Unit 8.4: “Plotting a Cosmic Collision Course”

NGSS Connections

Primary Performance Expectations:
• **MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [Assessment Boundary: Assessment does not include Kepler’s Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.] • **MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object’s layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.] • **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.** [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton’s Law of Gravitation or Kepler’s Laws.]

Semester Unifying Crosscutting Concept:	Scale, Proportion, and Quantity

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models ● Develop and use a model to describe phenomena. (MS-ESS1-2) **Analyzing and Interpreting Data** ● Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3) **Engaging in Argument from Evidence** ● Construct and present oral and written arguments 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. (MS-PS2-4) ***Connections to Nature of Science*** **Scientific Knowledge is based on Empirical Evidence** ● Science knowledge is based upon logical and conceptual connections between	**ESS1.A: The Universe and Its Stars** ● 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 can be characterized in various ways, and) that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2, MS-ESS1-3) ● 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** ● 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)	**Systems and System Models** ● Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-ESS1-2) **Scale, Proportion, and Quantity** ● Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3) **Systems and 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. (MS-PS2-4) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

evidence and explanations. (MS-PS2-4)		● Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-2) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-ESS1-3)
Secondary Subcomponents (not assessed)		
	PS2.A Forces and Motion (Secondary)* ● 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)	

CCSS.MATH.CONTENT.8.EE.B.5 (Supporting Common Core Math)

- ~~Graph proportional relationships, interpreting the unit rate as the slope of the graph~~. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

***Teacher Note:** In order for students to demonstrate their understanding of gravitational orbits, they need to understand how forces affect motion. These concepts come from MS-PS2-2 PS2.A Forces and Motion, which are covered in the unit and are assessed.