Figure 7.1 Johannes Kepler (left) showed how the planets move, and Isaac Newton (right) discovered that gravitational force caused them to move that way. ((left) unknown, Public Domain; (right) Sir Godfrey Kneller, Public Domain)

Chapter Outline

7.1 Kepler's Laws of Planetary Motion

7.2 Newton's Law of Universal Gravitation and Einstein's Theory of General Relativity

Introduction

What do a falling apple and the orbit of the moon have in common? You will learn in this chapter that each is caused by gravitational force. The motion

of all celestial objects, in fact, is determined by the gravitational force, which depends on their mass and separation.

Johannes Kepler discovered three laws of planetary motion that all orbiting planets and moons follow. Years later, Isaac Newton found these laws useful in developing his law of universal gravitation. This law relates gravitational force to the masses of objects and the distance between them. Many years later still, Albert Einstein showed there was a little more to the gravitation story when he published his theory of general relativity.

Teacher Support

Teacher Support Before students begin this chapter, it is useful to review the following concepts:

- Using significant figures in calculations—Demonstrate how to use the proper number of significant figures when adding and multiplying.
- Review scientific notation as related to significant figures.
- Converting units—Demonstrate how to convert from km/h to m/s.
- Review dimensional analysis. For example, N is equivalent to $\mathrm{kg\,m/s^2}$.
- Explain that metric units clearly distinguish between mass and weight, but that the commonly used English units do not.
- Calculating average—Demonstrate how to average two numbers.
- Review manipulation of formulas so that they may be expressed in terms of the unknown.
- Review Newton's laws of motion.