UNIT 1	Lesson C Theories, Laws, Models	3 Days

BENCHMARK(S):

SC.7.N.3.1 Recognize and explain the difference between theories and laws and give several examples of scientific theories and the evidence that supports them.
SC.6.N.3.1 Recognize and explain that a scientific theory is a well-supported and widely accepted explanation of nature and is not simply a claim posed by an individual. Thus, the use of the term theory in science is very different than how it is used in everyday life.
SC.8.N.3.2 Explain why theories may be modified but are rarely discarded.
SC.6.N.2.2 Explain that scientific knowledge is durable because it is open to change as new evidence or interpretations are encountered.
SC.7.N.1.6 Explain that empirical evidence is the cumulative body of observations of a natural phenomenon on which scientific explanations are based.
SC.7.N.1.7 Explain that scientific knowledge is the result of a great deal of debate and confirmation within the science community.
SC.7.N.2.1 Identify an instance from the history of science in which scientific knowledge has changed when new evidence or new interpretations are encountered.
SC.7.N.1.5 Describe the methods used in the pursuit of a scientific explanation as seen in different fields of science such as biology, geology, and physics.
SC.7.N.3.2 Identify the benefits and limitations of the use of scientific models.

CONTENT FOCUS & ITEM SPECS REFERENCE SHEET(S):

SC.7.N.3.1

SC.6.N.2.2

SC.7.N.1.5

ESSENTIAL CONTENT

LEARNING TARGETS:

- I can explain the difference between a scientific law and scientific theory.
- I can identify examples of both theories and laws.
- I can explain that scientific knowledge may change as new evidence is discovered or new scientific interpretations are formed.
- I can explain that scientific explanations are based on empirical evidence, logical reasoning, predictions, and modeling.
- I can identify instances in the history of science in which scientific knowledge has changed as a result of new evidence.
- I can describe and/analyze common methods and/or models used in different fields of science.

- I can identify both benefits and limitations of scientific models.
- I can explain why science knowledge is durable.

ESSENTIAL QUESTIONS:
- Why does science need both theories and laws?
- How do scientific investigations differ between various fields of science and environments?
- Why are models necessary in science?
- Why does scientific knowledge change?
- What is an example of a time when scientific knowledge changed?

HIGHER ORDER QUESTIONS:
1. Can a scientific theory become a scientific law? Why or why not?
2. How is the word theory used in science different from the word theory used in common language?
3. What are the pros and cons for all models listed: 2D models, 3D models, mechanical models, mathematical models, and digital models.

ALIGNED VOCABULARY:

- Scientific Theory
- Scientific Law
- Scientific Model
  - 2D models
  - 3D models
  - Mechanical models
  - Mathematical models
  - Digital models
- Empirical Evidence
- Natural Phenomenon
- Biology
- Geology
- Physics

KEY IDEAS:

Natural Phenomenon/Event (SSA will only use the wording Natural Event)
- Natural phenomena are **events that occur without human input**.
- Examples are tides, moon phases, weather, natural disasters, geysers, hibernation, rainbows, monarch butterfly migration

Empirical Evidence: the cumulative body of observations of a natural phenomenon
- The SSA will only use the term "evidence." It is still important for students to understand that laws and theories are not based on single pieces of evidence, but on all the evidence scientists have.

Scientific Laws:
- A scientific principle based on many observations of naturally occurring events that demonstrate it to be without exception under certain stated conditions.
  - Examples: Law of Universal Gravity, Law of Superposition, Law of Conservation of Mass/Energy.
  - Everytime a law is tested and/or observed the same data occurs
  - Many laws are expressed mathematically, especially in chemistry and physics.

Scientific Theories:

	● An explanation for some naturally occurring event developed from extensive observations, experimentation, and reasoning. See also law. ○ Examples include The Cell Theory, The Theory of Evolution, Theory of Plate Tectonics, and Atomic Theory **Both Scientific Laws and Theories** ● Are based on empirical evidence. ● Are widely accepted by almost all the scientists in that field of science. ● Are changed/edited/updated if and when new data no longer supports it. ○ Does not occur often because both are based on such large amounts of data **Examples of when scientific knowledge changed as a result of new evidence.** ● Scientistic evidence (observations of the night sky) once indicated that the sun and other planets revolved around earth. As technology and scientific tools improved planetary motion was more accurately observed and measured. The new evidence supports that the planets revolved around the sun. ● Scientists once classified Pluto as the 9th planet. As technology improved more about our solar system was discovered. This led to scientists reclassifying objects in our solar system based on new evidence. **Scientific knowledge is the result of a great deal of debate and confirmation within the science community.** **Science methods/ models** ● A scientific method is what scientists use to collect data. ○ All fields of science use observations, technology, experimentation, and investigations. ● A scientific model is a physical, conceptual, or mathematical representation of a real phenomenon that is difficult to observe Common methods and/or models used in different fields of science. ● Biology (The study of Life) ○ Models: Punnett Squares, Pedigrees, Cell models, DNA models, Chromosome models of mitosis and meiosis, Models and diagrams of the body, Models of cellular respiration and photosynthesis, food webs, carbon cycle

	○ Methods: Punnett Squares, Linnaean Classification, using microscope, Medical testing (like X-rays, blood work) to determine health. Analyzing the fossil record to better understand the theory of evolution, Analyzing limiting factors to predict populations. ● Geology (The study of the Earth) ○ Models: hurricane paths (Cone of Uncertainty), water cycle, rock cycle, plate tectonics ○ Methods: Satellite imaging of the earth, Mohs scale of hardness, analyzing weather patterns to predict future natural disasters. analyzing weathering and erosion patterns to plan prevention, analyzing changes in different landforms over time to predict how these landforms will change in the future, Radioactive dating ● Physics (The study of matter and energy) ○ Models: electromagnetic spectrum, convection models, energy transformation models, models of engines, models of atoms ○ Methods: Analyzing physical properties of a substance (melting/boiling points, density, conductivity, etc) to determine the substance. Analyzing light and sound waves through a substance to determine the substance. Using the electromagnetic spectrum to analyze stars. Using trigonometry to determine a star's distance from earth

POSSIBLE STUDENT MISCONCEPTIONS *(AND CORRECTIONS)***:**

- Theories can turn into laws.
  - *No, because theories and laws are different. Laws describe and Theories explain.*
- Laws are true and theories may or may not be true/ Laws are better than Theories.
  - *No. Both laws and theories are based on what scientists know now. When we have new data that no longer supports the "description/law" or "explanation/theory" then the law or theory is either updated or discarded.*
- Theories can change, but laws cannot.
  - *Again, laws can change if new data no longer supports the law.*
- Scientists don't debate because all science is based on facts.
  - *Scientists frequently debate. When scientists observe something new, there's frequent debate about what it is/means. Debates usually end when more evidence is collected that supports one side of the debate.*

NOT ASSESSED IN 8TH GRADE

- Examples of Theories and Laws that are not addressed in the 6th-8th curriculum (Big Bang, Relativity, Heisenberg Uncertainty, Hubble's law of cosmic expansion)
- Students do not need to know scientists associated with laws or theories.
- SSA assessment questions will not use the words "durable, empirical, or phenomenon."

LEARNING PROGRESSION			
PRIMARY:	**UPPER GRADES:** Grade 5- Explain the difference between an experiment and other types of scientific investigation. Recognize and explain that authentic scientific investigation frequently does not parallel the steps of "the scientific method."	**MIDDLE SCHOOL:** **SC.6.N.3.1** Recognize and explain that a scientific theory is a well-supported and widely accepted explanation of nature and is not simply a claim posed by an individual. Thus, the use of the term theory in science is very different than how it is used in everyday life. **SC.8.N.3.2** Explain why theories may be modified but are rarely discarded. SC.8.N.1.5 Analyze the methods used to develop a scientific explanation as seen in different fields of science. SC.8.E.5.10 Assess how technology is essential to science for such purposes as access to outer space and other remote locations, sample collection, measurement, data collection and storage, computation, and communication of information.	**HIGH SCHOOL:** SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and Earth/ space science, SC.912.N.1.4 Identify sources of information, and assess their reliability according to the strict standards of scientific investigation. SC.912.N.1.6 Describe how scientific inferences are drawn from scientific observations, and provide examples from the content being studied. SC.912.L.14.4 Compare and contrast structure and function of various types of microscopes.

LESSON RESOURCES

HMH (ADOPTED TEXTBOOK):

- Unit 1 Lesson 1 Text pages 4-16
- Quick Lab Pluto on Trial
- Virtual Lab Exploring Scientific Openness

CPALMS

- Scientific Theories and Scientific Laws (5E Lesson Plan)
- Theories and Laws: Analyzing Evidence (Basic Lesson Plan)
- The Main Event: Scientific Theories vs Scientific Laws (Student Tutorial)
- Math Models and Social Distancing (Student Tutorial)
- Science Research: Evidence Through Observation (Student Tutorial)
- Discovery of Infrared Light (Text Article)

GIZMOS:

Graphing Skills

Real-Time Histogram

Time Estimation

PENDA LESSONS:

- Science, Technology, and Scientific Models
- Scientific Theories and Laws
- Scientific Knowledge Can Change
- Durability of Scientific Knowledge

WRITING PROMPT/ CER:
Kelly explains that, "a scientific theory is just a scientific law that doesn't have as much evidence to support it." Respond to her statement, citing evidence to support your claim.

ADDITIONAL RESOURCES:

Articles

- "Planetary Motion: The Idea That Began a Science Revolution"
  580L MAX
- "How Scientific Models Help Us Understand the World" 860L 1030L

TARGETED REMEDIATION/ EXTENSION IDEAS

CHECK FOR UNDERSTANDING:	DEVELOPING:	ACHIEVING:	EXCEEDING: