Unit 04: Fundamental Forces I: Gravity and Orbits

Content Area: **Science**
Course(s):
Time Period: **Marking Period 3**
Length: **2-3 Weeks**
Status: **Published**

Summary

A historical overview of "models of the universe" leads to study of Kepler's Three Laws of Planetary Motion. Kepler's Laws are used to explain the cause of common astrological events (eclipses, etc) and are used to determine the scale of the solar system. Newton's Law of Universal Gravitation is explored in detail and is used to predict the orbital motion of celestial objects.

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Standards

9.4.12.CI	Creativity and Innovation
MA.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
MA.A-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.
TECH.8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
TECH.8.1.12.A.5	Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

Essential Questions

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- How did human understanding of the cosmos evolve from the time of the time of Johannes Kepler and Isaac Newton?

- What are Kepler's Laws of Planetary Motion and through what process did Johannes Kepler arrive at them?

- How did Isaac Newton formulate the Law of Universal Gravitation?

- How is the Law of Falling bodies derived from the Law of Universal Gravitation?

- How did the Law of Universal Gravitation unlock the mystery of the heavens?

Enduring Understanding

- The planets revolve around the sun in elliptical orbits with varying speed

- The idea of uniform circular motion in the heavens dominated astronomy for nearly 2000 years

- Every two bits of matter in the universe attract one another through a force related to their mass and the distance between them

Objectives

- Students will know that the force of gravity dominates the universe on the largest scales

- Students will be skilled at determining the gravitational force between two objects

- Students will know the physical implications of an inverse square law

- Students will be skilled at calculating the acceleration of falling bodies near the surface of a planet

- Students will be skilled at mathematically analyzing the orbits of planets, satellites and moons

- Students will know the history of solar system models

- Students will know scale of the solar system in Astronomical Units (AU)

- Students will be skilled at calculating the eccentricity and period of orbits

Learning Plan

"The circles have it". A brief history and discussion of ancient astronomy

Video: "The Mechanical Universe: Kepler's 3 Laws"

Lab: Drawing ellipses: Axes, foci, eccentricity, etc

Interactive presentation: Using Kepler's 3rd Law to determine the scale of the solar system

Phet Simulation: Gravity

Activity: Calculating the force of gravity between 2 people and between and proton and electron in the hydrogen atom

Video: "The Mechanical Universe: The apple and the moon"

Teacher presentation: Calculating the acceleration of a falling apple

Interactive presentation: Applications of Universal Gravitation: The mass of the earth, orbit of the moon, etc

Socratic questioning: Tidal forces and black holes

Cooperative problem solving: Orbital mechanics using Newton's Laws and Universal Gravitation

Assessment

Formative:

Do Now Questions

Exit Ticket Questions

Whole Class Discussion Participation

Small Group Discussion Participation

Individual Student Questions/Responses

Cooperative Problem Solving *(Orbital mechanics using Newton's Laws and Universal Gravitation)*

Lab Experiments *(Drawing ellipses: Axes, foci, eccentricity, etc.)*

Quizzes

Summative:

Formal Lab Report

Unit Test

Benchmark:

Honors Physics Midterm Exam

Alternative Assessments:

Guided Formal Lab Report

Unit Study Guide

Materials

Textbook PHYSICS: PRINCIPLES WITH APPLICATIONS 6th Edition GIANCOLI, PEARSON

Mechanical Universe Video Series

Cosmos Video Series

Equipment for demos

Chromebooks for PhET Simulation

Lab Equipment: cardboard, pushpins, string, markers

Computer / Smart board

¼ inch graph paper

Integrated Accommodation and Modifications

FOR SPECIAL EDUCATION STUDENTS , ELL, AT RISK AND STUDENTS GIFTED STUDENTS

https://docs.google.com/spreadsheets/d/1XVU7bji7iOgH8W9w9PLxDox44Da1R1oCxiSeoIztRGQ/edit?usp=sharing