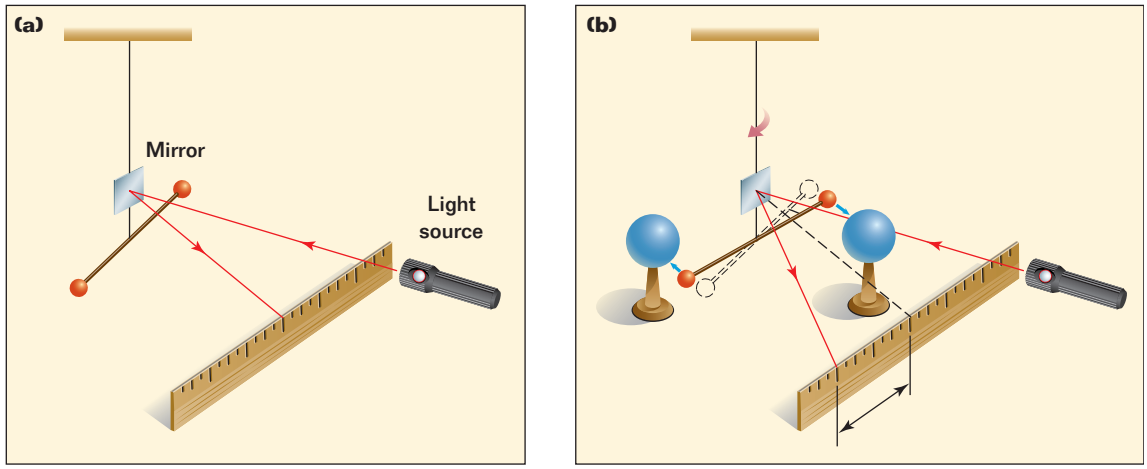

Figure 9
Henry Cavendish used an experiment similar to this one to determine the value of *G*.

Cavendish finds the value of *G* and Earth's mass

In 1798, Henry Cavendish conducted an experiment that determined the value of the constant *G*. This experiment is illustrated in **Figure 9.** As shown in **Figure 9(a),** two small spheres are fixed to the ends of a suspended light rod. These two small spheres are attracted to two larger spheres by the gravitational force, as shown in **Figure 9(b).** The angle of rotation is measured with a light beam and is then used to determine the gravitational force between the spheres. When the masses, the distance between them, and the gravitational force are known, Newton's law of universal gravitation can be used to find *G*. Once the value of *G* is known, the law can be used again to find Earth's mass.

Gravity is a field force

Newton was not able to explain how objects can exert forces on one another without coming into contact. His mathematical theory described gravity, but didn't explain how it worked. Later work also showed that Newton's laws are not accurate for very small objects or for those moving near the speed of light. Scientists later developed a theory of fields to explain how gravity and other field forces operate. According to this theory, masses create a gravitational field in space. A gravitational force is an interaction between a mass and the gravitational field created by other masses.

When you raise a ball to a certain height above Earth, the ball gains potential energy. Where is this potential energy stored? The physical properties of the ball and of Earth have not changed. However, the gravitational field between the ball and Earth *has* changed since the ball has changed position relative to Earth. According to field theory, the gravitational energy is stored in the gravitational field itself.

At any point, Earth's gravitational field can be described by the *gravitational field strength,* abbreviated *g*. The value of *g* is equal to the magnitude of the gravitational force exerted on a unit mass at that point, or $g = F_g/m$. The gravitational field **(g)** is a vector with a magnitude of *g* that points in the direction of the gravitational force.

Quick Lab

Gravitational Field Strength

MATERIALS LIST

- **spring scale**
- **hook (of a known mass)**
- **various masses**

You can attach a mass to a spring scale to find the gravitational force that is acting on that mass. Attach various combinations of masses to the hook, and record the force in each case. Use your data to calculate the gravitational field strength for each trial ($g = F_g/m$). Be sure that your calculations account for the mass of the hook. Average your values to find the gravitational field strength at your location on Earth's surface. Do you notice anything about the value you obtained?