## Grades 9–12

**3.3.9-12.D Earth and Space Science:** Space Systems

**Students who demonstrate understanding can** *use mathematical or computational representations to predict the motion of orbiting objects in the solar system.*

**Clarifying 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.

| Science and Engineering Practices (SEP) | Disciplinary Core Ideas (DCI) | Crosscutting Concepts (CCC) |
|---|---|---|
| **Using Mathematical and Computational Thinking**<br>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.<br>• Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. | **Earth and the Solar System**<br>• 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**<br>• 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).<br>***Connections to Engineering, Technology, and Applications of Science***<br>**Interdependence of Science, Engineering, and Technology**<br>• 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. |

**Pennsylvania Context:** N/A

**PA Career Ready Skills:** Advocate for oneself in education, employment, and within the community.

### Connections to Other Standards Content and Practices

| Standard Source | Possible Connections to Other Standard(s) or Practice(s) |
|---|---|
| **Agriculture (AFNR)** | CS.02.01.01.a: Research and describe different types of geographic data used in AFNR systems. |

| Standard Source | Possible Connections to Other Standard(s) or Practice(s) |
|---|---|
| **Science, Environmental Literacy and Sustainability (NAAEE)** | 9-12 Strand 1.F. Working with models and simulations: Learners create, use, test, and evaluate models to analyze environmental questions, problems, issues, or phenomena. |
| **PA Core Standards: ELA** | N/A |
| **PA Core Standards and Practices: Math** | MP.2: Reason abstractly and quantitatively.<br>MP.4: Model with mathematics.<br>CC.2.2.HS.D.1: Interpret the structure of expressions to represent a quantity in terms of its context.<br>CC.2.2.HS.D.7: Create and graph equations or inequalities to describe numbers or relationships. |
| **PA Standards: Social Studies** | N/A |
| **Educational Technology (ISTE)** | 1.5. Computational Thinker: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. |
| **Technology and Engineering (ITEEA)** | STEL-10: Assess how similarities and differences among scientific, mathematical, engineering, and technological knowledge and skills contributed to the design of a product or system. |