MVS Course Alignment Document

Earth Science MMC

STANDARD E1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS				
E1.1	**Scientific Inquiry**		**Unit**	**Lesson**
	E1.1A	Generate new questions that can be investigated in the laboratory or field.	All	At least 1 per unit
	E1.1B	Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.	All	At least 1 per unit
	E1.1C	Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity–length, volume, weight, time interval, temperature–with the appropriate level of precision).	All	At least 1 per unit
	E1.1D	Identify patterns in data and relate them to theoretical models.	All	At least 1 per unit
	E1.1E	Describe a reason for a given conclusion using evidence from an investigation.	All	At least 1 per unit
	E1.1f	Predict what would happen if the variables, methods, or timing of an investigation were changed.	2	2.2
	E1.1g	Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.	All	At least 1 per unit
	E1.1h	Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.	2	2.1
	E1.1i	Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.	9	9.4
E1.2	**Scientific Reflection and Social Implications**		**Unit**	**Lesson**
	E1.2A	Critique whether or not specific questions can be answered through scientific investigations.	9	9.4
	E1.2B	Identify and critique arguments about personal or societal issues based on scientific evidence.	8, 9	8.1, 9.4
	E1.2C	Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.	9	9.4
	E1.2D	Evaluate scientific explanations in a peer review process or discussion format.	9	9.4

E1.2E	Evaluate the future career and occupational prospects of science fields.	10	10.5
E1.2f	Critique solutions to problems, given criteria and scientific constraints.	9	9.4
E1.2g	Identify scientific tradeoffs in design decisions and choose among alternative solutions.	2	2.1
E1.2h	Describe the distinctions between scientific theories, laws, hypotheses, and observations.	2	2.1
E1.2i	Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.	2,3,9	2.1, 9.5
E1.2j	Apply science principles or scientific data to anticipate effects of technological design decisions.	2, 9	2.1, 9.5
E1.2k	Analyze how science and society interact from a historical, political, economic, or social perspective.	9	9.4

Standard E2: EARTH SYSTEMS			
E2.1	**Earth Systems Overview**	**Unit**	**Lesson**
E2.1A	Explain why the Earth is essentially a closed system is terms of matter.	2	2.2
E2.1B	Analyze the ineractions between the major systems(geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.	2	2.2
E2.1C	Explain, using specific examples, how a change in one system affects other Earth systems.	2	2.2
E2.2	**Energy in Earth Systems**	**Unit**	**Lesson**
E2.2A	Describe the Earth's principal sources of internal and external energy (e.g. radioactive decay, gravity, solar energy).	2, 9	2.2, 9.1
E2.2B	Identify differences in the origin and use of renewable (e.g. solar, wind, water, biomass) and nonrenewable(e.g. fossil fuels, nuclear[U-235]) sources of energy.	3	3.2
E2.2C	Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.	9	9.1
E2.2D	Identify the main sources of energy to the climate system.	9	9.1
E2.2e	Explain how energy changes form through Earth systems.	2	2.2
E2.3	**Biogeochemical Cycles**	**Unit**	**Lesson**
E2.3A	Explain how carbon exists in different forms such as limetone(rock), carbon dioxide(gas), carbonic acid(water), and animals(life) within Earth systems and how those forms can be benficial or harmful.	2	2.1
E2.3d	Explain how cabon moves hrough th Earth system (including the geosphere) and how it may benefit (e.g. improve soils for agriculture) or harm (e.g. act as a pollutant) society.	7	7.2.4
E2.4	**Resources and Human Impacts on Earth Systems**	**Unit**	**Lesson**

E2.4A	Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.	3,9	3.4, 9.1
E2.4B	Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.	3,8,9	3.4, 9.1, 9.4
E2.4c	Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion.	9	9.1
E2.4d	Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.	3	3.4

Standard E3 THE SOLID EARTH

E3.p1	**Landforms and Soils (prerequisite)**	**Unit**	**Lesson**
E3.p1A	Explain the origin of Michigan landforms. Describe and identify surface features using maps and satellite images. (prerequisite)	7	7.4
E3.p1B	Explain how physical and chemical weathering leads to erosion and the formation of soils and sediments. (prerequisite)	7	7.1
E3.p1C	Describe how coastal features are formed by wave erosion and deposition. (prerequisite)	7	7.5
E3.p3	**Basic Plate Tectonics (prerequisite)**	**Unit**	**Lesson**
E3.p3A	Describe geologic, paleontologic, and paleoclimatalogic evidence that indicates Africa and South America were once part of a single continent.	5	5.1, 5.2
E3.p3B	Describe the three types of plate boundaries (divergent, convergent, and transform) and geographic features associated with them (e.g. continental rifts and mid-ocean ridges, volcanic and island arcs, deep-sea trenches, transform faults).	5	5.1, 5.2
E3.p3C	Describe the three major types of volcanoes (shield volcano, stratovolcano, and cinder cones) and relationship to the Ring of Fire.	6	6.2
E3.1	**Advanced Rock Cycle**	**Unit**	**Lesson**
E3.1A	Discriminate between igneous, metamorphic, and sedimentarty rocks and describe the processes that change one kind of rock into another.	3	3.3
E3.1B	Explain the relaionship between the rock cycle and plate tectonics theory in regard to the origins of igneours, sedimentary, and metamorphic rocks.	3	3.3
E3.1c	Explain how the size and shape of grains in a sedimentary rock indicate the environment of formation(including climate) and deposition.	3	3.3
E3.1d	Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.	3	3.3
E3.1e	Explain how the texture(foliated, nonfoliated) of metamorphic rock can indicate whether it has experienced regional or contact metamorphism.	3	3.3

E3.2	Interior of the Earth		Unit	Lesson
	E3.2A	Describe the interior of the Earth(in terms of crust, mantle, and inner and outer cores) and where the magnetic field of the Earth is generated.	2	2.2
	E3.2B	Explain how scientists infer that the Earth has interior layers with discernable properties usings patterns of primary (*P*) and secondary (*S*) seismic waves arrivals.	2	2.1
	E3.2C	Describe the differences between oceanic and continental crust (including density, age, composition).	5	5.1, 5.2
	E3.2d	Explain the uncertaintities associated with models of the interior of the Earth an how these models are validated.	2	2.1
E3.3	**Plate Tectonics Theory**		**Unit**	**Lesson**
	E3.3A	Explain how plate tectonics accounts for the featues and processes (sea floor spreading, mid-ocean ridges, subduction zones, earthquakes and volcanoes, mountain ranges) that occur on or near the Earth's surface.	5	5.1, 5.2
	E3.3B	Explain why tectonic plates move using the concept of heart flowing through mantle convection, coupled with the cooing and sinking of aging ocan plates that result from their increased density.	5	5.1
	E3.3C	Describe the motion history of geologic features (e.g. Hawaii) using equations relating rate, time and distance.	5	5.1
	E3.3d	Distinguish plate boundaries by the pattern of depth and magnitude of earthquakes.	5	5.1
	E3.r3f	Describe how the direction and rate of movement for the North American plate has affected local climate over the last 600 million years. (*recommended*)	5	5.1
E3.4	**Earthquakes and Volcanoes**		**Unit**	**Lesson**
	E3.4A	E3.4A: Uses the distribution of earthquakes and volcanoes to locate and determine the types of plate boundaries.	5, 6	5.1, 6.1, 6.2
	E3.4B	E3.4B: Describe how the sizes of earthquakes and volcanoes are measured or characterized.	6	6.1, 6.2
	E3.4C	E3.4C: Describe the effects of earthquakes and volcanic eruptions on humans.	6	6.1, 6.2
	E3.4d	E3.4d: Explain how the chemical compositon of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.	6	6.2
	E3.4e	E3.4e: Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.	6	6.2
	E3.4f	E3.4f: Explain why fences are offset after an earthquake, using the elastic rebound theory.	6	6.1

Standard E4 THE FLUID EARTH				
E4.p1	**Water Cycle (prerequisite)**		**Unit**	**Lesson**

	E4.p1A	E4.p1A: Describe that the water cycle includes evaporation, transpiration, condensation, precipitation, infiltration, surface runoff, groundwater, and absorption (*prerequisite*).	7	7.2, 7.3
	E4.p1B	E4.p1B: Analyze the flow of water between the elements of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater. (*prerequisite*)	7	7.2, 7.3
	E4.p1C	E4.p1C: Describe the river and stream types, features, and process including cycles of flooding, erosion, and deposition as they occur naturally and as they are impacted by land use decisions. (*prerequisites*)	7	7.2, 7.3
	E4.p1D	E4.p1D: Explain the types, process, and beneficial functions of wetlands.	7	7.3
E4.p2	**Weather and the Atmosphere (prerequisite)**		**Unit**	**Lesson**
	E4.p2A	Describe the composition and layers of the atmosphere. *(prerequisite)*	9	9.1
	E4.p2B	Describe the differences between weather and climate. *(prerequisite)*	9	9.1
	E4.p2C	Explain the difference fog and dew formation and cloud formation. *(prerequisite)*	9	9.2
	E4.p2D	Describe relative humidity in terms of the moisture content of the air and the moisture capacity of the air and how these depen on the temperature. *(prerequisite)*	9	9.1, 9.2
	E4.p2E	Describe conditions associated with frontal boundaries (cold, warm, stationary, and occluded). *(prerequisite)*	9	9.3
	E4.p2f	Describe the characteristics and movement across North America of the major air masses and the jet stream. *(prerequisite)*	9	9.3
	E4.p2G	Interpret a weather map an ddescribe present weather conditions and predict changes in weather ove 24 hours. *(prerequisite)*	9	9.2, 9.3
	E4.p2H	Explain the primary causes of seasons. *(prerequisites)*	10	10.2
	E4.p2I	Identify major global wind belts (trade winds, prevailing westerlies, and polar easterlies) and tht their vertical components control the global distribution of rainforests and deserts. *(prerequisites)*	9	9.1
E4.p3	**Glaciers (prerequisite)**		**Unit**	**Lesson**
	E4.p3A	Describe how glaciers have affected the Michigan landscape and how the resulting landforms impact of our state economy. *(prerequisite)*	7	7.4
	E4.p3B	Explain what happens to the lithosphere when an ice sheet is removed, *(prerequisite)*	9	9.4
	E4.p3C	Explain the formation of the Great Lakes. *(prerequisite)*	7	7.4
E4.1	**Hydrologeology**		**Unit**	**Lesson**
	E4.1A	Compare and contrast surface water systems (lakes, rivers, streams, wetlands) and groundwater in regard to their relative sizes as Earth's freashwater reservoirs and the dynamics of water movement(inputs and outputs, residence times, sustainability).	7	7.2, 7.3

	E4.1B	Explain the features and processes of groundwater systems and how the sustainability of North American aquifers has changed in recent history (e.g the past 100 years) qualitatively using the concepts of recharge, residence tiem, inputs and outputs.	7	7.3
	E4.1C	Explain how water quality in both ground water and surface systems is impacted by land use decisions.	7	7.2, 7.3
E4.2	**Oceans and Climate**		**Unit**	**Lesson**
	E4.2A	Describe the major causes for the ocean's surface and deep water currents, including the prevailing winds, the Coriolis effect, unequal heating o the earth, changes in water temperature and salinity in high atitudes, and basin shape.	8	8.1, 8.2
	E4.2B	Explain how interactions between the oceans and the atmosphere influence global and regional climate. Include the major concepts of heat transfer by ocean currents, thermohaline circulation, boundary currents, evaporation, precipitation, climate zones, and the ocean as a major CO_2 reservoir.	8	8.1, 8.2
	E4.2c	Explain the dynamics (including ocean-atmosphere interactions) of the El-Nino-Southern Oscillation (ENSO) and its effect on continental climates.	8	8.1, 8.2
	E4.2d	Identify factors affecting seawater density and salinity and describe how density affects oceanic currents.	8	8.1, 8.2
	E4.2e	Explain the differences between maritime and continental climates with regard to oceanic currents.	8	8.1, 8.2
	E4.2f	Explain how the Coriolis effect controls oceanic circulation.	8	8.1, 8.2
	E4.2g	Explain how El Nino affects economies (e.g., in South America) *(recommended)*	8	8.1, 8.2
E4.3	**Severe Weather**		**Unit**	**Lesson**
	E4.3A	Describe the various conditions of formation associated with several weather (thunderstorms, tornadoes, hurricanes, floods, waves, and drought).	9	9.1, 9.3
	E4.3B	Describe the damage resulting from, and the social impact of thunderstorms, tornadoes, hurricanes, and floods.	9	9.3
	E4.3C	Describe severe weather and flood safety and mitigation.	9	9.3
	E4.3D	Describe the seasonal variations in severe weather.	9	9.3
	E4.3E	Describe the conditions associated with frontal boundaries that result in severe weather (thunderstorms, tornadoes, and hurricanes).	9	9.3
	E4.3F	Describe how mountains, frontal wedging(including dry lines), convection, and convergence form clouds and precipitation.	9	9.1, 9.3

Standard E5 THE EARTH IN SPACE AND TIME

E5.p1	**Sky Observations (prerequisites)**		**Unit**	**Lesson**
	E5.p1A	E5.p1A: Describe the motions of various celestial bodies and some effects of those motions. *(prerequisites)*	10	10.1, 10.2

	E5.p1B	E5.p1B: Explain the primary cause of seasons. *(prerequisites)*	10	10.1
	E5.p1C	E5.p1C: Explain how a light year can be used as a distance unit. *(prerequisite)*	10	10.1
	E5.p1D	E5.p1D: Describe the position and motion of our solar system in our galaxy. *(prerequisite)*	10	10.1
E5.1	**The Earth in Space**		**Unit**	**Lesson**
	E5.1A	Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.	10	10.2
	E5.1b	Describe how the Big Bang theory accounts for the formation of the universe.	10	10.1, 10.5
	E5.1c	Explain how observations of the cosmic microwave background have helped determine the age of the universe.	10	10.5
	E5.1d	Differentiate between the cosmological and Doppler red shift.	10	10.5
E5.2	**The Sun**		**Unit**	**Lesson**
	E5.2A	Identify patterns in solar activities (sunspot cycle, solar flares, solar wind).	10	10.4
	E5.2B	Relate events on the Sun to phenomena such as auroras, disruption of radio and satellite communications, and power grid disturbances.	10	10.4
	E5.2C	Describe how nuclear fusion produces energy in the Sun.	10	10.4
	E5.2D	Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemcial elements.	10	10.4
E5.2x	**Stellar Evolution**		**Unit**	**Lesson**
	E5.2e	E5.2e: Explain how the Hertzsprung-Russell (H-R) diagram can be used to deducr other parameters (distance).	10	10.5
	E5.2f	E5.2f: Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.	10	10.5
	E5.2g	E5.2g: Explain how the balance between fusionand gravity controls the evolution of a star (equilibrium).	10	10.5
	E5.2h	E5.2h: Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.	10	10.5
E5.3	**Earth History and Geolgic Time**		**Unit**	**Lesson**
	E5.3A	Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 Ga (billion years ago).	10	10.1, 10.5
	E5.3B	Describe the process of radioactive decay and explain how radioactive elements are used to date the rocks that contain them.	4	4.1
	E5.3C	Relate major events in the history of the Earth to the geolgic time scale, including formation of the Earth, formation of an oxygen atmosphere, rise of life, Cretaceous-Tertiary (K-T) and Permian extinctions, and Pleistocene ice age,	4	4.2
	E5.3D	Describe how index fossils can be used to determine time sequence.	4	4.2
E5.3x	**Geologic Dating**		**Unit**	**Lesson**

	E5.3e	Determine the approximate age of a sample, when given the half-life of a radioactive substance (in graph or tabular form) along with the ratio of daughter to parent substances present in the sample.	4	4.1
	E5.3f	Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot.	4	4.1
	E5.3g	Identify a sequence of geologic events using relative-age dating principles.	4	4.1, 4.2
E5.4	**Climate Change**		**Unit**	**Lesson**
	E5.4A	Explain the natural mechanism of the greenhouse effect, including comparisons of the major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone).	9	9.1, 9.4
	E5.4B	Describe natural mechanisms that could result in significant changes in climate (e.g., major volcanic eruptions, changes in sunlight received by the earth, and meteroite impacts).	9	9.4
	E5.4C	Analyze the empirical relationship betweenthe emissions of carbon dioxide, atmospheric carbon dioxide levels, and the average global temperature over the past 150 years.	9	9.4
	E5.4D	Based on evidence of observable changes in recent history and climate change models, explain the consequences of warmer oceans (includig the results of increased evaporation, shoreline and estuarine impacts, oceanic algae growth, and coral bleaching) and changing climatic zones (including the adaptive capacity of the biosphere).	8,9	8.2, 9.4
	E5.4e	Based on evidence from historical climate research (e.g. fossils, varves, ice core data) and climate change models, explain how the current melting of polar ice caps can impact the climatic system.	7,9	7.4,
	E5.4f	Describe geologic evidence that implies climates were significantly colder at times in the geologic record (e.g. geomorphology, striations, and fossils)	9	9.4
	E5.4g	Compare and contrast the heat-trapping mechanisms of the major greenhouse gases resulting from emissions (carbon dioxide, methane, nitrous oxide, fluorocarbons) as well as their abundace and heat-trapping capacity.	9	9.4
	E5.4h	Use oxygen isotope data estimate paleotemperature. *(recommended)*		
	E5.4i	Explain the causes of short-term climate changes such as catastrophic volcanic eruptions and impact of solar system objects. *(recommended)*	9	9.4
	E5.4j	Predict the global temperature increase by 2100, given data on the annual trends of CO2 concentration increase. *(recommended)*	9	9.4