HILLSBOROUGH TOWNSHIP SCHOOL DISTRICT

SCIENCE CURRICULUM

GRADE 7

AUGUST 2021

Grade 7 Science
Course Overview

The seventh grade science curriculum utilizes an inquiry-based storyline philosophy to explore students' questions that arise from students' interactions with phenomena. It continues to develop an understanding of the physical, life, and earth sciences and builds on the K–5 ideas and practices. At each step, students make progress on the classroom's questions through science and engineering practices to figure out a piece of a science idea. Each piece they figure out adds to the developing explanation, model, or designed solution. Each step may also generate questions that lead to the next step in the storyline. Together, what students figure out helps explain the unit's phenomena or solve the problems they have identified. A storyline provides a coherent path toward building science ideas and understanding piece by piece, anchored in students' own questions, experiences, and sensemaking.

The seventh grade science curriculum encourages inquiry and sensemaking through a wide variety of learning strategies and resources that develop science and engineering practices, core ideas, and crosscutting concepts. Students utilize laboratory investigations, educational websites, current events, articles, and other multimedia resources including videos, interactive websites, animations, and simulations to make sense of the world around them.

The seventh grade course of study includes six interconnected units: Contact Forces, Sound Waves, Forces at a Distance, Earth in Space, Genetics, and Natural Selection & Common Ancestry. During the Contact Forces unit students investigate causes of motion, and develop the idea that objects that collide can push on one another while they are in contact. Students connect the changes in the kinetic energy of an object to the energy being transferred to and from the object due to forces, and determine that the kinetic energy of an object is based on the two factors of mass and speed. In the Sound Waves unit students investigate how the frequency and amplitude of a sound wave can explain other macroscopic phenomena (loudness and pitch of a sound). Students explain at the molecular level how the deformation of materials results in oscillations that lead to the propagation of collisions of particles across a medium, and how the amplitude of the vibration is related to the energy of the wave. The Forces at a Distance unit help students explain how at-a-distance forces transfer energy between interacting objects in a system as the objects change position. This involves developing the idea of potential energy stored in systems of objects (e.g., magnets) and the transfer of this potential energy to the movement of objects depending on the objects' position and orientation to each other. Suring the Earth in Space unit students investigate force and motion of objects in space, and how forces that act in a direction perpendicular to the motion of the object can lead to circular patterns of motion (an orbit). Students develop a model using gravity to explain patterns of motion of the earth, sun, moon, other planets and their moons, stars in our galaxy, and other galaxies. Students also investigate differences in the composition and surface features (crust, atmosphere, volcanoes) of planets in the solar system. As students investigate patterns of inheritance data in the Genetics unit they develop a model for how heredity information is encoded in genes on chromosomes, how these molecules affect traits through production of proteins, and how these molecules provide a mechanism for passing traits across generations. Students use their models to explain how variation arises in sexual reproduction and how patterns in heredity occur. Students models and use the model to explain how variations in genetic information can affect traits through production of proteins. In the last unit of the year, student investigate Natural Selection & Common Ancestry by developing a model of natural selection that explains how trait distributions in populations shift over time. Students explore how differences between individuals and species' characteristics and behaviors enhance their fitness and how environmental changes can lead to shifts in trait distributions in a population over time. Students build on this model to investigate evidence from anatomical similarities and differences between organisms living today and organisms in the fossil record, and patterns in the traits of embryos from different species that are alive today, to extend a natural selection model to explain speciation.

The seventh grade science curriculum meets the requirements of the New Jersey Student Learning Standards for Science. It also helps to prepare students to meet and exceed the standards assessed by the New Jersey State administered assessments through higher order application of various skills required for complete understanding and sensemaking of science phenomena at the seventh grade developmental level.

<table>
<tr><th>Unit Title</th><th>Time Frame/Pacing</th></tr>
<tr><td>Contact Forces</td><td>35 - 39 days</td></tr>
<tr><th colspan="2">Phenomena/Anchoring Activity/Anchoring Question/Essential Questions</th></tr>
<tr><td colspan="2">
<u>Anchoring Phenomenon:</u>
Millions of phones are damaged a year in our country, and many of us have experienced such damage firsthand. We have a lot of experiences where a collision between two objects causes damage and also experiences where it surprisingly does not.

<u>Anchoring Question:</u>
Why do things sometimes get damaged when they hit each other?

<u>Supporting Questions:</u>

Lesson 1: What happens when two things hit each other?
Lesson 2: What causes changes in the motion and shape of colliding objects?
Lesson 3: Do all objects change shape or bend when they are pushed in a collision?
Lesson 4: How much do you have to push on any object to get it to deform (temporarily vs. permanently)?
Lesson 5: How does changing the mass or speed of a moving object before it collides with another object affect the forces on those objects during the collision?
Lesson 6: What have we figured out about objects interacting in collisions? How can we apply our new learning to answer questions about objects interacting in collisions?
Lesson 7: How much does doubling the speed or doubling the mass affect the kinetic energy of an object and the resulting damage that it can do in a collision?
Lesson 8: Where did the energy in our launcher system come from, and after the collisions where did it go to?
Lesson 9: How do other contact forces from interactions with the air and the track cause energy transfers in the launcher system?
Lesson 10: Why do some objects break or not break in a collision?
Lesson 11: What can we design to better protect objects in a collision?
Lesson 12: What materials best reduce the peak forces in a collision?
Lesson 13: How (and why) does the structure of a cushioning material affect the peak forces produced in a collision?
Lesson 14: How can we use our science ideas and other societal wants and needs to refine our designs?
Lesson 15: How can we use what we figured out to evaluate another engineer's design?
Lesson 16: How can we market our designs to our potential investors?

</td></tr>
<tr><th colspan="2">Enduring Understandings</th></tr>
</table>

- In a collision between two objects, the objects have to come into contact; sometimes something is damaged, but not always.
- Different factors and variables may cause objects to be damaged or not damaged in a collision.
- A collision can cause the objects involved to change motion and/or change shape.
- Energy transfer occurs during a collision.
- There is a force(s) between objects when they make contact during a collision.
- All solid objects bend or change shape in a collision and when other contact forces are applied to them
- All solid objects deform elastically when force is applied to them, up to a point.
- Different objects have a different elastic limit, which is the maximum amount of deformation they can withstand, beyond which they will deform permanently.
- Different objects have a different breaking point, which is the maximum amount of deformation they can withstand, beyond which they will crack or split apart.
- The type of material, the shape, and the thickness of an object all affect (a) how much it deforms when a force is applied to it, (b) its elastic limit and, (c) its breaking point.
- Objects in contact with each other apply equally strong forces on each other in opposite directions.
- Objects that collide apply an equally strong peak force (maximum force) on each other during the collision.
- A free body diagram can help represent the forces on the objects in a collision by considering each object separately
- Increasing the speed or mass of a moving object increases its kinetic energy (KE).
- The more KE that objects in a system have, the higher the peak forces they can produce in a collision.
- The more kinetic energy an object has the more damage it can do in a collision.
- The more kinetic energy an object has the more you have to push against the direction of its motion to get it to stop.
- The kinetic energy of an object is directly proportional to its mass; the KE of an object is proportional to the square of its speed.
- The more force you apply to an object the more that object speeds up.
- It takes more force to speed up a more massive object the same amount as a lower mass object.
- Potential energy can be stored in some systems when you change the shape or arrangement of parts in that system (e.g., a spring).
- Friction is a contact force due to interaction between surfaces in contact and is produced by the bumps (roughness) on surfaces as they push against each other.
- Interactions due to friction and air resistance apply contact forces to a moving object that are in a direction that is opposite its motion.
- Force interactions due to friction and air resistance transfer energy to the surfaces of the objects that slide over each other; this results in an increase in particle-level kinetic energy (a temperature increase).
- Energy can be transferred to and from collisions between objects and particles in the air.
- Materials that reduce peak force have similar structures, such as air pockets or space for air, and the ability to deform when a contact force is applied; these materials reduce the peak force equally on both objects involved in the collision.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
- MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- MS-LS1-8 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for storage as memories
- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Planning and Carrying Out Investigations • Collect data to produce data to serve as the basis for evidence to answer scientific question or test design. • Plan an investigation individually and collaboratively, and in the design identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. • Conduct an investigation and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. **Analyzing and Interpreting Data** • Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.	**PS2.A: Forces and Motion** • For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1) • The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2) • All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to	**Systems and system models** • Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems • Models are limited in that they only represent certain aspects of the system under study. **Energy and matter** • Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. • Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion). • The transfer of energy can be tracked as

• Analyze and interpret data to provide evidence for phenomena. **Constructing Explanations and Designing Solutions** • Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and retesting. **Engaging in Argument from Evidence** • Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	share information with other people, these choices must also be shared. (MS-PS2-2) **PS3.A: Definitions of Energy** • Motion energy is properly called kinetic energy ; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1) **ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) **LS1.D: Information Processing** • Each sense receptor responds to different inputs (mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed	energy flows through a designed or natural system. **Structure and function** • Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts; therefore, complex natural and • designed structures/systems can be analyzed to determine how they function. • Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped and used. **Stability and change** • Small changes in one part of a system might cause large changes in another part. • Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. **Patterns** • Macroscopic patterns are related to the nature of microscopic and atomic-level structure. • Graphs, charts, and images can be used to identify patterns in data

	in the brain, resulting in memories. (MS-LS1-8) **PS3.B: Conservation of Energy and Energy Transfer** • When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5) **PS3.C: Relationship Between Energy and Forces** • When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)	

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively. (MS-PS2-1), (MS-PS2-2), (MS-ESS1-3)
- 6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS2-1)
- 6.EE.A.2 Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-1), (MS-PS2-2)
- 7.EE.B.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-1), (MS-PS2-2)
- 7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-PS2-1), (MS-PS2-2)
- MP.2 Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- 6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1), (MS-ESS1-2), (MS-ESS1-3)
- 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. (MS-PS3-1)
- 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS3-1), (MS-ESS1-2), (MS-ESS1-3)
- 8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- 8.EE.A.2 Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number.

Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational. (MS-PS3-1)

- 8.F.A.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1)
- MP.4 Model with mathematics. (MS-ESS1-2)
- 6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2)
- 7.EE.B.6 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-2)
- CCSS.MATH.CONTENT.8.F.B.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models and in terms of its graph or a table of values.
- CCSS.MATH.CONTENT.8.F.B.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally
- 7.G.A.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

ELA

- RST.6-8. 1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS2-1), (MS-PS3-1), (MS-ESS1-3), (MS-ESS1-4)
- RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-1), (MS-PS2-2)
- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1), (MS-ESS1-3)
- WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.(MS-LS1-8)
- WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS1-4)
- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS1-1), (MS-ESS1-2)
- CCSS.ELA-LITERACY.SL.8.1.C Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas
- CCSS.ELA-LITERACY.SL.8.1.D Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.

- CCSS.ELA-LITERACY.W.8.1 Write arguments to support claims with clear reasons and relevant evidence.
- CCSS.ELA-LITERACY.W.8.1.B Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.

Computer Science and Design Thinking

- 8.1.8.CS.3 Justify design decisions and explain potential system trade-offs.
- 8.1.8.CS.4 Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.
- 8.1.8.AP.6 Refine a solution that meets users' needs by incorporating feedback from team members and users.
- 8.2.8.ED.1 Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
- 8.2.8.ED.2 Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.ED.3 Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.ED.5 Explain the need for optimization in a design process.
- 8.2.8.ED.6 Analyze how trade-offs can impact the design of a product.
- 8.2.8.ED.7 Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

Career Readiness, Life Literacies, and Key Skills

- 9.1.8.CR.4 Examine the implications of legal and ethical behaviors when making financial decisions.
- 9.4.8.CT.1 Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).
- 9.4.8.CT.2 Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
- 9.4.8.IML.3 Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping (e.g., 6.SP.B.4, 7.SP.B.8b)
- 9.4.8.IML.4 Ask insightful questions to organize different types of data and create meaningful visualizations.
- 9.4.8.IML.5 Analyze and interpret local or public data sets to summarize and effectively communicate the data.
- 9.4.8.TL.2 Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).

Social-Emotional Learning Competencies

- **Self-Awareness**
  - Recognize one's personal traits, strengths, and limitations.
  - Recognize the importance of self-confidence in handling daily tasks and challenges.
- **Self-Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.
- **Social Awareness:** Demonstrate an understanding of the need for mutual respect when viewpoints differ.

- **Responsible Decision-Making**
  - Develop, implement, and model effective problem-solving and critical thinking skills.
  - Identify the consequences associated with one's actions in order to make constructive choices.
- **Relationship Skills:** Utilize positive communication and social skills to interact effectively with others.

Learning Targets	Investigations/Resources	Formative Assessment
Lesson 1 Develop a model to describe interactions between two objects as they collide and show the changes that occur in the structure of both objects when one object is damaged as a result and also when neither object is damaged as a result. Ask questions that arise from observations of collisions between two objects in order to seek additional information about factors (causes) that might affect the outcome of such collisions.	Model what we think might happen at the moment of impact and a split second after a collision where something breaks and a collision where something doesn't break. Consider some of the factors that could have made a difference in the outcomes of these collisions.	Initial Model: Objects During Collisions Consensus Discussion Driving Question Board (DQB)
Lesson 2 Collect data on changes in the motion and shape of colliding objects that serve as the basis for evidence that energy transfer occurs during the collision and that there are forces between colliding objects. Construct an argument supported by empirical evidence and scientific reasoning to support a model showing that changes in motion of colliding objects (connected to subsystems) results from energy transfer between them (cause) and changes in the shape of those objects results from force(s) between them (cause).	Explore colliding objects and record observations about changes in their motion and shape. Analyze slow-motion videos of some of these collisions. Develop a model to represent what we know about energy transfer and forces occurring in collisions when we see changes in motion of objects, shape of objects, or damage to objects.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 3	Make a claim about whether all solid objects bend or not when pushed during a collision.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook)

Construct and revise a written argument using evidence from various sources of data (slow-motion videos, photos, and first hand investigations) to support or refute the claim that all objects do bend or change shape when pushed in a collision.	Analyze slow-motion videos, carry out an investigation with a laser and a mirror, and analyze images from a timelapse concrete joint load testing video. Argue for whether our original claims are supported or refuted by the evidence.	Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 4 Plan an investigation, identifying controls to keep constant, and carry out the investigation to produce data to serve as the basis for evidence to develop a mathematical model for the relationship (pattern) between the amount of force applied to an object and the amount it deforms. Analyze and interpret graphical data (patterns) from tests of compression force vs. amount and type of deformation (temporary vs. permanent) to provide evidence that supports an argument that all objects behave elastically up to a specific limit beyond which permanent damage occurs (stability and change).	Plan and carry out an investigation to look at the relationship between contact force applied and the amount of deformation that occurs in different materials. Construct graphs of our data and compare them to those from other materials tests. Develop a model to represent the elastic and nonelastic behavior of all solid objects in response to varying amounts of force applied to them.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion List of variables Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 5 Plan and carry out an investigation and identify patterns in the data collected from the investigation to provide evidence that when peak contact forces on each object during the collision are equal in strength, the strength of those forces increases when the mass or the speed of the object that was moving before the collision increases.	Carry out investigations to explore the strength of forces between two objects when they collide. Plan and carry out an investigation about how different speeds and masses of objects affect the amount of peak force on each object. Develop and use a model to represent the relationship between the energy of a moving object and the strength of the peak forces from a collision	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Evaluate Investigation Plan Revisit Driving Question Board Models WIS/WIM Update Progress Tracker

Develop and use subsystem models (free body diagrams) to represent how the peak contact forces on two different objects compare in a collision and how these are related to corresponding changes in the kinetic energy of a moving object before it collides due to an change in its mass or the speed.		
Lesson 6 Apply science ideas and use evidence to construct an explanation for how the amounts of peak force and energy transfer (cause) in soccer collisions result in instability in the brain (concussions, effect) due to sudden changes at the cellular level.	Look back at questions from our Driving Question Board and answer questions we have made progress on during Lesson 1-5. Take an assessment to apply our science ideas to a new context and determine we need to figure out what causes more damage and energy transfer during a collision--increases in mass or increases in speed.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker Assessment: Applications and Free Body Diagrams
Lesson 7 Construct, analyze, and interpret graphical displays of data collected from a computer simulation to identify patterns in the data, including a linear relationship between the mass of a moving object and its kinetic energy and its kinetic energy and a nonlinear relationship between the speed of a moving object and its kinetic energy. Construct an explanation based on quantitative relationships (scale) for whether decreasing the mass of a moving object or decreasing its speed would have a bigger effect on the peak forces produced in a collision between it and a stationary object and use these ideas to further explain why this would cause damage in some collisions but not others (effect).	Carry out an investigation to determine how doubling the speed of an object vs. doubling its mass affects the amount of damage it does in a collision. Analyze data to determine how to quantify the relative change in the kinetic energy of an object. Use a computer simulation to collect additional data on changes in the mass and the speed of a moving object and the amount of kinetic energy. Develop mathematical models of these relationships and use them to predict and explain how this could affect the amount of damage in a collision.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Systems Models Mathematical Models WIS/WIM Update Progress Tracker

Lesson 8 Develop and use a model to identify other parts of the system the cart and box are making contact with or colliding into that could be producing contact forces on these subsystems, causing energy to be transferred to or from them as the box and cart travel down the track.	Develop a model to show where energy is transferred between the spring, cart, and box and how contact forces cause this energy transfer. Use this to start brainstorming other places where contact forces may be causing energy transfer in the system.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 9 Apply scientific ideas and evidence to construct an explanation for the causes of motion and kinetic energy changes that happen before and after collisions and how these affect the outcome of a collision. Respectfully provide and receive critiques about claims to identify relevant evidence to support an explanation for how energy transfers through the cart-launcher system before and right after a collision. Develop and revise a model to identify other parts of the system the cart and box are making contact with or colliding into that are producing contact forces on these subsystems, causing energy to be transferred to or from them as the box and cart travel down the track.	Conduct investigations to gather evidence to explain what other forces affect the kinetic energy of an object before a collision. Develop claims using our evidence and provide and receive feedback with peers to synthesize our ideas. Revise our model to show additional places in the launcher system where energy is transferred and how contact forces cause this energy transfer.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Revised Models WIS/WIM Update Progress Tracker
Lesson 10 Apply scientific ideas to explain why some collision-related phenomena resulted in damage while others did not and to explain how the contributing factors (energy, matter, peak forces)	Revisit our collision types from Lesson 1 and explain why some objects were damaged and others weren't in different collisions. Use these ideas to answer questions on the Driving	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models

could change to result in different collision outcomes. Apply scientific ideas to explain multiple baseball phenomena, including the effects of air density and wind on ball speed (changes to the stability of the system and its effect on kinetic energy changes due to air resistance), bat mass vs. bat speed (interpreting patterns in graphical and tabular data to determine the linear and nonlinear effects on increases of kinetic energy within the system), and bat type (the effect deformation has on peak forces in the system and kinetic energy) on how the game is played.	Question Board and take an assessment to apply our new ideas to a new set of collision-related phenomena in the context of baseball.	WIS/WIM Assessment: Lab application of evidence
Lesson 11 Define a problem that can be solved with the development of a protective device to reduce damage (peak force) during a collision by identifying and considering multiple criteria and constraints along with specific materials, shapes, and designs of devices that reflect our science ideas of how certain material properties function in a collision. Design a solution to a problem to reduce the damage to an object in a collision (by reducing peak forces) by considering the properties of different, individual materials and shapes being used to serve particular functions.	Look back at our anchor phenomena and discover that some phones were in protective cases when they were damaged. Develop new phone case criteria and constraints and design our own protection device for something we want to protect. Receive feedback on our designs and consider what criteria and constraints all designs need to protect objects. Develop questions about our designs and ideas for investigation. Determine that we need to figure out the best damage-reducing materials.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Initial Device Design Update Progress Tracker
Lesson 12 Analyze data to determine which materials reduce peak force in a collision and analyze the similarities	Conduct an investigation to determine what easily accessible materials reduce peak force in a collision.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion

(visual patterns across materials) in the properties of those materials (macroscopic deformability). Develop a model to explain how the changes in the structures of cushioning materials contribute to their function (a reduction in peak forces) at a microscopic level during a collision.	Compare the structure of the materials and find similarities in their compositions that might affect their function. Determine that the peak force is reduced equally on both objects, regardless of size. Develop a model to explain how the structures of the materials function in a collision that helps to reduce peak forces on the objects we want to protect.	Revisit Driving Question Board Models WIS/WIM Initial Device Design Update Progress Tracker
Lesson 13 Construct an explanation for how (and why) the structure of a cushioning material affects the peak forces produced (function) in a collision, relating the amount of space available for deformation, the total contact time during a collision, and the peak forces produced from the addition of such structures. Develop and use subsystem models (free body diagrams) to represent how the peak contact forces on different objects in a collision compare when they have different cushioning structures between them. Critically read a scientific text adapted for classroom use to determine how concussions can result in breaks in the axons of neurons (structure) and why this can lead to memory loss (function), how a snug fit (structure) for a helmet would affect its performance (function), and how other changes in the structure of cushioning material (in a helmet) would affect its performance (function).	Develop a model to represent how the structures of materials compare in the top four performers for peak force reduction. Use scaled-up versions of these structures to generate data using slow-motion video about the unobservable mechanisms at work in the system. Carry out an investigation to determine how the amount of force applied to different points of a cushioning structure is affected by the shape of that structure.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Initial Device Design Update Progress Tracker
Lesson 14	Redesign our protective devices and receive	Check-Ins (Do Nows, Entrance Tickets, Exit

Optimize the performance of a design by prioritizing the particular functions and properties of materials based upon stakeholder feedback to assess the relative effectiveness of the materials. Engage in a quantitative analysis using prioritized scores and consider the trade-offs of prioritizing particular uses and functions of materials to assess their relative effectiveness for the optimization of the design.	stakeholder feedback. Use the feedback and considerations to inform decisions on primary, secondary and tertiary criteria for materials in a decision matrix. Evaluate the overall scores of the materials and consider the consequences of each change made to the protective devices.	Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Initial Device Design Device Redesign Update Progress Tracker
Lesson 15 Develop and use a series of models to represent (a) the relative strength of the forces (change and stability) being applied to three different objects and subsystems in contact in a collision, (b) in each case what interaction (cause) is producing this force (effect) on the object, and (c) the direction of these forces in three different free body diagrams and use the ideas from these models to support or refute an argument for the effect on peak forces on heads during a collision. Construct an explanation for why a design solution will optimize performance, including the prioritized criteria, constraints brought from stakeholders, and trade-offs made when revising the design to meet criteria. Design a solution to a problem to reduce the damage to an object in a collision (by reducing peak forces) by considering the properties of different materials and shapes being used to serve particular functions.	Evaluate other engineers' design solutions to protect cheerleaders from concussions in collisions using the science and engineering ideas we have figured out over the course of the unit. Design our own solution and argue how it takes into consideration the criteria, constraints, and trade-offs considered in the proposed solution. Revisit the DQB to take stock of the questions we have answered.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker End-of-unit assessment
Lesson 16	Develop a presentation to share our design with potential investors.	Initial Device Design Presentation

Communicate and present information orally about the proposed performance of a protective device, explaining how specific structures and materials have been manipulated to reduce peak forces in a collision.	Create a scale prototype and test our design and/or add visual aids to our presentation. Present our design ideas to investors.	Prototype Rubric

Instructional Modifications and/or Accommodations
(ELL, Special Education, Gifted, At-Risk of Failure, 504) When appropriate

- Accommodations as per IEP/504/ELL
- Use gestures in addition to talking
- Word wall: use student-friendly definitions, make connections to cognate/root words when possible, and include a visual representation of the word
- Emphasize socially safe activity structures (e.g., small-group or partner work before a whole-class discussion)
- Science notebook: Students should be encouraged to record their ideas using linguistic (e.g., written words) and nonlinguistic (e.g.,taping in photographs, creating drawings, tables, graphs, mathematical equations, and measurements) modes.
- Encourage all students to use words and/or drawings when representing and recording their investigation setup and observations.
- Use classroom norms to support engagement by creating a space where students are not worried about being right or wrong.
- Having different modes for interacting with the readings will provide different ways to access the readings
- Graphs with pre-labeled axes as needed
- Provide options for investigations when applicable (giving students a choice to pursue a line of inquiry that is more relevant to them)
- Provide hands-on materials for students to demonstrate their ideas when possible/relevant
- Provide cause/effect sentence stems when relevant/as needed
- Provide paper copies of DQB questions as needed

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Mid Unit Baseball Assessment • End of Unit Summative Assessment	• Bolded keywords • Word banks • Reference images • Read directions to students to help with comprehension as needed • Provide access to anchor charts and classroom labels relevant to science concepts • Scribe for students or allow students to use a talk-to-text feature on Chromebooks when responding to questions as needed • Paper copies of assessment as needed/appropriate

Hillsborough Township Public Schools
Grade 7 Science Curriculum

Unit Title	Time Frame/Pacing
Sound Waves	24 days

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Anchoring Phenomenon:
Loud music from a truck makes a window in the parking lot move. A speaker moved when it produced sound.

Anchoring Question:
How can a sound make something move?

Supporting Questions:
- Lesson 1: How does a sound source make something like this happen?
- Lesson 2: What is happening when speakers and other music makers make sounds?
- Lesson 3: Do all objects vibrate when they make sounds?
- Lesson 4: How do the vibrations of the sound source compare for louder versus softer sounds?
- Lesson 5: How do the vibrations from a sound source compare for higher-pitch versus lower-pitch sounds?
- Lesson 6: How can any object make so many different sounds?
- Lesson 7: What is actually moving from the sound source to the window?
- Lesson 8: Do we need air to hear sound?
- Lesson 9: How can we model sound traveling through a solid, liquid, or gas?
- Lesson 10: What exactly is traveling across the medium?
- Lesson 11: How does sound make matter around us move?
- Lesson 12: What goes on in people's ears so they can detect certain sounds?
- Lesson 13: What transfers more energy, waves of bigger amplitude or waves of greater frequency?
- Lesson 14: How can we explain our anchoring phenomenon, and which of our questions can we now answer?

Enduring Understandings

- All objects move back and forth (vibrate) when making sounds.
- Objects vibrate further back and forth (deform more) when a greater force is applied, creating louder sounds.
- Sound sources that produce higher-pitch notes vibrate more frequently.
- Air that is near the sound source is not moving all the way from the sound source to our ears when sounds are produced.
- Sound can travel through all different kinds of matter (solids, liquids, and gasses), not just air. Sound cannot travel through an empty space with no matter; sound needs matter to travel.

- Solids, liquids, and gases are made of particles moving through empty space, with different spacing in each state of matter.
- Particles can collide with other particles in a gas and bump into neighboring particles in a solid or a liquid.
- If a push is transferred into the particles at one place in the medium (any state of matter that sound travels through), it might result in a series of collisions among neighboring bands of particles across the medium.
- When an object moves back and forth, it produces bands of compressed and expanded particles that move through the medium (bands of compression travel, but particles do not).
- The density of particle compression gets greater when the amplitude of vibration at the sound source increases.
- The distance between compression bands appears to change when we change the frequency of vibration.
- Collisions transfer energy across a medium.
- Waves with bigger amplitude transfer more energy than waves with less amplitude.
- Waves with higher frequency transfer more energy than waves with less frequency.
- Proportional increases in amplitude have a bigger effect on the energy transferred than increases in frequency

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- MS-PS4-1 Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
- MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Developing & Using Models • Evaluate limitations of a model for a proposed object or tool. • Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed. • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop and/or use a model to predict	**PS4.A: Wave Properties** • A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) • A sound wave needs a medium through which it is transmitted. (MS-PS4-2)	**Patterns** • Patterns can be used to identify cause and effect relationships. • Graphs, charts, and images can be used to identify patterns in data. • Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. **Scale, Proportion & Quantity** • Proportional relationships (e.g., speed as

and/or describe phenomena. • Develop a model to describe unobservable mechanisms. • Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. **Using Mathematics & Computational Thinking** • Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. • Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems. **Engaging in Argument from Evidence** • Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. • Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. • Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a		the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. • Phenomena that can be observed at one scale may not be observable at another scale. • Scientific relationships can be represented through the use of algebraic expressions and equations

phenomenon or a solution to a problem.		

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively. (MS-PS4-1)
- MP.4 Model with mathematics. (MS-PS4-1)
- 6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)
- 6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS4-1)
- 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS4-1)
- 8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. *(MS-PS4-1)*
- CCSS.MATH.8.FA.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- CCSS.MATH.6.SP.B.5 Summarize numerical data sets in relation to their context, such as by giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.
- CCSS.MATH.8.F.B.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.
- CCSS.MATH.8.F.A.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

ELA

- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1)
- CCSS.ELA-LITERACY.SL.8.1.C Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
- CCSS.ELA-LITERACY.W.8.1 Write arguments to support claims with clear reasons and relevant evidence.
- CCSS.ELA-LITERACY.W.8.1.B Support claims with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
- CCSS.ELA-LITERACY.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- CCSS.ELA-LITERACY.SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- CCSS.ELA-LITERACY.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

- CCSS.ELA-LITERACY.W.8.1.A Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
- CCSS.ELA-LITERACY.RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

Computer Science and Design Thinking

- 8.1.8.CS.3 Justify design decisions and explain potential system trade-offs.
- 8.1.8.CS.4 Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.
- 8.2.8.ED.1 Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
- 8.2.8.ED.2 Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.ED.3 Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.ED.5 Explain the need for optimization in a design process.
- 8.2.8.ED.6 Analyze how trade-offs can impact the design of a product.

Career Readiness, Life Literacies, and Key Skills

- 9.1.8.CR.4 Examine the implications of legal and ethical behaviors when making financial decisions.
- 9.4.8.CT.1 Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).
- 9.4.8.CT.2 Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
- 9.4.8.IML.3 Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping (e.g., 6.SP.B.4, 7.SP.B.8b)
- 9.4.8.IML.4 Ask insightful questions to organize different types of data and create meaningful visualizations.
- 9.4.8.IML.5 Analyze and interpret local or public data sets to summarize and effectively communicate the data.
- 9.4.8.TL.2 Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).

Social-Emotional Learning Competencies

- **Self-Awareness**
  - Recognize one's personal traits, strengths, and limitations.
  - Recognize the importance of self-confidence in handling daily tasks and challenges.
- **Self-Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.
- **Social Awareness:** Demonstrate an understanding of the need for mutual respect when viewpoints differ.
- **Responsible Decision-Making**
  - Develop, implement, and model effective problem-solving and critical thinking skills.

- ○ Identify the consequences associated with one's actions in order to make constructive choices.
- **Relationship Skills:** Utilize positive communication and social skills to interact effectively with others.

Learning Targets	Investigations/Resources	Formative Assessment
Lesson 1 Develop a model to explain how a sound source (cause) can make another object move (effect). Ask questions about patterns in observations that can be investigated to figure out how sound travels and causes movement in other objects.	Observe a perplexing phenomenon: Sound from a truck appears to make a window move from the parking lot. Note observations of this phenomenon as well as of a speaker in the classroom. Observations, models, and other sound-related phenomena lead us to add a broad set of questions about sound to our DQB and to list ideas for investigations to pursue.	Initial Model Consensus Discussion Driving Question Board (DQB)
Lesson 2 Analyze and interpret data to identify patterns in the data that provide evidence of the relationship between a force (cause) on an instrument and the motion/vibration (effect) of the instrument. Develop a model to describe how a force applied to an instrument causes its shape to change, leading it to repeatedly deform above and below its initial position (effect) as it vibrates and use that model to predict what a force will do to another instrument.	Observe various musical instruments and a speaker when they are making sounds and connect what we discover to what we observe when we analyze slow-motion videos of similar objects. Co-construct a model to represent the shape changes observed in these objects over time, and we will apply this model to another instrument.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models- Vibration of an instrument to create sound WIS/WIM Update Progress Tracker
Lesson 3 Engage in argument from evidence to support or refute our predictions about whether all solid objects vibrate (cause) when they make sounds (effect), even when we cannot see them vibrate.	Wonder whether all solid objects vibrate when they're making sounds. Use a simple, new device to "zoom in" on a couple of solid objects not intended to make sounds to see if they vibrate while they're making sounds. The results of this test will give us evidence that all solid	Progress Tracker

	objects are springy enough to vibrate when they make sounds and that objects vibrate differently when making different sounds.	
Lesson 4 Use mathematical representations of position versus time graphs generated from a tool used to scale up the vibrations of an object to describe wave patterns and support scientific conclusions about how objects move when they make louder or softer sounds.	Use a motion detector to collect data from a vibrating wooden stick. Notice wave patterns in that data, called amplitude and frequency. Conclude that the amplitude of vibration changes when sounds get louder, but the frequency does not change related to loudness	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Update Progress Tracker
Lesson 5 Use mathematical representations of position versus time graphs generated from a tool used to scale up the vibrations of an object to describe wave patterns and support scientific conclusions about how objects move when they make higher-pitch and lower-pitch sounds.	Change the length of the wooden stick in order to collect data on how vibrations at the sound source compare for changes in pitch. Identify patterns in graphs related to the amount of time a vibration takes (its frequency) for sound sources that produce different-pitch sounds.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Update Progress Tracker
Lesson 6 Use a model to explain how a force applied to an instrument causes the sound source to vibrate (effect) and make a sound even if we cannot see it. Construct an argument using evidence from graphs to support an explanation for which patterns of frequency and amplitude of a wave are indicators of attributes of sounds that we can hear.	Use graphs of the position of a sound source that is vibrating to argue for which sounds are being made and apply what we have figured out to revise our initial class consensus model and return to our DQB. Take an individual assessment, applying what we have learned to explain new phenomena.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Assessment: Argument from investigative evidence applied to new phenomena.
Lesson 7 Respectfully provide and receive critiques in order to revise initial claims about whether air is being moved (cause) all the way from the sound source to	Investigate the idea from our initial models that air is traveling from the sound source to the window by placing a sound maker in a sealed container and testing whether we can still hear it. This will help us	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board

our ears when we hear the sounds or when the window moves (effect).	to reason that air isn't moving all the way from the sound maker to our ears.	Consensus Models WIS/WIM Update Progress Tracker
Lesson 8 Use evidence from investigations to compare and critique competing claims and argue that air or another medium such as liquid or solid is needed (cause) to hear sound or move the window (effect).	Test whether air is needed to hear sound by investigating how sound moves through any type of matter and whether it can move across empty space with no matter in it (a vacuum). These findings will support the claim that sound needs a medium (gas, liquid, or solid) to travel through.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Update Progress Tracker
Lesson 9 Develop and use a model to describe unobservable parts (particles) of the system and how they would interact with one another in any state of matter to transfer energy from a vibrating sound source through collisions with one another across a medium.	Recall that models of all states of matter include particles, empty space, and motion. Simulate what happens in matter as a vibrating object interacts with it. This model will suggest that motion (or energy) might be transmitted through the medium from one place to another through particle collisions.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Update Progress Tracker
Lesson 10 Apply mathematical concepts to make sense of data generated from a model to test ideas about how changing the frequency and amplitude of the sound source affects the patterns in the wavelengths and compression of particles as energy moves across the system.	Run a computational simulation exploring how particle collisions propagate across a medium from a vibrating sound source. Our investigations will help us to develop models for the nature of the wave traveling across the medium, including a particle density model with bands of dense and less-dense batches of matter and the direction of energy transfer across the medium, for different amplitude and frequency sound vibrations of the sound source.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Update Progress Tracker
Lesson 11 Develop and use a model to describe phenomena using unobservable mechanisms for how a sound source could cause vibrations that produce sounds, which cause particles of matter in the surrounding	Consider all we've learned so far and work in small groups to develop a model to explain a new phenomenon: salt jumping on plastic wrap stretched over a bowl when a drum is hit.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models

medium to be compressed and expanded, which then collide with neighbors to transfer energy across the medium, which results in movement of an object farther away.	Summarize in a checklist the key ideas for explaining this phenomenon, then apply that checklist to revising the model of the truck speaker and window phenomenon.	WIS/WIM Update Progress Tracker Revised Individual Models of the truck speaker and window phenomenon.
Lesson 12 Critically read scientific texts adapted for classroom use to determine the central ideas and obtain scientific information to describe patterns of how the structures in the ear interact with each other to transfer energy from the eardrum to fluid in the cochlea and to a series of sensory cells that move (more or less) in response to vibrations of particular frequencies, which send signals along different nerve cells to the brain.	Students will explore their unanswered questions regarding how our ears detect sounds by reading about the structures of the ear and watching videos and animations of those structures. Then they will annotate a model showing how energy is transferred through the ear to the nerve cells that send signals to the brain.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Update Progress Tracker
Lesson 13 Apply mathematical concepts and processes to find and analyze patterns in numerical data and graphs of how the energy transferred by a vibrating object changes in proportion to changes in the amplitude and/or frequency of the object's vibrations.	Conduct an investigation to analyze how changing the amplitude or frequency of an object's vibrations changes the amount of energy transferred by that sound. From this investigation, conclude that increasing the vibrations' amplitude or frequency increases the energy transferred by the sound. Furthermore, increases in amplitude have a greater effect on the energy transferred by a vibrating object than do increases in frequency.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Update Progress Tracker
Lesson 14 Develop and use a model to explain how loud sounds and the energy transfer associated with high amplitude sound waves cause damage to ear structures.	Revisit the Driving Question Board and discuss all of our questions that we have now answered. Then we will demonstrate our understanding by individually taking an assessment. Reflect on our experiences in the unit.	Student Transfer Task Assessment: Use data to explain how the energy of a vibration changes when the amplitude or frequency of the vibration changes.

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate
• Accommodations as per IEP/504/ELL • Be intentional about naming the concept of changing scales to help us see, and connect back to examples of changing scale that students have already experienced. • Students may need a direct definition for words like laser and reflect, and you may choose to add them to a word wall display, including a drawing or image. • Check that students are able to make predictions and say what the outcomes would mean based on the cause-and-effect relationships they observed in the instruments and speaker making sounds.   ○ If some students are able to talk or write about the cause-and-effect implications, but others cannot, be sure to elicit multiple examples of what those outcomes might make us think during the share-out discussion. • When recording definitions in their notebooks, students should write in their own words rather than copying a "standard" definition from the teacher. • When adding words to the word wall, have several students share their definitions and ask the class if they agree or disagree with that definition. • Emphasize the relationship between structure and function as needed by introducing the idea that similar structures (smaller bars or tines) tend to have similar functions (produce higher pitches). • If students have trouble making comparisons between the graphical representations for loud vs. soft sounds, they may benefit from seeing the two graphs displayed side by side • Allow students choice in how they test their ideas when applicable • Plan partnerships ahead of time when possible

Common Assessment(s)	Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate
POSSIBLE: • Mid Unit Instrument Assessment • End of Unit Summative Assessment	• Bolded keywords • Word banks • Reference images • Read directions to students to help with comprehension as needed • Provide access to anchor charts and classroom labels relevant to science concepts • Scribe for students or allow students to use a talk-to-text feature on Chromebooks when responding to questions as needed • Paper copies of assessment as needed/appropriate

Unit Title	**Time Frame/Pacing**
Forces at a Distance	6 weeks (30 days)

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Anchoring Phenomenon:
A speaker system with a magnet and a coil of wire moves back and forth without the parts touching.

Anchoring Question:
How can a magnet move another object without touching it?

Supporting Questions:

- Lesson 1: What causes a speaker to vibrate?
- Lesson 2: What can a magnet pull or push without touching?
- Lesson 3: How does energy transfer between things that are not touching?
- Lesson 4: What can we figure out about the invisible space around a magnet?
- Lesson 5: How does the magnetic field change when we add another magnet to the system?
- Lesson 6: How can we use magnetic fields to explain interactions at a distance between the magnet and the coil?
- Lesson 7: How does changing the distance between two magnets affect the amount of energy transferred out of the field?
- Lesson 8: How does the energy transferred from a battery to a wire coil compare to the energy transferred from a computer to a speaker?
- Lesson 9: How do the magnet and the electromagnet work together to move the speaker?
- Lesson 10: How does distance affect the strength of force pairs in a magnetic field?
- Lesson 11: What else determines the strength of the force pairs between two magnets in a magnetic field?
- Lesson 12: What cause-effect relationships explain how magnetic forces at a distance make things work?

Enduring Understandings

- The energy that makes magnets move when they get close to each other does not get transferred through air.
- The space around a magnet has a particular 3- dimensional shape, which we call a magnetic field.
- The magnetic field is not the same in every location around a magnet and seems to weaken and disappear as you move farther away from the magnet.
- Electromagnets also have a magnetic field.
- Forces in the magnetic field have a direction - out of or away from the north pole and into or toward the south pole.
- When we look at the magnetic field around two magnets, the magnetic field looks different than if we are looking at only one magnet.
- When the forces are attractive (i.e., S-N or N-S), then the magnetic field connects in the middle with a line of pointers pointing in the same direction.
- When the forces are repulsive (i.e., S-S or N-N), then the pointers curve away from each other in the middle.

- When two magnets have repulsive forces between them and they are brought close together, kinetic energy is transferred into the magnets when they are released and they move back apart.
- When two magnets have attractive forces between them and they are moved apart, kinetic energy is transferred into the magnets when they are released and they move back together.
- Changing the distance between two magnets changes the amount of energy that can be transferred into and out of a magnetic field.
- More batteries in a circuit give more current, which transfers more energy, and results in stronger forces.
- Electric current changes direction when you flip the battery in a circuit.
- The frequency of the changes in current determines the pitch of the sound.
- Current that flips direction causes the poles of an electromagnet to flip.
- When the poles flip, the direction of forces (attractive vs. repulsive) flips in the field produced by the electromagnet.
- Changing the current in the electromagnet changes the poles of the electromagnet and the shape of the magnetic field.
- The magnetic field around a magnet (and thus an electromagnet) gets stronger when it is closer to another magnet, which means that the force between two magnets will be stronger as the magnets get closer together.
- The force with which a magnet pulls or pushes on something attracted to it or repelled by it is dependent on the distance between the magnet and the object or between two magnets.
- Where magnets are in relation to each other determines how much potential energy is in the system.
- Magnetic forces can vary in strength across a field, and the whole field can get stronger and bigger when you make the magnet stronger.
- Bigger magnets have stronger magnetic fields around them than smaller magnets of the same material, which means that the forces between two magnets will be stronger.
- Forces transfer energy into and out of a magnetic field.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-PS2-3 Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
- MS-PS2-5 Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

<table>
<tr><th colspan="3">3-Dimensional Learning Components</th></tr>
<tr><th>Science and Engineering Practices</th><th>Disciplinary Core Ideas (DCI)</th><th>Crosscutting Concepts</th></tr>
<tr>
<td>Asking Questions and Defining Problems
• Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
• Ask questions to determine relationships between independent and dependent variables and relationships in models.
• Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.
• Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Developing and Using Models
• Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed.
• Use and/or develop a model of simple systems with uncertain and less predictable factors.
• Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.</td>
<td>PS2.B: Types of Interactions
• Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
• Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)
• Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, a magnet, or a ball, respectively). (MS-PS2-5)

PS3.A: Definitions of Energy
• A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)

PS3.C: Relationship Between Energy and Forces
• When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)</td>
<td>Cause and Effect
• Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
• Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Systems & System Models
• Models can be used to represent systems and their interactions—such as inputs, processes and outputs— and energy, matter, and information flows within systems.</td>
</tr>
</table>

• Develop a model to describe unobservable mechanisms. **Planning and Carrying Out Investigations** • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. • Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.		

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking
Math • MP.2 Reason abstractly and quantitatively(MS-P2-2), (MS-PS2-3) • 6.EE.A.2 Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-2) • 7.EE.B.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-2) • 7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-PS2-2) • MP.2 Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-5) • 6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1), (MS-PS3-5) • 6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio a:b with $b \neq 0$, and use rate language in the context of a ratio relationship. (MS-PS3-1)

- 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS3-1), (MS-PS3-5)
- 8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- 8.EE.A.2 Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational. (MS-PS3-1)
- 8.F.A.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1), (MS-PS3-5)
- CCSS.MATH.8.F.B.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
- CCSS.MATH.8.F.B.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

ELA

- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS2-3), (MS-PS3-1), (MS-PS3-5)
- RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-2), (MS-PS2-5)
- WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS2-2), (MS-PS2-5)
- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)
- WHST.6-8.1 Write arguments focused on discipline content. (MS-PS3-5)
- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)
- CCSS.ELA-Literacy.SL.6.1.c Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.

Computer Science and Design Thinking

- 8.1.8.CS.3 Justify design decisions and explain potential system trade-offs.
- 8.1.8.CS.4 Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.
- 8.1.8.AP.6 Refine a solution that meets users' needs by incorporating feedback from team members and users.
- 8.2.8.ED.1 Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
- 8.2.8.ED.2 Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.ED.3 Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.ED.5 Explain the need for optimization in a design process.

Career Readiness, Life Literacies, and Key Skills

- 9.1.8.CR.4 Examine the implications of legal and ethical behaviors when making financial decisions.
- 9.4.8.CT.1 Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).
- 9.4.8.CT.2 Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
- 9.4.8.IML.3 Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping (e.g., 6.SP.B.4, 7.SP.B.8b)
- 9.4.8.IML.4 Ask insightful questions to organize different types of data and create meaningful visualizations.
- 9.4.8.IML.5 Analyze and interpret local or public data sets to summarize and effectively communicate the data.
- 9.4.8.TL.2 Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).

Social-Emotional Learning Competencies

- **Self-Awareness**
  - Recognize one's personal traits, strengths, and limitations.
  - Recognize the importance of self-confidence in handling daily tasks and challenges.
- **Self-Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.
- **Social Awareness:** Demonstrate an understanding of the need for mutual respect when viewpoints differ.
- **Responsible Decision-Making**
  - Develop, implement, and model effective problem-solving and critical thinking skills.
  - Identify the consequences associated with one's actions in order to make constructive choices.
- **Relationship Skills:** Utilize positive communication and social skills to interact effectively with others.

Learning Targets	Investigations/Resources	Formative Assessment
Lesson 1 Develop an initial model to describe how interactions between parts of a speaker system (magnet and coil of wire) cause sound without those parts touching each other. Ask questions about how interactions between parts of a speaker system (magnet and coil of wire) cause sound without those parts touching each other.	Dissect a store bought speaker and then build a homemade speaker. Develop an initial model to describe how interactions between parts of a speaker system cause sound without touching each other.	Initial Systems Model Consensus Discussion Driving Question Board (DQB)

	Generate questions for our Driving Question Board (DQB) using a cause-effect scaffold that we will return to throughout the unit.	
Lesson 2 Collect data to establish that magnets interact with certain objects to cause paired forces that are either attractive (both pulls) or repulsive (both pushes) and that changing the orientation of either of the magnets will cause both forces to reverse direction. Collect data to answer questions about the coil of wire and provide evidence to support the claim that connecting the coil of wire to a battery causes the same paired forces between the coil and a magnet as between two magnets.	Experiment with magnets, coils and other metal objects to establish that while certain metals do interact with magnets, including other magnets, the copper coil does not. Notice force pairs between the magnet and the coil only when the coil is hooked up to a battery.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 3 Develop and test a set of hypotheses to produce evidence that energy can transfer between magnets without transferring through matter, causing the magnets to move. Construct an argument supported by empirical evidence and scientific reasoning that energy can transfer between magnets without going through matter, causing the magnets to move.	Wondering how energy could transfer between parts of the speaker when the parts aren't touching. Think the energy might be transferring through the air. Write two hypotheses that predict the cause-and-effect relationships we would observe if energy transferred between magnets through the air.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Hypotheses Predictions Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 4 Ask questions about the cause and effect relationships that produce the patterns we observed (and will observe) in the direction or size of forces in a magnetic field around a permanent magnet as it interacts with another object(s) near it.	Wonder about the space around a magnet that seems to push and pull on certain things. Learn that this space is called a magnetic field. Decide to investigate the field with test objects, like iron filings and compasses.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker

Use diagrams and simulations to model the patterns we observe in the forces experienced by test objects placed near a magnet or a coil of wire connected to a battery (magnetic fields).	Learn what the magnetic field looks like and that the field is not the same in every location around a magnet.	
Lesson 5 Use a computer interactive to model the effect on the patterns in the magnetic field when we add an electromagnet to the single magnet system.	Use a computer interactive to simulate the fields between a magnet and a coil for both attractive and repulsive forces at two different distances apart. Make diagrammatic models of the fields and come to consensus around how to represent the fields.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models of magnetic fields WIS/WIM Update Progress Tracker
Lesson 6 Develop an initial model to describe how forces and energy transfer in magnetic fields explain cause and effect relationships between parts of a speaker system (magnet and coil of wire). Ask questions about how interactions between parts of a speaker system (magnet and coil of wire) cause sound without those parts touching each other.	Develop an initial model to describe how forces and energy transfer in magnetic fields explain cause and-effect relationships between parts of a speaker system (magnet and coil of wire). Ask questions about how interactions between the magnet and the coil of wire cause sound without those parts touching each other.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker Individual assessment: Magnetic field model
Lesson 7 Plan and carry out an investigation using a cart on a track to determine how changing the distance between two magnets affects the amount of energy transferred from the field between them. Develop an explanation using results from the investigation to explain the interactions and behavior of the cart system using ideas about forces and potential energy.	Plan and carry out an investigation using a cart on a track to determine how changing the distance between two magnets that experience repulsive forces between them affects the energy transferred in a magnetic field between them. Use our results to explain how changing the distance between two magnets affects the amount of energy transferred into and out of the magnetic field.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 8	Vary the volume and frequency of sounds being produced by a sound generator on a computer and	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook)

Ask questions and carry out investigations to answer questions about how the pattern of energy flow compares in different systems using a speaker, a wire coil, a lightbulb, a battery, and a computer. Critically read scientific text to gather evidence to explain the differences in the electric current produced by the computer (the cause) that results in a changing magnetic field within the speaker system (the effect).	observe the effects. Gather information using various materials including light bulbs to help explain how changes in the electric current produced by the computer results in changes to a magnetic field within the speaker system.	Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 9 Revise a model to describe how changes in a magnetic field due to changing electric current explain cause and effect relationships between parts of a speaker system (magnet and coil of wire). Ask questions about how changing the speaker system (cause) could affect the strength of the forces in the magnetic field (effect).	Add to our list the cause-and-effect relationships. Construct a classroom consensus model to explain these relationships and how they work together to produce the patterns of movement we see in the speaker. After a brainstorm and a reading jigsaw, wonder what we could do to make magnetic forces strong enough to lift trains and cars.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker Model Rubric
Lesson 10 Plan an investigation to produce data to support hypotheses about the cause-and-effect relationship between distance and magnetic forces, including identifying independent and dependent variables. Construct and use a graphical display of data to identify patterns in the mathematical relationship between distance and magnetic forces that can be used as evidence to either support or refute a hypothesis.	Co-design and then carry out an investigation using a digital scale to test the relationship between distance and magnetic force. Analyze graphs to determine the relationship between distance and magnetic force between two magnets.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 11	Plan and carry out an investigation to produce data to support a hypothesis about what factors cause	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook)

Plan and carry out an investigation to produce data to support a hypothesis about what factors cause changes in the strength of magnetic forces. Analyze and interpret data to identify linear and nonlinear relationships between various independent variables and their effect on the strength of magnetic forces.	changes in the strength of magnetic forces.	Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker Group Collaboration Assessment
Lesson 12 Revise a model to explain various phenomena that rely on magnetic forces at a distance using a series of cause-effect relationships. Plan an investigation to determine the effect of changing the metal in an electromagnet on the forces in the system.	Take stock of how far we have come and apply our new ideas about the strength of forces to both the speaker and the other electromagnet applications we have considered. Revisited the DQB one last time to answer our remaining questions.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Assessment transfer task to elicit student ideas about forces at a distance as they design an experiment, using the cause-effect language they have been practicing throughout this unit.

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate

- Accommodations as per IEP/504/ELL
- Strive to give students an opportunity to share their ideas with one or two peers before going public with the whole class.
- If possible connect a speaker to your music-playing device and play a song for your students. If students lightly touch the speaker, they can feel the vibrations (especially helpful for hearing/vision impaired students)
- Using letter or number coding alongside color coding for models
- Have students jot down some ideas in their notebooks after their partner talk and before sharing out when time permits
- Draw on prior experience (ex: magnets)
- Break down compound words with students to support understanding (ex: electromagnet)
- Add complex/new vocabulary to a word wall, student glossary, or both

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate**
• Mid Unit Assessment	• Bolded keywords

• End of Unit Summative Assessment	• Word banks • Reference images • Read directions to students to help with comprehension as needed • Provide access to anchor charts and classroom labels relevant to science concepts • Scribe for students or allow students to use a talk-to-text feature on Chromebooks when responding to questions as needed • Paper copies of assessment as needed/appropriate

Unit Title	**Time Frame/Pacing**
Earth in Space	7 weeks (35 days)

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

<u>Anchoring Phenomenon:</u>
People across cultures and time have studied the sky and relied on the sky in their lives.

<u>Anchoring Question:</u>
Why do we see patterns in the sky, and what else is out there that we can't see?

<u>Supporting Questions:</u>
- Lesson 1: What patterns in the sky set the rhythms for our lives?
- Lesson 2: Why do we see seasonal patterns?
- Lesson 3: Why do we see the shape of the Moon change?
- Lesson 4: What other patterns related to the Moon can our model explain?
- Lesson 5: Why doesn't the Moon fall down onto Earth?
- Lesson 6: How do objects get in orbit?
- Lesson 7: What is the solar system, and how did it form?
- Lesson 8: How do systems in space explain the patterns in the sky that set the rhythms for our lives?
- Lesson 9: Are we alone?
- Lesson 10: Could there be life in our solar system?
- Lesson 11: Can we see systems like our solar system around other stars?
- Lesson 12: How can we use light to detect whether there are planets around other stars?
- Lesson 13: What else can light tell us about planets in other star systems?
- Lesson 14: What is the potential for life in other star systems?
- Lesson 15: What is beyond the stars?
- Lesson 16: What is our place in the universe?

Enduring Understandings

- Because of Earth's tilt, the sunlight shines on us directly when we are tilted toward the Sun. When we are tilted away from the Sun, the sunlight is at an angle. This causes the seasonal temperature changes we experience.
- When the sunlight is direct on the top half of Earth (the Northern Hemisphere), it is at an angle in the Southern Hemisphere, and vice versa. This is why the seasonal patterns are the opposite in places like Australia and South Africa compared to our area.

- The Moon is a sphere; it is going around Earth in a (nearly) circular orbit.
- Unlike the Sun, the Moon doesn't shine on its own.
- Light from the Sun shines on only half of the Moon; what we see when we look up at the Moon is only the part of the sphere that sunlight shines on.
- The shape of the Moon we see from one day to the next is a result of its position in space relative to Earth; the shape can be explained in terms of how much of the sunlit side we can see.
- Sometimes the Moon looks like it covers the Sun and we get a solar eclipse. Sometimes the Moon falls into Earth's shadow and we get a lunar eclipse.
- The Moon's orbit is not perfectly flat relative to Earth's orbit around the Sun; it is tilted just a little. This is why we don't see eclipses every month.
- Gravity forces are attractive and increase in strength with increased mass of the interacting objects and decrease in strength as the distance between the objects increases.
- An object will only orbit a planet if it is moving at the right speed and has the right amount of gravity force acting on it. If the speed is too slow or the force of gravity is too strong, the orbiting object will collide with the planet. If the speed is too fast or the force of gravity is too weak, the orbiting object will fly away.
- Just like objects that fall toward Earth, an object in orbit around Earth has a gravity force acting on it, pulling it toward Earth.
- Orbiting objects have sufficient speed and height that by the time they fall the distance of their initial height, they have moved far enough across Earth's surface that the curvature of the planet prevents them from reaching the ground.
- Planets, asteroids, and comets orbit the Sun in our solar system.
- The stars and constellations appear fixed in the sky behind the objects in the solar system and do not orbit the Sun.
- The solar system was formed billions of years ago when a cloud of dust spun and gravity pulled together most of the matter to form the Sun and planets.
- The patterns in the sky that help set the rhythms of our lives are explained by the locations and motions of objects in space, which are determined by gravity.
- Stars are scattered at different distances from the Earth-Sun system, and we need to change our scale and/or our perspective in order to see and represent this. From our perspective we see the familiar constellations.
- As Earth orbits the Sun, from the perspective of Earth the Sun appears to move through different constellations in the sky. When this happens, we cannot see the constellation because the Sun is out at the same time.
- Our solar system is made up of a great diversity of objects, including planets, moons, asteroids, and dwarf planets.
- There is the potential for life in our solar system, both in the past and in the present.
- Light is the only way that we can get information about objects outside of our solar system because they are so far away.
- Telescopes collect light from space so that we can see objects more clearly.
- Because light can travel through space, it cannot be a matter wave, like sound or water waves.
- The stars in the sky have planets orbiting around them, and maybe even moons, asteroids, and comets as well.
- Light coming from a star is made up of all the colors.
- When light passes through glass, or air, some wavelengths of light interact and get absorbed or reflected, while other wavelengths are transmitted without interacting.
- Which wavelengths of light are transmitted depends on the substance the light is moving through.
- Earth orbits the Sun, making the Sun and Earth part of our solar system along with other planets, asteroids, comets, and so forth.

- Moons orbit planets, creating subsystems of the solar system.
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- MS-ESS1-1 Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons.
- MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
- MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.
- MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Developing and Using Models • Use and/or develop a model of simple systems with uncertain and less predictable factors. • Develop and/or use a model to predict and/or describe phenomena. • Develop a model to describe unobservable mechanisms. • Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. **Analyzing and Interpreting. Data** • Analyze and interpret data to provide evidence for phenomena. • Consider limitations of data analysis (e.g.,	**ESS1.A: The Universe and Its Stars** • Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1) • Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2) **ESS1.B: Earth and the Solar System** • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2), (MS-ESS1-3) • This model of the solar system can explain eclipses of the sun and the moon. Earth's	**Patterns** • Macroscopic patterns are related to the nature of microscopic and atomic-level structure. • Graphs, charts, and images can be used to identify patterns in data. **Scale, Proportion, Quantity** • Scientific relationships can be represented through the use of algebraic expressions and equations. • Phenomena that can be observed at one scale may not be observable at another scale. **Systems, System Models** • Systems may interact with other systems; they may have sub-systems and be a part

measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials). **Construct. Explanation and Designing Solutions** • Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. • Construct an explanation using models or representations. • Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events. **Obtaining, Evaluating and Communicating Information** • Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s). • Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings. • Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1) • The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2) **PS2.B: Types of Interactions** • Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3) • Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4) • Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, a magnet, or a ball, respectively). (MS-PS2-5) **PS4.B: Electromagnetic Radiation** • When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the	of larger complex systems. • Models can be used to represent systems and their interactions—such as inputs, processes and outputs— and energy, matter, and information flows within systems. • Models are limited in that they only represent certain aspects of the system under study.

	light. (MS-PS4-2) • The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) • A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) • However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)	

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively. (MS-ESS1-3)
- MP.4 Model with mathematics. (MS-ESS1-1), (MS-ESS1-2)
- 6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1), (MS-ESS1-2), (MS-ESS1-3)
- 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS1-1), (MS-ESS1-2), (MS-ESS1-3)
- 6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2)
- 7.EE.B.6 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-2)
- CCSS.MATH.CONTENT.7.RP.A.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction 1/2/1/4 miles per hour, equivalently 2 miles per hour. In this lesson, students calculate the ratio of light per unit area to solve a real world problem: explaining temperature variation over a year.

ELA

- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-3)
- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3)

- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS1-1),(MS-ESS1-2)
- WHST.6-8.1 Write arguments focused on discipline-specific content. (MS-PS2-4)
- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-2)
- RST.6–8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Computer Science and Design Thinking

- 8.1.8.CS.1 Recommend improvements to computing devices in order to improve the ways users interact with the devices.
- 8.1.8.IC.1 Compare the trade-offs associated with computing technologies that affect an individual's everyday activities and career options.
- 8.1.8.IC.2 Describe issues of bias and accessibility in the design of existing technologies.
- 8.2.8.ED.3 Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.ED.6 Analyze how trade-offs can impact the design of a product.

Career Readiness, Life Literacies, and Key Skills

- 9.1.8.CR.4 Examine the implications of legal and ethical behaviors when making financial decisions.
- 9.4.8.CT.1 Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).
- 9.4.8.CT.2 Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
- 9.4.8.IML.3 Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping (e.g., 6.SP.B.4, 7.SP.B.8b)
- 9.4.8.IML.4 Ask insightful questions to organize different types of data and create meaningful visualizations.
- 9.4.8.IML.5 Analyze and interpret local or public data sets to summarize and effectively communicate the data.
- 9.4.8.TL.2 Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
- SL #5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

Social-Emotional Learning Competencies

- **Self-Awareness**
    - Recognize one's personal traits, strengths, and limitations.
    - Recognize the importance of self-confidence in handling daily tasks and challenges.
- **Self-Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.
- **Social Awareness:** Demonstrate an understanding of the need for mutual respect when viewpoints differ.
- **Responsible Decision-Making**

  - Develop, implement, and model effective problem-solving and critical thinking skills.
  - Identify the consequences associated with one's actions in order to make constructive choices.
- **Relationship Skills:** Utilize positive communication and social skills to interact effectively with others.

Learning Targets	Investigations/Resources	Formative Assessment
Lesson 1 Develop an initial model of systems in space to describe patterns we observe in the sky. Ask questions about systems in space that arise from observations of patterns in the sky.	Consider how changes in sunlight can impact our daily lives, and then brainstorm other interesting patterns in the sky based on our own experience, stories from our friends and family, and a series of podcasts about how humans across cultures and throughout time have relied on and made connections to the sky. Model some of the patterns we have identified, develop questions for the Driving Question Board, and then brainstorm ideas for where to go next	Patterns in the Sky initial systems models Consensus Discussion Driving Question Board (DQB)
Lesson 2 Develop, revise, and use models of the Earth-Sun system to explain seasonal patterns of the motion of the Sun in the sky and of temperatures over the surface of Earth. Use data to refute the claim that distance from the Sun causes the patterns of seasonal temperature variation that we experience on Earth.	Use planetarium software to observe the motion of the Sun through the sky over a year. Notice that in summer there the day gets longer, and the apparent path of the Sun gets wider and higher. Learn that Earth's axis of rotation is tilted. Model the system in small groups to explain the patterns we noticed. Use our models to explain seasonal temperature variation.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 3 Develop and use a model of the Earth-Sun-Moon system to predict and explain patterns we observe in the way the apparent shape of the Moon changes	Look at the current shape of the Moon and then look for patterns in photographs of the Moon over a month.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board

over time.	Look at historic images of the Moon from cultures around the world. Use a 3-D model to help make sense of the positions of the objects in the Earth-Sun-Moon system and how the apparent shape of the Moon we see changes. Use an interactive to help us explain how changes in the position of the Moon affects the shape of the Moon we see.	System Models WIS/WIM Update Progress Tracker
Lesson 4 Construct an explanation and critique peer explanations for lunar phases, lunar eclipses, and solar eclipses using a revised model of the Earth-Sun-Moon system. Communicate information gathered from multiple appropriate sources about how the interactions in the Earth-Moon-Sun system change the appearance of the Moon from the perspective on Earth.	Watch videos of two kinds of eclipses. Reproduce and explain what we saw in the videos using a computer interactive and then with a physical model of the system. Compile the ideas we want to include in a conceptual model. Model and then explain (in our own videos) how the position of the Moon changes what you see on Earth in eclipses and lunar phases. Provide feedback to our peers before taking an individual assessment.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker Individual Assessment: Student Video Eclipse Models
Lesson 5 Use a simulation of the Earth-Moon system to model the effects of changes to the system on the gravitational forces between orbiting objects.	Consider why the Moon orbits Earth even though it's made of rocks, which usually fall down toward Earth when thrown up into the air from Earth. Use a computer simulation of the Earth-Moon system, noticing how the mass and speed of the Moon and its distance from Earth affect the force of gravity and the Moon's motion. Depending on how	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker

	these factors change, the Moon eithers stays in orbit, crashes into Earth, or flies away.	
Lesson 6 Obtain information from text to describe the role of gravity in maintaining the balance necessary for an object to be in orbit.	If the Moon is a rock in space, wonder what it would take to get an ordinary rock on Earth into orbit. Read about a thought experiment involving a cannonball launched from the top of a mountain, and construct an explanation that orbiting objects are pulled by gravity toward Earth like other objects, but they move fast enough that they "fall" with Earth's curvature, never reaching the ground.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 7 Obtain and communicate information from a computer interactive and a video about the patterns of motion of other objects (e.g., planets, moons, and stars) in our solar system and how gravity created the stable system we see today.	Examine the structure and movement of objects in the solar system using an interactive and then share what was noticed. Watch a video about the formation of the solar system to gather information about the role of gravity in this process. Argue how gravity led to the objects and the patterns of motions of those objects (planets and moons) in the computer interactive.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 8 Develop a model of stars and our solar system by representing subsystems of systems at different scales. Respectfully provide and receive critiques about a model of systems in space that explains patterns we see in the shape and motion of objects in the sky. Construct an explanation of patterns we observe in the shape and motion of stars in the sky using a	Look back at the DQB to identify a set of patterns about stars that we haven't explained. Watch a video about seasonal constellations, and then in small groups we make a physical model to explain the patterns we see. Individually model these systems on paper as an assessment. Take stock of all the questions we have answered	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker Individual Assessment: Model the solar system at different subscales to explain the patterns of constellations we see from Earth.

model of stars and our solar system.	already and get ready to shift gears and talk about life in space.	
Lesson 9 Ask questions to identify evidence that we could observe that will support or challenge a claim about if there is life in the vast universe.	Compare various pop culture references to life in space. Make a class barometer to show how much we agree or disagree with the idea that there is really life in space out there somewhere, and then consider what questions we need to answer to support our claims and add them to the DQB. \Make plans about where to go next to begin answering our questions about life in space.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Class Barometer Update Progress Tracker
Lesson 10 Obtain and communicate the central ideas from an infographic to support an argument from evidence about the potential for life on the various objects that make up our solar system, including planets, their moons, asteroids, and dwarf planets.	Jigsaw gathering information from a series of infographics to learn more about the diverse collection of objects in our solar system where we might look for life. Argue that there is potential for life in our solar system, both past and present, but that it is unlikely that it was or is intelligent. Decide to investigate outside of the solar system next.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 11 Read a scientific text adapted for classroom use to obtain evidence about how light waves can be used to study stars that are too distant to visit, and the existence of systems orbiting around those stars.	Wondering if there are systems around other stars, so we read an article about looking at images of stars through a telescope. The reading doesn't answer our questions because we don't see planets around other stars with our eyes, but we are not quite convinced that this means there are definitely not systems there.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 12	Compare two arguments about whether or not other	Check-Ins (Do Nows, Entrance Tickets, Exit

Use a model of a star system to generate light curve data to test ideas about what patterns could indicate the presence of planets orbiting a very distant star in our galaxy. Consider the limitations of using light curves to detect planets passing in front of a star that is so distant we cannot see the system directly and evaluate how this might affect the accuracy of the conclusions we draw from the data about the prevalence of planets in other star systems. Students compare two arguments about whether or not other star systems include planets, analyze the use of evidence, decide what additional evidence is needed to support either argument, and use patterns in the data to provide that evidence.	star systems include planets and decide what additional evidence is needed to support either argument. Use a model of a star system to generate light curve data to establish what the data would like if a star did have a planet. Look at light curve data and see that there appear to be many stars with planets.	Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker Assessment: Transit Data Evidence
Lesson 13 Analyze and interpret data from star spectra to provide evidence for the existence of a planet that is too far for us to observe directly. Develop an explanatory model for how light changes as it passes through the atmosphere of an exoplanet using a wave model of light to explain how the structure of the wave determines color.	Use our experience with sunsets to think about how the color of light changes as it passes through the atmosphere of a planet. Play with prisms to determine that sunlight is made up of all the colors. Obtain information about how astronomers use color, which tells us about the wavelength of light, to learn more about the properties of exoplanets.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker Student Explanation: Exoplanet Interpretation
Lesson 14 Obtain, evaluate, synthesize, and communicate information about the discovery, location, and potential for finding life on an exoplanet that is too distant to observe directly, using a podcast format.	Work in small groups to obtain, evaluate, and communicate information about exoplanets from multiple sources. Create podcasts to share with the class that describe the exoplanet, where this planet is compared to Earth, how the planet was discovered, and create an	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker

	argument about if this planet could potentially support life.	Student Podcasts/Infographic: Communication of Exoplanet Discovery
Lesson 15 Obtain and synthesize information across multiple sources about the organization of space systems in our universe from the human scale to the galactic scale. Develop a model of the universe that shows how gravity forces bound space systems at multiple scales. Compare and critique two arguments emphasizing the same evidence (images of galaxies) about the organization of systems in space.	Look at a photo taken by the Hubble telescope of blobs in the space between stars. Learn that these are galaxies, islands of stars much like the ones we see in the sky. Watch the movie Powers of Ten to visualize how scientists model the universe at various scales. Notice that the universe appears to be organized into systems held together by gravity, separated by vast emptiness.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models WIS/WIM Update Progress Tracker
Lesson 16 Develop a mathematical model to predict the number of communicating civilizations in our galaxy based on what we know about systems in space, including galaxy clusters, galaxies, star systems, and moon systems around planets.	Wondering if we can come up with an estimate about the probability of life in space. Use what we know about the universe to quantify the probability of life in space. Go back to our DQB to take stock of where we have been and reflect on Earth's very special place in the universe.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board System Models Mathematical Model WIS/WIM Update Progress Tracker

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate

- Accommodations as per IEP/504/ELL
- Use gestures in addition to talking
- Word wall: use student-friendly definitions, make connections to cognate/root words when possible, and include a visual representation of the word
- Emphasize socially safe activity structures (e.g., small-group or partner work before a whole-class discussion)
- Science notebook: Students should be encouraged to record their ideas using linguistic (e.g., written words) and nonlinguistic (e.g.,taping in photographs, creating drawings, tables, graphs, mathematical equations, and measurements) modes.
- Encourage all students to use words and/or drawings when representing and recording their investigation setup and observations.

<table>
<tr><td colspan="2">

- Use classroom norms to support engagement by creating a space where students are not worried about being right or wrong.
- Having different modes for interacting with the readings will provide different ways to access the readings
- Graphs with pre-labeled axes as needed
- Provide options for investigations when applicable (giving students a choice to pursue a line of inquiry that is more relevant to them)
- Provide hands-on materials for students to demonstrate their ideas when possible/relevant
- Provide cause/effect sentence stems when relevant/as needed
- Provide paper copies of DQB questions as needed

</td></tr>
<tr><td>Common Assessment(s)</td><td>Assessment Modifications and/or Accommodations
(ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate</td></tr>
<tr><td>

- Mid Unit Assessment
- End of Unit Summative Assessment

</td><td>

- Bolded keywords
- Word banks
- Reference images
- Read directions to students to help with comprehension as needed
- Provide access to anchor charts and classroom labels relevant to science concepts
- Scribe for students or allow students to use a talk-to-text feature on Chromebooks when responding to questions as needed
- Paper copies of assessment as needed/appropriate

</td></tr>
</table>

Unit Title	**Time Frame/Pacing**
Genetics	26 days

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Anchoring Phenomenon:
There are cattle (and several other animals) that have extra-big muscles.

Anchoring Question:
Why are living things different from one another?

Supporting Questions:

- Lesson 1: How do organisms get all these differences?
- Lesson 2: What do muscles look like up close?
- Lesson 3: How do diet and exercise affect muscle size?
- Lesson 4: How do most animals get bigger muscles?
- Lesson 5: Where do the babies with big muscles come from?
- Lesson 6: What is the connection between chromosomes and the heavily muscled phenotype?
- Lesson 7: What does the myostatin protein do?
- Lesson 8: How did those animals get extra-big muscles?
- Lesson 9: Why don't offspring always look like their parents or their siblings?
- Lesson 10: How do farmers control the traits of their livestock?
- Lesson 11: Do asexual organisms have genetic material if they don't have sperm and eggs?
- Lesson 12: How do asexual organisms pass on genetic information if they don't have sperm and eggs?
- Lesson 13: Can our explanation for how a single gene contributes to the variation in one physical trait (musculature) be used to explain variation in other physical traits?
- Lesson 14: How common are other trait variations?
- Lesson 15: How much of trait variation in a population is controlled by genes or the environment?
- Lesson 16: Why are living things different from one another?

Enduring Understandings

- There are lots of variations of characteristics in living things.
- Chromosomes are passed from parents to offspring when the sperm and egg fuse during fertilization.
- One chromosome in each pair shown on the karyotype comes from each parent.

- Specific regions of the chromosomes are called genes, and the possible variations of a gene are called alleles.
- Genotype is the variation of alleles an individual gets from its parents.
- A mutation is a structural change in the genetic information that can result in changes to proteins produced, which can affect the structure and functions of the organism, thereby changes its trait.
- The proportion of offspring with different phenotypes can be predicted depending on the genotypes of the parents.
- Some mutations can have beneficial and negative effects on an organism.
- There is genetic information inside asexual organisms even though asexual organisms don't have sperm and eggs.
- Genetic information is a physical structure. We can use tools to see it with our eyes.
- Several different methods of asexual reproduction all result in genetically identical offspring.
- One allele makes one protein, but every trait is not always influenced by just one gene.
- Different traits and variations are influenced differently by genes and environment.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- MS-LS3-1 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
- MS-LS4-5 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Developing and Using Models • Evaluate limitations of a model for a proposed object or tool. • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop a model to describe unobservable mechanisms.	**LS1.B: Growth and Development of Organisms** • Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) • Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. **LS3.A: Inheritance of Traits**	**Cause and Effect** • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. • Cause and effect relationships may be used to predict phenomena in natural or designed systems. • Phenomena may have more than one cause, and some cause and effect

Using Math and Computational Thinking

- Unknown practice identifier: 5.1 use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.
- Apply mathematical concepts and/or processes (such as ratio, rate, percent, basic operations, and simple algebra) to scientific and engineering questions and problems.

Obtaining, Evaluating and Communicating Information

- Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).
- Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.
- Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts.
- Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.

- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)

LS3.B: Variation of Traits

- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)

LS4.B: Natural Selection

- In artificial selection, humans have the capacity to influence certain characteristics

relationships in systems can only be described using probability.

Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.

Scale, proportion, and quantity

- The observed function of natural and designed systems may change with scale.
- Phenomena that can be observed at one scale may not be observable at another scale.

	of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)	

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- 6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-5)
- 6.SP.B.4 Summarize numerical data sets in relation to their context. (MS-LS1-5)
- MP.4 Model with mathematics. (MS-LS3-2)
- 6.SP.B.5 Summarize numerical data sets in relation to their context. (MS-LS3-2)
- CCSS.MATH.CONTENT.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- CCSS.MATH.CONTENT.7.SP.B.3 Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.
- CCSS.MATH.CONTENT.7.SP.C.5 Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.
- CCSS.MATH.CONTENT.7.SP.C.7 Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.
- CCSS.MATH.CONTENT.7.SP.C.7.B Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process.
- CCSS.MATH.CONTENT.7.SP.C.8 Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.
- CCSS.MATH.CONTENT.7.SP.C.8.A Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.
- CCSS.MATH.CONTENT.7.SP.C.8.B Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event.
- CCSS.MATH.CONTENT.7.SP.C.8.C Design and use a simulation to generate frequencies for compound events.
- CCSS.MATH.CONTENT.7.RP.A.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.
- CCSS.MATH.CONTENT.7.SP.A.1 Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random

sampling tends to produce representative samples and support valid inferences.

ELA

- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-5), (MS-LS4-5)
- RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-5)
- WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-5)
- WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-5)
- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS3-1), (MS-LS3-2)
- RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics. (MS-LS3-1), (MS-LS3-2)
- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS3-1), (MS-LS3-2)
- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS3-1), (MS-LS3-2)
- WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS4-5)
- CCSS ELA SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- CCSS ELA LITERACY RI.8.7 Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea.
- CCSS.ELA-LITERACY.RI.8.9 Analyze a case in which two or more texts provide conflicting information on the same topic and identify where the texts disagree on matters of fact or interpretation.
- CCSS.ELA-LITERACY.RI.8.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
- CCSS.ELA-LITERACY.RI.8.10 By the end of the year, read and comprehend literary nonfiction at the high end of the grades 6-8 text complexity band independently and proficiently.
- CCSS.ELA-LITERACY.SL.8.1.A Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
- CCSS.ELA-LITERACY.RI.8.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
- CCSS.ELA-LITERACY.RI.8.2 Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.

- CCSS ELA-LITERACY.L.8.4.B Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word.
- CCSS.ELA-LITERACY.W.8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- CCSS.ELA-LITERACY.W.8.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic.
- CCSS.ELA-LITERACY.RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
- CCSS.ELA-LITERACY.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- CCSS.ELA-LITERACY.W.8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- CCSS.ELA-LITERACY.SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
- CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

Computer Science and Design Thinking

- 8.1.8.CS.3: Justify design decisions and explain potential system trade-offs.
- 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.NT.3: Examine a system, consider how each part relates to other parts, and redesign it for another purpose.
- 8.2.8.NT.4: Explain how a product designed for a specific demand was modified to meet a new demand and led to a new product.

Career Readiness, Life Literacies, and Key Skills

- 9.4.8.CI.3 Examine challenges that may exist in the adoption of new ideas (e.g., 2.1.8.SSH, 6.1.8.CivicsPD.2).
- 9.1.8.CR.4 Examine the implications of legal and ethical behaviors when making financial decisions.
- 9.4.8.CT.1 Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).
- 9.4.8.CT.2 Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
- 9.4.8.IML.3 Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping (e.g., 6.SP.B.4, 7.SP.B.8b)
- 9.4.8.IML.4 Ask insightful questions to organize different types of data and create meaningful visualizations.
- 9.4.8.IML.5 Analyze and interpret local or public data sets to summarize and effectively communicate the data.
- 9.4.8.TL.2 Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).

Social-Emotional Learning Competencies

• **Self-Awareness**
  ○ Recognize one's personal traits, strengths, and limitations.
  ○ Recognize the importance of self-confidence in handling daily tasks and challenges.
• **Self-Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.
• **Social Awareness:** Demonstrate an understanding of the need for mutual respect when viewpoints differ.
• **Responsible Decision-Making**
  ○ Develop, implement, and model effective problem-solving and critical thinking skills.
  ○ Identify the consequences associated with one's actions in order to make constructive choices.
• **Relationship Skills:** Utilize positive communication and social skills to interact effectively with others.

Learning Targets	Investigations/Resources	Formative Assessment
Lesson 1 Develop and/or use a model to predict what is causing these animals to have extra-big muscles. Ask questions that arise from careful observation of pictures of animals with different musculature and living things that have variations in one or more of their features to seek information about what causes these variations in populations.	Observe a bull and other animals that have extra-big muscles. Develop initial models to explain what could be causing this phenomenon. Realize that there is a range of musculature on animals, and we explore several other examples of living things that have wide variations in some of their features. After listing related phenomena, develop a Driving Question Board and ideas for future investigations. Some cattle have extra-big muscles that we've never seen before, and we don't know how they got that way.	Initial Model Consensus Discussion Driving Question Board (DQB)
Lesson 2 Obtain, evaluate, and communicate information about muscles in various media and visual displays, including models of complex protein structures, to describe (1) how the function of those proteins depends on their shape and (2) how the muscle cells	Observe images and video animations about what muscles look like up close and how muscles work. Compare photos and data about muscle cells from extra-big-muscled animals and typical ones.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM

of extra-big-muscled animals compare with those of typical animals.		Update Progress Tracker
Lesson 3 Obtain, evaluate, and communicate information to determine the effect of exercise in the development of muscle tissue. Analyze and interpret data in graphs, charts, and images to identify patterns in the roles of diet and exercise in the development of muscle tissue.	Students examine data in texts, images, graphs, and charts in order to determine the effect of diet and exercise on muscle growth.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 4 Develop and use a model to construct and predict a scientific explanation based on evidence for how different environmental factors (cause) influence variation in a trait (effect).	Update our classroom consensus model to include our recent findings about the role diet and exercise play in making muscles. Attempt to apply our class model to explain how the extra-muscled cattle would have developed their muscles, but are not convinced of our model's implications. Ask a farmer more about these cattle and find out that they have calves that are heavily muscled. Discuss how this information impacts our model.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Revised Consensus Models WIS/WIM Update Progress Tracker
Lesson 5 Develop and use a model to describe the patterns that emerge between the number and types of chromosomes in the sex cells of parents and the body cells of offspring, and how the chromosomes in a muscle cell of the offspring consist of a subset of chromosomes from each parent. Use the patterns in the model to predict that each parent must randomly contribute half of their chromosomes to sex cells.	Observe cow family photos to find patterns between relatedness and musculature. Wonder how muscles actually get from parents to offspring, and we zoom in to look at the chromosomes inside sperm and egg cells. Make connections between the karyotype of an offspring's muscle cell and chromosomes in the sex cells of the parents.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker

Lesson 6 Develop and use a model to describe correlational relationships among chromosome pairs containing two variants, specific proteins, and the trait of musculature. Obtain, evaluate, and communicate information by critically reading a scientific text adapted for classroom use to obtain evidence that a distinct gene is the cause for the production of a specific protein related to the trait of musculature.	View a video and discuss the super-small yet hugely complex scale of chromosomes. Reassemble the cattle family trees with added information about each individual's chromosomes and myostatin proteins and the class builds a consensus model showing the connections they found. Read and discuss a summary of a genetic study to find evidence of causal relationships among allele, protein, and phenotype.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models- Family Trees WIS/WIM Update Progress Tracker
Lesson 7 Obtain, evaluate and communicate information from a scientific text about how the shape (structure) of the myostatin protein affects its function, which then influences the variation of a trait an individual shows (how much muscle an organism grows).	Evaluate and critically read an article about the function of the myostatin protein. Obtain information and communicate during class discussion using evidence from the text about how the structure of myostatin affects muscle growth.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 8 Develop and use a model to evaluate and construct a scientific explanation based on evidence for how different environmental and genetic (cause) factors influence variation in a trait (effect) at different scales.	Update the classroom consensus model to include students' recent findings about the role genes, alleles and the myostatin protein play in making extra-big muscles. Update our Progress Tracker with a partner and revised our initial model individually. Looking at a cattle family, we realize that the siblings don't look the same. Discuss how this information impacts our current model.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Consensus Models WIS/WIM Update Progress Tracker Individual Assessment: Explanation
Lesson 9 Use mathematics and computational thinking to find	Investigate the inheritance patterns of the myostatin gene by comparing the proportion of different	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook)

patterns about genotypic and phenotypic outcomes resulting from crossing individuals with specific genotypes. Plan and carry out an investigation to collect data and uncover patterns that support the idea that alleles separate when sex cells form and then recombine at fertilization, so each parent contributes half of the genes acquired (at random) by the offspring. Obtain, evaluate, and communicate information regarding the effect of selective breeding in one type of sexually reproducing organism. Use mathematics and computational thinking to determine the effect of selective breeding in sexually reproducing organisms by examining the frequency of certain trait variations and combinations in a population over time.	genotypes collected from pedigrees that show the results of known crosses. Use simple mathematical models to help us predict the outcome of known genetic crosses.	Consensus Discussion Revisit Driving Question Board Mathematical Models WIS/WIM Update Progress Tracker
Lesson 10 Obtain, evaluate, and communicate information regarding the effect of selective breeding in one type of sexually reproducing organism. Use mathematics and computational thinking to determine the effect of selective breeding in sexually reproducing organisms by examining the frequency of certain trait variations and combinations in a population over time.	Read two articles about how farmers breed animals for desired traits, and we ran a computer simulation where we controlled breeding in order to create individuals with desired traits.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 11 Plan and carry out an investigation to produce data to serve as the basis for evidence that asexual organisms have genetic information inside their cells that can be visualized (scale) even though they	Question whether asexual organisms have genetic material if they don't have sex cells. Plan an investigation using bananas and strawberries to break open cells and test whether asexual	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Observations

are not produced from sperm and eggs.	organisms have genetic information. Carry out our investigations and discuss the results as a class.	Models WIS/WIM Update Progress Tracker
Lesson 12 Obtain, evaluate, and communicate information about how organisms reproduce asexually and transfer their genetic information to their offspring, which results in offspring with identical genetic information. Plan and carry out an investigation to see whether asexual reproduction causes offspring identical to their parent.	Work in small groups to research and share about an organism that uses asexual reproduction. Discuss how the genetic information of offspring from asexual reprodcution compares to that of the parent. Observe and bisect live planaria to see if they will, in fact, be identical after they've regenerated.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Observations Models WIS/WIM Update Progress Tracker
Lesson 13 Analyze and interpret data to find patterns in how structural changes in genes may affect proteins, which may result in harmful or beneficial effects to the organism. Obtain, evaluate, and communicate information about how structural changes in genes may cause changes to proteins, which may result in harmful or beneficial effects to the organism.	Jigsaw several articles looking at different traits to see if our gene-to-trait story with MSTN is the same. After constructing a simple model and comparing our models, share out with the class the patterns observed, and discuss whether these traits are harmful or beneficial.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Observations Models WIS/WIM - Histograms Update Progress Tracker Peer Feedback Self Assessment
Lesson 14 Use mathematics and computational thinking with a digital tool to find patterns in a large set of trait variation data.	Collect data from our own class's arm spans, and create a graph to represent them. Measure the lengths of many sunflower seeds and use digital tools to graph those. Generate histograms and adjust the "bin" size to see how that changes the shape of the graph.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Observations Models WIS/WIM - Histograms Update Progress Tracker

	Consider where heavily muscled cattle would be represented if we were able to show the variety of musculature for cattle on a graph like these.	
Lesson 15 Obtain, evaluate, and communicate information about how different traits and variations are affected differently by genes and environment. Develop and use models to show multiple causes of variation within a trait.	Check on our planaria and share our observations about their development. Develop an analogy to help explain how different phenotypes can be differently influenced by environment and genes, and revise our classroom consensus model to reflect how different factors influence musculature in cattle. Read about other trait variations and develop models to communicate how genes and environmental factors impact those traits.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Observations Models WIS/WIM Update Progress Tracker
Lesson 16 Obtain, evaluate, and communicate information to explain what causes living things to be different from one another. Construct an explanation using models or representations to describe how environmental and genetic factors influence the growth of organisms and why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation in the context of goldfish coloration and size.	Revisit our Driving Question Board to evaluate and answer their questions. Use this time to ask any clarifying questions to refine our understanding about our models for how living things are different from one another. Demonstrate understanding on a summative assessment transfer task involving goldfish.	Transfer Task: Goldfish Breeding

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate

- Accommodations as per IEP/504/ELL
- Use gestures in addition to talking
- Word wall: use student-friendly definitions, make connections to cognate/root words when possible, and include a visual representation of the word

- Emphasize socially safe activity structures (e.g., small-group or partner work before a whole-class discussion) - Science notebook: Students should be encouraged to record their ideas using linguistic (e.g., written words) and nonlinguistic (e.g.,taping in photographs, creating drawings, tables, graphs, mathematical equations, and measurements) modes. - Encourage all students to use words and/or drawings when representing and recording their investigation setup and observations. - Use classroom norms to support engagement by creating a space where students are not worried about being right or wrong. - Having different modes for interacting with the readings will provide different ways to access the readings - Graphs with pre-labeled axes as needed - Provide options for investigations when applicable (giving students a choice to pursue a line of inquiry that is more relevant to them) - Provide hands-on materials for students to demonstrate their ideas when possible/relevant - Provide cause/effect sentence stems when relevant/as needed - Provide paper copies of DQB questions as needed	
Common Assessment(s)	**Assessment Modifications and/or Accommodations** **(ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate**
- Mid Unit Assessment - End of Unit Summative Assessment	- Bolded keywords - Word banks - Reference images - Read directions to students to help with comprehension as needed - Provide access to anchor charts and classroom labels relevant to science concepts - Scribe for students or allow students to use a talk-to-text feature on Chromebooks when responding to questions as needed - Paper copies of assessment as needed/appropriate

Unit Title	**Time Frame/Pacing**
Natural Selection & Common Ancestry	26 days

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Anchoring Phenomenon:
A giant penguin, named Pedro, that lived 36 million years ago, has important anatomical similarities and differences from penguins that are alive today.

Anchoring Question:
How could things living today be connected to the things that lived long ago?

Supporting Questions:

- Lesson 1: How could penguins and other things living today be connected to the things that lived long ago?
- Lesson 2: How similar or different are different types of penguins?
- Lesson 3: How do the traits of other ancient penguins compare to modern penguins?
- Lesson 4: Why are there similarities and differences in the traits we see between modern penguins and ancient penguins?
- Lesson 5: How might other living things be connected to ancient organisms?
- Lesson 6: How are organisms living today connected to organisms that lived long ago?
- Lesson 7: How do traits found in a population change over a shorter amount of time?
- Lesson 8: How can we model what is causing the changes in the populations happening across all our case studies?
- Lesson 9: How well does our general model predict and explain the changes happening over time in a different population?
- Lesson 10: Why does our general model tend to produce different outcomes in different environmental conditions?
- Lesson 11: Can our model explain changes over really long periods of time?

Enduring Understandings

- Earth's climate, the positions of the continents, and sea levels have changed many times over the last 60 million years.
- The structures of some other living things today (like whales, horses, horseshoe crabs) look similar to but not exactly like the most similar-looking fossils we can find.
- Sometimes, but not always, there are noticeable differences in body structures (limbs, skulls, teeth, shells). Sometimes, but not always, there are changes in overall size of the organism.
- The further back in the fossil record we go, the more pronounced those structural differences are (and the less penguin-like, horse-like, whale-like that type appears to be).
- Sometimes, but not always, characters of organisms seem to match the environment in which they lived (e.g., teeth or limbs adapted for forests or grasslands).

- There are clear patterns of differences in the body structures of certain types of organisms over really long periods of time (multiple generations) and across different environments.
- There must have been some population(s) of ancient organisms that had offspring that were lines of descendants that led to modern organisms.
- The traits are somehow changing in a line of descendants from one of the ancient populations to one of the modern ones.
- Thinking about the relationship among structure and function, change and stability over time, and the causes and effects on both individuals and the population can provide useful lenses for developing a model to explain a complex biological system.
- We can explain the traits' distribution shifts in a population over time as an indirect effect (outcome) resulting from environmental change plus heritable trait variation that shifts the competitive advantage that individuals with certain trait variations have for surviving and reproducing.
- Changing the environment can lead to different changes in the traits of the population.
- Traits that provide an individual a competitive advantage in one environment may give it a disadvantage in another environment.
- Competitive advantage affects the chances (or probability) of certain individual outcomes.
- The longer this process (natural selection) continues (over more generations) the more variations tend to be removed from the descendant population.
- Natural selection tends to produce different outcomes in different environmental conditions.
- Any change in the environment that affects the resources needed for survival and reproduction can lead to shifts in the distribution of traits in a population.
- Natural selection tends to remove certain variations from a population over time; this outcome becomes more pronounced as time goes on.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- MS-LS1-4 Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- MS-LS4-1 Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
- MS-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
- MS-LS4-3 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
- MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
- MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts

Analyzing and Interpreting. Data • Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. • Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. • Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials). • Analyze and interpret data to determine similarities and differences in findings. **Construct. Explanation and Designing Solutions** • Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. • Construct an explanation using models or representations. • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. • Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events. • Apply scientific ideas or principles to	**LS1.B: Growth and Development of Organisms** • Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4) • Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4) • Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) **LS4.A: Evidence of Common Ancestry and Diversity** • The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1) • Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2) • Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)	**Patterns** • Graphs, charts, and images can be used to identify patterns in data. **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. **Structure and Function** • Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. **Stability and Change** • Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. • Small changes in one part of a system might cause large changes in another part. • Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

design, construct, and/or test a design of an object, tool, process or system. **Engaging in Argument from Evidence** • Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. • Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**LS4.B: Natural Selection** • Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4) • In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5) **LS4.C: Adaptation** • Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)	

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- 6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-4)
- 6.SP.B.4 Summarize numerical data sets in relation to their context. (MS-LS1-4)
- MP.4 Model with mathematics. (MS-LS4-6)
- 6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4), (MS-LS4-6)
- 6.SP.B.5 Summarize numerical data sets in relation to their context. (MS-LS4-4), (MS-LS4-6)
- 6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-LS4-1), (MS-LS4-2)
- 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-LS4-4), (MS-LS4-6)

- CCSS.MATH.CONTENT.7.SP.A.1 Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.
- CCSS.MATH.CONTENT.7.SP.B.3 Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.
- CCSS.MATH.CONTENT.6.SP.A.3 Recognize that a measure of center for a numerical data set (mean/median) summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.
- CCSS.MATH.CONTENT.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- CCSS.MATH.CONTENT.8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.
- CCSS.MATH.CONTENT.8.SP.A.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

ELA

- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-4)
- RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (MS-LS1-4)
- WHST.6-8.1 Write arguments focused on discipline content. (MS-LS1-4)
- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-LS4-1), (MS-LS4-2), (MS-LS4-3), (MS-LS4-4)
- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS4-1), (MS-LS4-3)
- RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-LS4-3), (MS-LS4-4)
- WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS4-2), (MS-LS4-4)
- WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-2), (MS-LS4-4)
- SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-2), (MS-LS4-4)
- SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS4-2), (MS-LS4-4)
- CCSS.ELA-Literacy.RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. On day 1, students gather additional information from an audio recording and transcript about a giant penguin fossil that was discovered in the desert of Peru and use it to glean important insights about the traits and characteristics of the penguin fossil that was discovered.
- CCSS.ELA-Literacy.SL.6.1.c Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text,

or issue under discussion.

Computer Science and Design Thinking

- 8.1.8.DA.1 Organize and transform data collected using computational tools to make it usable for a specific purpose.
- 8.1.8.AP.6 Refine a solution that meets users' needs by incorporating feedback from team members and users.
- 8.2.8.ED.2 Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.ED.3 Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.NT.3 Examine a system, consider how each part relates to other parts, and redesign it for another purpose.
- 8.2.8.NT.4 Explain how a product designed for a specific demand was modified to meet a new demand and led to a new product.

Career Readiness, Life Literacies, and Key Skills

- 9.1.8.CR.4 Examine the implications of legal and ethical behaviors when making financial decisions.
- 9.4.8.CT.1 Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).
- 9.4.8.CT.2 Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
- 9.4.8.IML.3 Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping (e.g., 6.SP.B.4, 7.SP.B.8b).
- 9.4.8.IML.4 Ask insightful questions to organize different types of data and create meaningful visualizations.
- 9.4.8.IML.5 Analyze and interpret local or public data sets to summarize and effectively communicate the data.
- 9.4.8.TL.2 Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).

Social-Emotional Learning Competencies

- **Self-Awareness**
  - Recognize one's personal traits, strengths, and limitations.
  - Recognize the importance of self-confidence in handling daily tasks and challenges.
- **Self-Management:** Identify and apply ways to persevere or overcome barriers through alternative methods to achieve one's goals.
- **Social Awareness:** Demonstrate an understanding of the need for mutual respect when viewpoints differ.
- **Responsible Decision-Making**
  - Develop, implement, and model effective problem-solving and critical thinking skills.
  - Identify the consequences associated with one's actions in order to make constructive choice.s
- **Relationship Skills:** Utilize positive communication and social skills to interact effectively with others.

Learning Targets	Investigations/Resources	Formative Assessment

Lesson 1 Analyze and interpret data, to find patterns in penguins that are alive today using data cards containing photos, maps, charts, measurements, and descriptive text. Develop an initial explanation and identify evidence needed to determine what caused the observed changes in the existence, diversity, and disappearance of different kinds of penguins throughout history. Ask questions that arise from initial observations of patterns in the images depicting anatomical similarities and differences of penguins that are alive today and of a fossil of a penguin from long ago.	Record what we notice and wonder about penguins living today and of a fossil of a giant penguin from long ago. Develop initial explanations of how these penguins could be connected. Brainstorm possible mechanisms to help explain two things: (1) Where did all the ancient penguins go? and (2) Where did all the different types of modern penguins come from? Develop a Driving Question Board to guide future investigations.	Initial Model Consensus Discussion Driving Question Board (DQB)
Lesson 2 Analyze and interpret data to find patterns across heritable traits between different types of modern penguins and ancient penguins. Ask questions about ancient ancestors of modern penguins based on close analysis of patterns in the trait data for modern penguins and Pedro, comparing this to information on the data cards from Lesson 1, orienting to corresponding bones in skeletal models of penguins and humans, and rewatching the penguin live cam or video recording from Lesson 1; describe the type of data that would be needed in order to answer some of these	Analyze data on a set of heritable characters in modern penguins to look for patterns and infer connections between them and Pedro. Develop questions on how other heritable characters (bone related) would compare for these penguins and for other ancient penguin fossils.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker

questions.		
Lesson 3 Develop and use a timeline of a large data set to identify patterns in heritable trait variations found in different penguins across different points in time. Analyze and interpret data from data tables, images, maps, and descriptive text to identify patterns of similarities and differences in heritable trait variations, environments, and geographic locations of ancient penguin fossils across time.	Analyze data tables of bone related traits for ancient penguin fossils and modern penguins and develop a timeline-based representation of the patterns in the data. Analyze images, maps, and descriptions of the environments of where these fossils formed.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 4 Develop an explanation based on preliminary evidence to illustrate that changes over time occur in the existence, diversity, and disappearance of different kinds of penguins throughout history.	Revise our initial explanation to account for the patterns in the data from the previous lessons. We still have many candidate ideas for what might be causing these patterns. Wonder whether we would see a similar pattern in the types of other organisms. Add questions to our Driving Question Board.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker Explanations Students construct three mini explanations in response to these questions: "Where did all the different types of ancient penguins go? Where did all the different types of modern penguins come from? Why are there similarities and differences in the traits we see between modern and ancient penguins?" To construct these explanations, students use various representations in the timeline model they are developing as a class to represent the similarities and differences in their characters.
Lesson 5 Analyze and interpret data from images to identify patterns of similarities and differences in modern	Investigate organisms other than penguins to see whether the patterns of connections between ancient and modern organisms that we saw with penguins	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion

organisms and the fossil record and use the patterns to look for relationships between ancient and modern organisms. Respectfully provide and receive critiques about organizational models of the similarities and differences (patterns, stability, and change) in some of the characters of organisms observed over time and in different environments based on evidence from the fossil record.	also occur in other types of organisms. Sort ancient and modern horseshoe crabs, horses, and whales to see what patterns of similarities exist in their structural characters. Consider and discuss whether and how the patterns we notice in their structural characters might be related to where they lived or when they lived. Confirm that similar kinds of relationships exist in ancient and modern horseshoe crabs, horses, and whales as well as in penguins.	Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 6 Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support an explanation for whether the types of things that lived long ago are ancestors to the modern organisms we see today (stability and change). Ask questions related to what is causing changes in a whole population of organisms?	Argue for whether the fossil data we've been investigating represents what is found in only one individual or represents what is typical of any individual in their population. Construct revised explanations for how modern organisms are connected to ancient organisms. Add new questions to our Driving Question Board related to possible mechanisms causing this change.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion: Make and defend a claim about whether ancient penguins (and other organisms) are the ancestors of modern penguins (and other organisms). Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 7 Analyze and interpret data representing mean, median, or variability to examine patterns of changes over time that affect the predominance of certain traits in a population. Communicate and evaluate scientific information about a system of cause and effect relationships to explain how traits that support successful survival and reproduction become more common and those that do not become less common.	Explore four cases where trait distributions in the population changed over a few generations. Use a jigsaw strategy to analyze data from different studies on our group's assigned case. Develop arguments for how what was happening in the different studies could be connected to one another. Develop a model to explain what was causing the	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker

Using models, construct an explanation of changes over time in the distribution of traits in a population in response to changes in environmental conditions.	shift in trait distribution over time for our individual cases.	
Lesson 8 Respectfully provide and receive critiques about one's explanations and model ideas by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail related to what in the system is remaining stable (e.g., traits within individuals and patterns of inheritance) and what is changing (e.g., distribution of traits) and what causal mechanisms (e.g., competitive advantages, selection events) are at work on different populations in different (eco)systems. Develop a model that includes unobservable mechanisms describing more than one cause-and-effect relationship between different parts and components in a system to explain how natural selection leads to a change in the distribution of traits in a population over time, while heritable traits of each individual remain stable.	Compare each of our case-specific system models (for finches, moths, swallows, and plants) and argue for which parts and interactions these cases have in common. We develop a general model to explain what causes changes in the population. Argue that this model should be able to predict and explain changes in other populations too (like bacteria), and identify what we need to test it.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker
Lesson 9 Construct and present an oral and written argument that changes in environmental conditions may increase or decrease the probability of specific trait variations being passed on in a population, using evidence derived from analysis of graphical data representations generated from an investigation using a computer simulation. Explain the ways in which our general model of	Carry out two investigations using a computer simulation. Argue for why we get different outcomes when we simulate different types of white blood cells in the environment with the same starting population of bacteria.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models WIS/WIM Update Progress Tracker

natural selection was refined based on the results of our bacteria simulation investigations and explain what parts and interactions would need to be redesigned in the simulation to test additional causal relationships from our general model of natural selection.		
Lesson 10 Plan and carry out an investigation in a simulated environment to collect data about how environmental conditions may increase or decrease the probability of specific trait variations being passed on in a population. using evidence derived from analysis of graphical data representations generated from a computer simulation in two different investigations. Construct an explanation based on evidence collected from running a simulation and using science ideas included in our General Model for Natural Selection for how and why small changes in an environment may cause large changes in trait variations in a population over long periods of time.	Plan and carry out an investigation using a new bacteria simulation to test what will happen when we change the environment by a different factor other than predation. Run our experiment, collect data, and use our model (natural selection) to explain our results.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models- Changes in Bacteria Populations Assessment WIS/WIM Update Progress Tracker
Lesson 11 Use a model of adaptation by natural selection acting over generations to describe cause and effect relationships that predict how and why organisms' traits changed over time (millions of years) in response to changes in environmental conditions. Construct a scientific explanation to account for how natural selection (cause) could explain why the traits of modern penguins are different than the	Attempt to apply our model of natural selection to explain differences in traits in horses over very long periods of time. Use our model of natural selection to explain differences in traits in penguins over very long periods of time. Revisit our Driving Question Board to answer our questions and ask new ones.	Check-Ins (Do Nows, Entrance Tickets, Exit Tickets, Interactive Notebook) Consensus Discussion Revisit Driving Question Board Models- Changes in Bacteria Populations Assessment WIS/WIM Update Progress Tracker Related Phenomena Assessment

traits of very ancient penguins (effect) and why traits changed in penguins over millions of years (effect). Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information regarding cause and effect relationships and stability and change in lines of evolutionary descent.		

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate

- Accommodations as per IEP/504/ELL
- Use gestures in addition to talking
- Word wall: use student-friendly definitions, make connections to cognate/root words when possible, and include a visual representation of the word
- Emphasize socially safe activity structures (e.g., small-group or partner work before a whole-class discussion)
- Science notebook: Students should be encouraged to record their ideas using linguistic (e.g., written words) and nonlinguistic (e.g.,taping in photographs, creating drawings, tables, graphs, mathematical equations, and measurements) modes.
- Encourage all students to use words and/or drawings when representing and recording their investigation setup and observations.
- Use classroom norms to support engagement by creating a space where students are not worried about being right or wrong.
- Having different modes for interacting with the readings will provide different ways to access the readings
- Graphs with pre-labeled axes as needed
- Provide options for investigations when applicable (giving students a choice to pursue a line of inquiry that is more relevant to them)
- Provide hands-on materials for students to demonstrate their ideas when possible/relevant
- Provide cause/effect sentence stems when relevant/as needed
- Provide paper copies of DQB questions as needed

Common Assessment(s)	**Assessment Modifications and/or Accommodations** **(ELL, Special Education, Gifted, At-Risk of Failure, 504) when appropriate**
• Mid Unit Assessment • End of Unit Summative Assessment	• Bolded keywords • Word banks • Reference images • Read directions to students to help with comprehension as needed • Provide access to anchor charts and classroom labels relevant to science concepts • Scribe for students or allow students to use a talk-to-text feature on Chromebooks when

	responding to questions as needed • Paper copies of assessment as needed/appropriate