LOCS Parent University

WHAT SCIENCE COURSES SHOULD MY HIGH SCHOOL STUDENT TAKE?

Tonight:

- ✓ Overview of the Michigan Science Standards
- ✓ Required High School Science Course Sequence
- ✓ AP Offerings
- ✓ Sample Course Pathways

Michigan Science Standards

The Michigan Science Standards (MSS) were adopted in November 2015. They replace the High School Content Expectations (HSCEs) and the Grade Level Content Expectations (GLCEs) in science.

The Michigan Science Standards are adapted from the Next Generation Science Standards (NGSS). The NGSS are built from a document titled “A Framework for K-12 Science Education”.

Michigan Science Standards are organized into the following grade bands:

- K-5
- 6-8
- 9-12

Students are assessed in Science by the MDE on the M-STEP in grades 5, 8, and 11. Full testing accountability for the Science M-STEP occurs in the 2019-2020 school year.

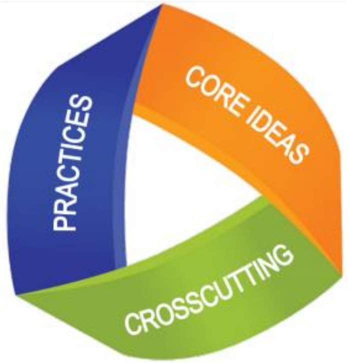
Michigan Science Standards

KEY DIFFERENCES

- The Michigan Science Standards are actually Performance Expectations.
- Engineering is embedded into Performance Expectations.
- The Michigan Science Standards are three-dimensional.

THREE-DIMENSIONS

- Science and Engineering Practices
  - *Skills*
- Cross-cutting Concepts
  - *Lenses*
- Disciplinary Core Ideas (DCI)
  - *Content*



Science and Engineering Practices

Scientists and engineers are engaged in a variety practices to figure things out and design solutions.

Example: Ask students to produce an explanation about the causal mechanism for the phenomena—at their level of scientific knowledge and show how their interpretation of the data is evidence for their explanation.

Crosscutting Concepts

These are big ideas that run through all domains of science. These can be thought of as lenses in which scientists or engineers interact with science concepts.

Example: How do the different components of the system interact?

Crosscutting Concepts

- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change

Disciplinary Core Ideas

The Michigan Science Standards are grouped into four domains. Students' understanding in each domain builds through K-12 journey. With fewer core ideas, teachers can go into more depth and students can explore more deeply.

Example: **ESS1.A: The Universe and Its Stars**

Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

Disciplinary Core Ideas

Life Science	Physical Science
LS1: From Molecules to Organisms: Structures and Processes LS2: Ecosystems: Interactions, Energy, and Dynamics LS3: Heredity: Inheritance and Variation of Traits LS4: Biological Evolution: Unity and Diversity	PS1: Matter and Its Interactions PS2: Motion and Stability: Forces and Interactions PS3: Energy PS4: Waves and Their Applications in Technologies for Information Transfer
Earth & Space Science	**Engineering & Technology**
ESS1: Earth's Place in the Universe ESS2: Earth's Systems ESS3: Earth and Human Activity	ETS1: Engineering Design ETS2: Links Among Engineering, Technology, Science, and Society

HSCE (OLD) vs. MSS (NEW)

HSCE

E5.1 The Earth in Space

E5.1A Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.

E5.1b Describe how the Big Bang theory accounts for the formation of the universe.

E5.1c Explain how observations of the cosmic microwave background have helped determine the age of the universe.

E5.1d Differentiate between the cosmological and Doppler red shift.

E5.2 The Sun

E5.2A Identify patterns in solar activities (sunspot cycle, solar flares, solar wind).

E5.2B Relate events on the Sun to phenomena such as auroras, disruption of radio and satellite communications, and power grid disturbances.

E5.2C Describe how nuclear fusion produces energy in the Sun.

E5.2D Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.

MSS

HS-ESS1-1. **Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.** [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [*Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.*]

HS-ESS1-2. **Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.** [Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).]

HS-ESS1-3. **Communicate scientific ideas about the way stars, over their life cycle, produce elements.** [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.] [*Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.*]

HS-ESS1-4. **Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.** [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.] [*Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus.*]

Physical Science

Evidence Statement for HS-ESS1-4

Observable features of the student performance by the end of the course:		
1	Representation	
	a	Students identify and describe* the following relevant components in the given mathematical or computational representations of orbital motion: the trajectories of orbiting bodies, including planets, moons, or human-made spacecraft; each of which depicts a revolving body's eccentricity e = f/d, where f is the distance between foci of an ellipse, and d is the ellipse's major axis length (Kepler's first law of planetary motion).
2	Mathematical or computational modeling	
	a	Students use the given mathematical or computational representations of orbital motion to depict that the square of a revolving body's period of revolution is proportional to the cube of its distance to a gravitational center ($T^2 \propto R^3$, where T is the orbital period and R is the semi-major axis of the orbit — Kepler's third law of planetary motion).
3	Analysis	
	a	Students use the given mathematical or computational representation of Kepler's second law of planetary motion (an orbiting body sweeps out equal areas in equal time) to predict the relationship between the distance between an orbiting body and its star, and the object's orbital velocity (i.e., that the closer an orbiting body is to a star, the larger its orbital velocity will be).
	b	Students use the given mathematical or computational representation of Kepler's third law of planetary motion ($T^2 \propto R^3$, where T is the orbital period and R is the semi-major axis of the orbit) to predict how either the orbital distance or orbital period changes given a change in the other variable.
	c	Students use Newton's law of gravitation plus his third law of motion to predict how the acceleration of a planet towards the sun varies with its distance from the sun, and to argue qualitatively about how this relates to the observed orbits.

Engineering Embedded - Physical Science

HS-PS1-6. **Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*** [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [*Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**PS1.B: Chemical Reactions** • In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary)*	**Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable.

K-12 Coherence

K-PS2-1. **Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.** [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [*Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.*]

3-PS2-1. **Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.** [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [*Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.*]

MS-PS2-1. **Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*** [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [*Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.*]

HS-PS2-1. **Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.** [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.] [*Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.*]

High School Sequence- course 1

- **PHYSICAL SCIENCE (REQUIRED) 1.0 credit, grades 9-12**

  Physical Science is an introductory course covering Chemistry and Physics topics. Physical Science is intended to not only prepare students for the Physical Science portion of the MME but to also meet Michigan’s high school graduation requirements. This course is aligned with the Michigan Science Standards (MSS). Topics of study include: Structure and Properties of Matter, Chemical Reactions, Forces and Interactions, Energy, Waves and Electromagnetic Radiation, and Engineering and Design.

  * Lab-based class

  *3 credits of science required for graduation

High School Sequence – course 2

- **BIOLOGY (REQUIRED) 1 credit, grades 9-12**

  Prerequisite: Physical Science

  Biology is an introductory life science course. Biology is intended to not only prepare students for the Biology portion of the MME but to also meet Michigan's high school graduation requirements. This course is aligned with the Michigan Science Standards (MSS). Topics include: Structure and Function, Matter and Energy in Organisms and Ecosystems, Interdependent Relationships in Ecosystems, Inheritance and Variation of Traits, Natural Selection and Evolution, and Engineering and Design.

  * Lab-based class

  *3 credits of science required for graduation

High School Sequence – course 3

- **EARTH SCIENCE (REQUIRED) 1 credit, grades 10-12**
  Prerequisite: Physical Science and Biology
  Earth Science is the capstone course in the science sequence. Earth Science is intended to prepare students for the Earth Science portion of the MME and to meet Michigan's high school graduation requirements. This course is aligned with the Michigan Science Standards (MSS). Topics include: Space systems, History of the Earth, Earth's Systems, Weather and Climate, Human Sustainability and Engineering and Design.

  * Lab-based class

  *3 credits of science required for graduation

Science AP Offerings

- ADVANCED PLACEMENT

  The Advanced Placement (AP Program) sponsored by the College Board, was created in 1955 as a cooperative educational endeavor between secondary schools and colleges/universities. It exposes high school students to college level material through involvement in an AP or Honors course, and it gives them the opportunity to demonstrate that they have mastered it by taking an AP examination. The AP program enriches the secondary school experience of students who are willing and able to apply themselves to college level studies and provides the means for colleges to grant credit, placement, or both, to students who have successfully done so.

Science AP Offerings

- The following are a list of the Science AP Courses offered at LOHS:
  - AP Biology
  - AP Chemistry
  - AP Computer Science
  - AP Physics 1 & 2
  - AP Physics C: E&M
  - AP Physics C: Mechanics
  - *AP Environmental Science*

Possible Pathways

Biology Pathway

9th	10th	11th	12th
Physical Science (1)	Biology (1)	Earth Science (1)	AP Biology (1.5)
	Honors Chemistry (1)	Zoology (1) or Honors Human Anatomy (1)	Organic Chemistry (.5) & AP Chemistry (1.5)

Physics Pathway

9th	10th	11th	12th
Physical Science (1) &	Earth Science (1)	AP Physics 1 (1.5)	AP Physics 2 (1.5) or
Biology (1)			AP Physics C: Mechanics (1) &/or E and M (1)

Possible Pathways

Chemistry Pathway

9th	10th	11th	12th
Physical Science (1) &	Honors Chemistry (1)	Earth Science	Organic Chemistry (.5)
Biology (1)			AP Chemistry (1.5)

Environmental Pathway

9th	10th	11th	12th
Physical Science (1)	Biology (1)	Earth Science (1)	AP Environmental Science (1.5)
		Environmental Science (.5)	Astronomy & Meteorology (.5) and/or Geology (.5)

Possible Pathways

Health and Human Services Pathway

9th	10th	11th	12th
Physical Science (1) &	Earth Science (1)	Zoology or Honors Human Anatomy (1)	AP Biology (1.5)
Biology (1)	Forensic Science I (.5)	Forensic Science 2 (.5)	

Earth Science Pathway

9th	10th	11th	12th
Physical Science (1)	Biology (1)	Earth Science (1)	AP Environmental Science (1.5)
		Astronomy & Meteorology (.5)	Geology (.5)

Possible Pathways

CTE Engineering/Manufacturing and Industrial Technology Pathway

9th	10th	11th	12th
Physical Science (1)	Biology (1)	Earth Science (1)	AP Physics 1 (1.5) or AP Physics C (1)
	Engineering & Design (1)	Engineering Technology, Manufacturing and Engineering (1)	

*All of these CTE courses can satisfy Senior level math if taken as a Senior
**Engineering Technology, Manufacturing and Engineering can be swapped out with: Architectural Design, Interior Design, Animation, and/or Engineering Research and Design

Computer Science Pathway

9th	10th	11th	12th
Physical Science (1) &	Earth Science (1)	Computer Programming (1)	AP Computer Science (1.5)
Biology (1)	Computer Applications (.5)		

**Other courses could include: Database Fundamentals, Digital Design, Web Languages, Independent Study, Internship

Possible Pathways

Non AP Pathway

9th	10th	11th	12th
Physical Science (1)	Biology (1)	Earth Science (1)	Forensic Science II (.5)
		Forensic Science I (.5)	

Science Sampling Pathway

9th	10th	11th	12th
Physical Science (1)	Biology (1)	Earth Science (1)	AP Physics 1 (1.5)
Engineering & Design 1 (.5)	Forensic Science I (.5)	Zoology (1)	Environmental Science (.5)

Thank You For Attending!

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