PHYSICS		
HS-ESS1-4: Earth's Place in the Universe		
HS-ESS1-4: Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.		
Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.		
Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus.		
Evidence Statements: HS-ESS1-4		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Using Mathematical and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical or computational representations of phenomena to describe explanations.	**ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.	**Scale, Proportion, and Quantity** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). **Connections to Engineering,Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.
Connections to other DCIs in this grade-band: HS.PS2.B		
Articulation of DCIs across grade-bands: MS.PS2.A ; MS.PS2.B ; MS.ESS1.A ; MS.ESS1.B		
NJSLS- ELA: N/A		
NJSLS- Math: MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3, HSA-SSE.A.1, HSA-CED.A.2, HSA-CED.A.4		
5E Model		
HS-ESS1-4: Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.		
Engage Anticipatory Set	Video: Gravity Visualized https://www.youtube.com/watch?v=MTY1Kje0yLg	
Exploration Student Inquiry	Gravity, Orbits and Kepler's Law https://phet.colorado.edu/en/contributions/view/3874 Satellite Motion Lab In this activity, students will experiment with satellite motion using an interactive simulation, gaining an understanding of Kepler's Laws of Satellite Motion and Newton's Synthesis. https://phet.colorado.edu/en/contributions/view/3709	

	Going Full Circle on Gravity and Orbits- Day 1 In this lesson, students apply the circular motion equations to Newton's Universal Law of Gravity to derive circular orbit equations. http://betterlesson.com/lesson/637802/going-full-circle-on-gravity-and-orbits-day-1 Going Full Circle on Gravity and Orbits- Day 2 In this lesson, students determine that satellites in a certain orbit are geostationary based on observations and what they know about orbital periods. http://betterlesson.com/lesson/638515/going-full-circle-on-gravity-and-orbits-day-2
Explanation **Concepts and Practices**	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ESS1.B: Earth and the Solar System Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.
Elaboration Extension Activity	Tides Students will graph the tides in a region over a multi-day period to explain the factors which influence tides on the Earth and draw or identify the positions of the Earth, Moon, and Sun given specific tidal conditions. http://betterlesson.com/lesson/641869/tides
Evaluation Assessment Tasks	Assessment Task A: In the activities above, students will use mathematical representations to predict orbital changes in the solar system.