- Planetary Motion: The chapter explores the numerical modeling of planetary motion around the Sun. It addresses questions related to how planets move in space and how their orbits can be simulated computationally.
- Choice of Units: It discusses the importance of selecting appropriate units for describing planetary motion and the advantages of using astronomical units over standard SI units. This includes considerations of distance, time, and mass units.
- Numerical Methods: The chapter introduces the Euler-Cromer method as a numerical technique for solving differential equations describing planetary motion. It discusses why this method is preferred over others like the Euler method for oscillatory problems.
- Kepler's Laws: The chapter mentions Kepler's laws of planetary motion, specifically focusing on the third law, which relates the period and semi-major axis of an orbit. It discusses how numerical simulations can be used to confirm Kepler's laws.
- Astronomical Units (AU): Understanding the concept of astronomical units, which are used to express distances within the solar system relative to the average distance between the Earth and the Sun.
- Differential Equations: Familiarity with differential equations and their numerical solution methods, particularly for modeling physical systems like planetary orbits.
- Newtonian Mechanics: Understanding of basic principles of classical mechanics, such as Newton's laws of motion and the gravitational force law, which are fundamental to describing planetary motion.
- Numerical Methods: Knowledge of numerical techniques like the Euler-Cromer method for solving differential equations numerically, including their strengths and limitations.
- Kepler's Laws: Understanding Kepler's laws of planetary motion, including their implications for the shape and dynamics of planetary orbits, and how they can be confirmed through numerical simulations.- The inverse square dependence of gravitational force and its relation to Coulomb's law suggest a fundamental aspect of nature.
- The inverse square law arises from the concept of field lines and the geometry of space.
- Experimental tests of Kepler's laws help verify the inverse square law for gravity.
- Illustration of an elliptical orbit scenario with a sun positioned at one focus, labeled F.
- Semimajor and semiminor axes denoted as "a" and "b" respectively.
- Eccentricity represented by "e".
- Results displayed for exponent value of 2, indicating an inverse square law.
- Initial conditions set for elliptical orbit where sun lies at one focus, adhering to Kepler's first law.
- Calculated orbit retraces itself accurately over multiple orbits, confirming constancy of ellipse's orientation with time.
- Smaller time step utilized to minimize numerical errors and potential precession effects compared to circular orbit simulation.
- For exponent value of 3.00, representing an inverse cube law, planetary behavior drastically differs, leading to unstable orbits.
- Hypothetical planet in this scenario undergoes a close approach to the sun followed by ejection due to numerical errors.

- Results for exponent value of 2.50 show relatively more stable elliptical paths with significant rotation of ellipse's axes after a few orbits.
- Orbits become marginally more stable as exponent value approaches 2, although deviations from perfect circularity lead to instability due to rapid amplification of small deviations.
- Historical experiment utilized the solar system to test the inverse-square law's accuracy.
- Advancements in telescopes and time-keeping enhanced astronomical precision.
- Deviations from Kepler's laws observed in systems with multiple planets, especially evident in Mercury and Pluto's orbits.
- Precession of Mercury's perihelion initially posed a discrepancy between experimental and theoretical predictions.
- Einstein's theory of general relativity provided a solution, predicting deviations from the inverse-square law and explaining Mercury's precession accurately.
- Introduction of a third celestial body complicates analytical solutions significantly.
- Objective: Evaluate Jupiter's gravitational influence on Earth's motion.
- Force calculation based on the inverse-square law between Earth and Jupiter.
- Simplifying assumption of coplanar orbits for ease of analysis.
- Determination of force components between Earth and Jupiter.
- Calculation of Earth's velocity components considering gravitational forces from both Jupiter and the Sun.
- Program adaptation to include interactions between two planets and their gravitational forces.