Module 7: Forces and Motion

Core Idea: PS2: Motion and Stability: Forces and Interactions

Prerequisite Learning: 2.PS2.1, 2.PS2.2, 2.PS2.3, 3PS2.1, 3PS2.2

Percent of Time: 11%

Standard	Questions and Phenomenon Prompts	Module Vocabulary	Teacher Background/ Clarification Statement
5.PS2.1 Test the effects of balanced and unbalanced forces on the speed and direction of motion of objects. **Learning Targets:** • Identify and describe the different forces on an object's motion (pushing, pulling, starting, stopping, changing direction). • Identify and interpret the effect of two or more forces acting upon an object in a scenario. • Investigate the greater the unbalanced force applied to an object, the greater the change in motion of a given object (different strengths and directions). • Investigate the effect of balanced forces applied to an object, when the object does not move because the opposing forces are holding the object in place. **Crosscutting Concept:** • **Stability and Change-** Students begin to describe changes in terms of time over which they occur; their rate. **Science and Engineering Practice:** • **Planning and carrying out controlled investigations-** Students carry out investigations in groups, where conditions and variables are controlled, utilize appropriate instruments, and deliberately plan multiple trials.	If you are sitting on a swing and not moving what happens if someone comes along and gives you a push? What would happen if 2 students of the same size and strength were pulling on a tug of war rope with equal force from opposite sides?	Attract Repel Balanced forces Unbalanced forces Direction Distance Mass Force Gravity Motion Position Pull Push Speed System	Descriptions of forces should include both a strength of the forces and direction that it pushes/ pulls. Objects at rest have multiple forces acting on them, but the forces work together and add up to a net force of zero. When the sum of forces is not zero, the forces are unbalanced and motion of the object will change (speed up, slow down, or change direction). Quantitative solutions are beyond the scope of this standard.

5.PS2.2 Make observations and measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. **Learning Targets:** • Observe and take measurements on the motion of an object as it repeats a pattern over time (a see saw, a pendulum swinging, a paddle ball game, a ball rolling in a bowl or curved track). • Provide evidence from observations and measurements that a pattern will be identified from the data on the motion of the object. • Provide evidence from observations and measurements that the pattern in the motion of the object can be used to predict future motion. **Crosscutting Concept:** • **Pattern-** Students recognize, classify, and record patterns involving rates of change. **Science and Engineering Practice:** • **Developing and using models-** Student models begin to become abstract and metaphorical, incorporating relationships between events and predictive aspects for recurring events.	Why does a see-saw with two students on it keep moving? What happens if both of those students picked their feet up? Can you predict what motion would happen after one student moved up into the air?		This standard introduces the idea that there can be patterns in motion by looking at examples where patterns are obvious. Examples include: a swing or pendulum moving back and forth, an object bobbing up and down at the end of a spring, or a carousel traveling a circular track. By studying the pattern of an object's motion, predictions can be made about its future motion. Example: By studying the time it takes a swing to move back and forth, you can predict when it will return to its starting position.
5.PS2.3 Use evidence to support that the gravitational force exerted by Earth on objects is directed toward the Earth's center. **Learning Targets:** • Demonstrate and explain gravity's effect on objects when dropped (when something is falling it is actually being pulled toward Earth's center by the force of gravity). • Use evidence to explain how all objects fall toward the center of the Earth no matter the object's location (objects in the southern hemisphere do not fall off the planet into space, they fall toward the Earth).	Why do people not fall off the Earth or float away into space? What would happen to us if gravity was stronger? Weaker? Observe the phenomenon of gravity.		Experiences should count as evidence. For example, "When I drop a ball, it falls toward to surface of Earth."

Crosscutting Concept: • **Cause and Effect-** Students use patterns as evidence in an argument or to make predictions, construct explanations, and engage in arguments. **Science and Engineering Practice:** • **Developing and using models-** Student models begin to become abstract and metaphorical, incorporating relationships between events and predictive aspects for recurring events.			
5.PS2.4 Explain the cause and effect relationship between two factors (mass and distance) that affect gravity. **Learning Targets:** • Describe how gravitational forces are attractive and depend on the masses of interacting objects. • Identify and explain that the greater the mass of an object the greater the gravitational force exerted (the Sun keeps the planets in orbit around it). • Identify and explain that objects that are far apart exert less gravitational force on each other than objects that are close together (the moon stays in orbit around the Earth because it is so close to it). **Crosscutting Concept:** • **Cause and Effect-** Students use patterns as evidence in an argument or to make predictions, construct explanations, and engage in arguments. **Science and Engineering Practice:** • **Engaging in argument from evidence-** Students create and identify evidence-based arguments and consider whether an argument is supported by evidence or relies on opinions or incomplete representations of relevant evidence.	Why does the moon revolve around the Earth and not the Sun? Which object do you think has more gravitational pull on the Earth, the moon or the Sun?		Students should know that all objects exert a force on one another, however this force is EXTREMEMLY small, unless the objects are very large (such as the Earth). All objects fall at the same rate. Gravity exerts a larger force on larger objects and a smaller force on smaller objects. Objects that are farther from Earth's center (i.e. astronauts launching toward space) experience less gravitational attraction.

5.PS2.5 Explain how forces can create patterns within a system (moving in one direction, shifting back and forth, or moving in cycles), and describe conditions that affect how fast or slowly these patterns occur. **Learning Targets:** • Identify causes of motion from the patterns observed in the motion of an object (gravity causes objects to fall in one direction- toward Earth, elastic or springs can cause an object to move back and forth as in a paddle ball, a yo-yo performing around the world, a skip it toy, or the planets orbiting the sun are examples of moving in cycles). • Identify and describe conditions that affect how slow or fast these patterns occur. **Crosscutting Concept:** • **Pattern-** Students recognize, classify, and record patterns involving rates of change. **Science and Engineering Practice:** • **Engaging in argument from evidence-** Students create and identify evidence-based arguments and consider whether an argument is supported by evidence or relies on opinions or incomplete representations of relevant evidence.	What were some things we identified as moving in patterns? What happens to this paddle ball's speed when I exert more force on it?		This standard builds on 5.PS2.2 by focusing on the forces that create regular patterns. Objects moving back and forth could include an object bobbing up and down on the end of a spring or someone sitting on a swing. Students can observe the system of forces acting on the object. Example: Each time a spring moves upwards, the spring's force causes it to speed up. Simultaneously, the force of gravity eventually decreases the spring's upward motion and becomes the dominant force. This changes the direction of the spring to a downward motion. An example of objects moving in cycles can come from 5.ESS1.3 in which students explore the circular motion of planets and moons. The circular motion of planets is maintained by the Sun's gravitational pull, while the circular motion of moons is exerted by the planet they orbit. Students could relate the difference in force needed to twirl a baseball vs a tennis ball on the end of a string in order to help make sense of differing amounts of force (gravity) needed.