graphs, tables, diagrams)	23
Skill 3.3	Identify the procedures and criteria for formally reporting experimental procedures and data to the scientific community	23
Skill 3.4	Identify relationships between factors (e.g. inverse, direct, linear) as indicated by experimental data	24
Competency 4.0	Understand how to create, use, and interpret physical and mathematical models (e.g. maps, charts, graphs, diagrams) commonly used in Earth science	26
Skill 4.1	Describe alternative models for conveying given information from Earth science	26
Skill 4.2	Describe methods by which given physical and graphic models are created	27
Skill 4.3	Classify different types of maps (e.g. topographic, geologic) used in Earth science and analyze the information conveyed by that type of map	29
Skill 4.4	Interpret diagrams relating to Earth science (e.g. crustal movements)	31
Competency 5.0	Understand proper and safe use of equipment and materials used in Earth science investigations	33
Skill 5.1	Identify the operating principles for various instruments	33
Skill 5.2	Describe basic safety procedures in a laboratory or field situation (e.g. wearing safety glasses)	34
Skill 5.3	Apply proper procedures for dealing with given accidents and injuries in the Earth science laboratory or in the field	35

SUBAREA II.

ASTRONOMY

Competency 6.0 Understand the physical characteristics and motions of the Earth as well as the evidence of and methods used to determine these characteristics and motions 37

Skill 6.1 Describe historical methods used to study the characteristics and motions of the Earth (e.g., Foucault pendulum)..... 37

Skill 6.2 Identify the physical characteristics of the Earth (e.g., diameter, tilt of axis, distance from the Sun) and how they can be determined 39

Skill 6.3 Describe the consequences of the Earth’s motions (e.g., length of day, change in seasons, length of year) 40

Competency 7.0 Understand the structure, composition, and features of the Sun (including its production and transmission of energy) and the importance of the Sun to Earth processes 41

Skill 7.1 Describe the methods by which the Sun’s diameter, surface temperature, and chemical composition are determined 41

Skill 7.2 Identify the layers of the Sun 43

Skill 7.3 Describe the Sun’s source of energy (fusion reaction) 44

Skill 7.4 Describe the solar surface as the immediate source of energy fro the Earth’s surface 44

Skill 7.5 Understand the sunspot cycle and its possible effects on the Earth’s climate 45

Competency 8.0 Understand the properties, features, and movements of the Earth’s moon; the interactions among the Earth, Moon, and Sun (including phases, tides, and eclipses); and the role of technology and exploration in obtaining knowledge about the Earth, Moon, and Sun 47

Skill 8.1 Relate surface features (e.g., maria, craters, mountains) of the Earth’s moon to events in the history of the Moon.... 47

TEACHER CERTIFICATION STUDY GUIDE

Skill 8.2	Describe the relationship between the height of ocean tides and the relative positions of the Earth, Moon, and Sun	47
Skill 8.3	Describe the relationships between the phases of the Moon and the relative positions of the Earth, Moon, and Sun	48
Skill 8.4	Explain how the lunar exploration program has added to our knowledge of the Earth Moon system	49
Competency 9.0	Understand the scale and organization of the solar system, the role of gravity in the solar system, characteristics of the bodies within the solar system, and physical and mathematical models that describe these objects and their real and apparent motions	50
Skill 9.1	Describe the characteristics (e.g., size, density, surface temperature) of the planets	50
Skill 9.2	Identify the relative sizes, distances, tilts, and positions of the planets.....	53
Skill 9.3	Identify the position of the planets on the ecliptic	54
Skill 9.4	Describe the origin and properties of comets and meteors	54
Skill 9.5	Use the apparent motion of celestial objects to infer solar system models (i.e., geocentric, heliocentric).	55
Skill 9.6	Apply Kepler’s laws to describe and predict the motions of the planets.	57
Competency 10.0	Understand stars, their motions and life cycles, and the methods and technology used to study them.....	58
Skill 10.1	Compare types of telescopes (e.g., optical, radio, infrared, ultraviolet) and the ways in which they are used to acquire information on star characteristics	58
Skill 10.2	Identify methods and uses of spectroscopy.....	61
Skill 10.3	Identify types of stars (e.g., pulsars, Cepheid variables) and their characteristics	62

TEACHER CERTIFICATION STUDY GUIDE

Skill 10.4	Use the H-R diagram to analyze the life cycles of stars.....	64
Skill 10.5	Analyze stellar life cycles to understand the formation and initial development of the solar system.....	65
Competency 11.0	Understand evidence regarding the size, structure, scale, and motions of the universe, the Milky Way galaxy, and the solar system	69
Skill 11.1	Describe the evidence regarding the location of the solar system within the Milky Way galaxy	69
Skill 11.2	Identify historical methods of inferring the size, structure, and motions of the galaxy and the solar system (e.g., star observations and counts).....	70
Skill 11.3	Describe the evidence for and interpretations of an expanding universe (e.g., red shift and the Doppler effect).....	72
Skill 11.4	Analyze types of evidence used to infer scales and relative motions of the solar system, the Milky Way galaxy, the universe (e.g., in relation to relative size and distance).....	72

SUBAREA III.

METEOROLOGY

Competency 12.0	Understand the composition, structure, and properties of the Earth's atmosphere and the mechanisms and effects of energy transfer involving the Earth-atmosphere system	75
Skill 12.1	Identify the properties (e.g., density, composition, temperature) of the atmosphere from the Earth's surface through the thermosphere and the significance of changes in these properties	75
Skill 12.2	Analyze how various wavelengths of solar radiation (e.g., ultraviolet, visible light, infrared) are affected as the radiation enters and passes through the atmosphere and is absorbed by and radiated from the Earth's surface	77
Skill 12.3	Identify the processes by which energy is transferred to and within the atmosphere (e.g., radiation, convection, conduction).....	79

TEACHER CERTIFICATION STUDY GUIDE

Skill 12.4	Analyze global wind patterns in terms of latitudinal variations in insolation and the Coriolis effect.	80
Competency 13.0	Understand the properties of water, conditions in the atmosphere that favor phase changes, and the energy relationships among phase changes, cloud formation, and precipitation.....	83
Skill 13.1	Relate the physical properties of water (e.g., high specific heat, surface tension) to the chemical structure and properties of water molecules.....	83
Skill 13.2	Describe the energy changes involved in the transition between phases of water (i.e., latent heat)	84
Skill 13.3	Describe the atmospheric conditions under which fog and clouds with various characteristics form (e.g., adiabatic temperature changes, dew-point, atmospheric stability)	85
Skill 13.4	Describe the conditions under which precipitation forms	89
Skill 13.5	Predict the type of precipitation that will fall to the Earth's surface under given conditions.....	90
Competency 14.0	Understand characteristics of broad-scale weather systems and local weather, the relationship between them, and the methods and instruments used to collect weather data.....	93
Skill 14.1	Identify the types and characteristics of air masses, their movements, the kinds of fronts that form between air masses	93
Skill 14.2	Identify the horizontal and vertical movements of air in high- and low-pressure areas	94
Skill 14.3	Describe the use of weather instruments (e.g., thermometer, psychrometer) for collecting given types of weather data	96
Competency 15.0	Understand weather maps, how they are prepared, and how they are used.	98
Skill 15.1	Interpret symbols used on weather maps.....	98

TEACHER CERTIFICATION STUDY GUIDE

Skill 15.2	Describe the methods used to generate weather maps	102
Skill 15.3	Infer recent weather in a given location based on one or more weather maps	110
Skill 15.4	Predict future weather in a given location based on one or more weather maps	114
Competency 16.0	Understand the principles and technology of weather forecasting and the effects of weather and weather forecasting on humans	115
Skill 16.1	Describe the use of weather models in forecasting	115
Skill 16.2	Identify the role of computers and satellite photographs in generating weather forecasts.	115
Skill 16.3	Describe types of hazardous weather	118
Skill 16.4	Identify types and functions of weather precautions	124
Skill 16.5	Explain the role of the National Weather Service in issuing weather alerts.....	126
Competency 17.0	Understand the locations and characteristics of the Earth’s major climatic regions and analyze factors that affect local climate and the relationship between weather and climate	129
Skill 17.1	Infer the climatic zone in which a given area is located based on temperature and precipitation data	129
Skill 17.2	Identify the factors that affect the climate in a given region (e.g., insolation, wind patterns, topography).....	131
Skill 17.3	Describe the relationship between the climate of a region and its weather	133
Competency 18.0	Understand the effects of human activities and natural processes on the atmosphere, theories about the long-range effects of human activities on global climate, and methods of controlling and minimizing those effects	134
Skill 18.1	Identify common air pollutants and their sources and effects.....	134

TEACHER CERTIFICATION STUDY GUIDE

Skill 18.2	Describe pollutants and atmospheric chemical reactions involving these pollutants	137
Skill 18.3	Describe factors that affect local air pollutant concentrations (e.g., population density).....	138
Skill 18.4	Analyze the theory of global warming due to increased levels of atmospheric carbon dioxide from the burning of fossil fuels.....	139

SUBAREA IV. GEOLOGY AND OCEANOGRAPHY

Competency 19.0 Understand the processes of mineral and rock formation, the characteristics of different types of minerals and rocks, and the methods used to identify and classify them..... 144

Skill 19.1	Use classification schemes (e.g., Mohs' scale of hardness, crystal form, chemical composition) to identify common rock-forming minerals	144
Skill 19.2	Identify the processes by which different kinds of rocks are formed.....	148
Skill 19.3	Classify a given rock as sedimentary, igneous, metamorphic	154

Competency 20.0 Understand the structure of the earth, the constructional forces that have shaped its surface, theories and evidence of crustal movements, and the effects of crustal movements on landscape 158

Skill 20.1	Use seismic waves to infer the Earth's internal structure	158
Skill 20.2	Use the theory of dynamic equilibrium (e.g., isostasy) to explain landscape development	159
Skill 20.3	Describe the evidence for continental drift and seafloor spreading	160
Skill 20.4	Apply the theory of plate tectonics to explain landscape development and geologic phenomena (e.g., volcanism, earthquakes) and to predict future movements of land masses.....	162

TEACHER CERTIFICATION STUDY GUIDE

Competency 21.0	Understand erosional-depositional processes that change the Earth’s surface (e.g., weathering, erosion) and the relationship between these processes and landscape development	164
Skill 21.1	Describe the processes of mechanical, chemical, and biological weather and factors that affect the rate at which rocks weather and soils are produced.	164
Skill 21.2	Identify the processes of erosion by various agents (e.g., wind, water, glaciers) and factors that affect erosion rates and patterns.	167
Skill 21.3	Explain the processes by which given landscape features (e.g., eskers, moraines) are formed.	170
Skill 21.4	Describe the effects of glaciation on the Massachusetts landscape.	172
Competency 22.0	Understand characteristics of the major geologic time divisions and theories and supporting evidence of the Earth’s geologic history	173
Skill 22.1	Identify the conditions and characteristic fossils of the various geologic periods.....	173
Skill 22.2	Apply the laws and principles of geology (e.g., law of original horizontality, law of superposition) to interpret diagrams of rock strata.....	175
Skill 22.3	Identify the principles, applications, and limits of radioactive dating.	178
Skill 22.4	Use paleontological information to infer to geologic history of a given area.	179
Competency 23.0	Understand the hydrologic cycle and the processes by which water moves on and beneath the Earth’s surface, and use this knowledge to analyze local weather budgets	181
Skill 23.1	Analyze a cross-sectional diagram of a water table and surrounding rock strata to predict movement of groundwater (e.g., aquifers, gradient).	181

TEACHER CERTIFICATION STUDY GUIDE

Skill 23.2	Describe the effects of various factors (e.g., vegetation, gradient, rock strata) on components of a local water budget.	182
Competency 24.0 Understand ocean water and its movements.....		185
Skill 24.1	Describe the circulation patterns in the oceans and factors that influence these patterns (e.g., temperature variations, wind systems, Coriolis effect).	185
Skill 24.2	Describe the types, causes, and effects of tidal and wave motions of ocean water.	188
Competency 25.0 Understand the structure and topography of the ocean basin.		190
Skill 25.1	Identify ocean zones (e.g., littoral, benthic) in terms of their physical characteristics.	190
Skill 25.2	Describe the major structural features of the ocean floor.	191
Skill 25.3	Identify the factors involved in changing the structure of the ocean floor.	193
Competency 26.0 Understand marine life and the marine habitat		195
Skill 26.1	Identify the characteristics and major groups of marine plants and animals.	195
Skill 26.2	Describe the zonation of marine plants and animals.	197
Skill 26.3	Describe the relationships between marine organisms and the marine environment.	199
Sample Test		201
Answer Key		212
Rationales with Sample Questions		213