Honors Physics - Unit 4 - Gravitational and Planetary Motion

Unit Focus

In this brief unit, students apply their knowledge of circular motion and forces to analyze the motion of man made and natural (celestial) satellites. Students will study the laws of physics that govern the motion of planets, moons and the universal law of gravitation that holds the universe together. As a culminating experience, students will determine the mass of Neptune using the Law of Gravity and their understanding of circular motion from the prior unit.

Stage 1: Desired Results - Key Understandings

Standard(s)

Next Generation Science
High School Physical Sciences: 9 - 12

- Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. *HS-PS2-1*

Next Generation Science Standards (DCI)
Science: 11

- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. *PS2.9.B2*
- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. *PS2.9.B3*

Madison Public Schools Profile of a Graduate
Critical Thinking

- Analyzing: Examining information/data/evidence from multiple sources to identify possible underlying assumptions, patterns, and relationships in order to make inferences. (POG.1.2)

Transfer

T1 Analyze qualitative and quantitative data to interpret patterns, draw conclusions, and/or make predictions.

Meaning

Understanding(s)

U1 There is an attractive gravitational force between any two objects that is dependent on their masses and distance between them.
U2 Planets, moons and other celestial bodies move in elliptical orbits due to the force of gravity acting on them by the object(s) they orbit.

Essential Question(s)

Q1 How do the fundamental forces of the universe explain the behavior and interactions of objects? (e.g. particles, people, stars, planets)

Acquisition of Knowledge and Skill

Knowledge

K1 All objects exert an attractive gravitational force on other objects; the magnitude of this force depends on the mass of each object and the distance between the objects.
K2 There is a relationship between the orbit radius and the period of orbit for orbiting celestial bodies
K3 The orbits of planets are elliptical
K4 Geosynchronous satellites have a specific orbit altitude
K5 A gravitational field exists around every object

Skill(s)

S1 Students will be able to determine the gravitational force that one mass puts on another mass. They will understand that this force is always an attractive force and is mutual (i.e. the same force is felt by both objects).
S2 Students will be able to determine the acceleration due to gravity (g) at any point above the earth and for any other planets.
S3 Students will be able to determine the speed necessary to maintain a satellite (planet, moon etc) in circular orbit about another mass. In this case, gravitational force is equal to the centripetal force.
S4 Students will be able to apply Kepler's Laws to analyze the period and orbit radii for celestial objects.
S5 Students will be able to calculate the strength of the gravitational field at any point away from a planet or other object.