ates up toward the ball. To the astronaut, the ball appears to be accelerating downward, and this situation is identical to the situation described in **(a).** In other words, the astronaut may *think* that his spaceship is on Earth and that the ball falls because of gravitational attraction. Because gravitational mass equals inertial mass, the astronaut cannot conduct any experiments to distinguish between the two cases. Einstein described this realization as "the happiest thought of my life."

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Gravity and light

Now, imagine a ray of light crossing the accelerating elevator. Suppose that the ray of light enters the elevator from the left side. As the light ray travels across the elevator from left to right, the floor of the elevator accelerates upward. Thus, to an astronaut in the elevator, the light ray would appear to follow a parabolic path.

If Einstein's theory of the equivalence between gravitational fields and accelerating reference frames is correct, then light must also bend this way in a gravitational field. Einstein proposed using the sun's gravitational field to test this idea. The effect is small and difficult to measure, but Einstein predicted that it could be done during a solar eclipse. Einstein published the theory of general relativity in 1916. Just three years later, in 1919, the British astronomer Arthur S. Eddington conducted observations of the light from stars during an eclipse. This experiment provided support for Einstein's theory of general relativity.

Curved spacetime

Although light traveling near a massive object such as the sun appears to bend, is it possible that the light is actually following the straightest path? Einstein theorized that the answer to this question is yes. In general relativity, the three dimensions of space and the one dimension of time are considered together as four-dimensional space-time. When no masses are present, an object moves through "flat" space-time. Einstein proposed that masses change the shape of space-time, as shown in **Figure 2.** A light ray that bends near the sun is following the new shape of the distorted space-time.

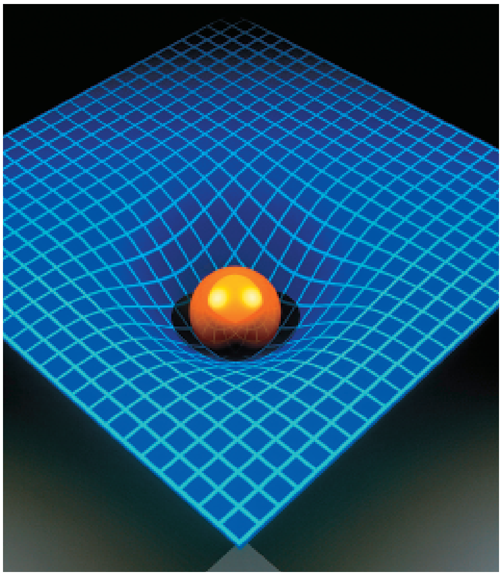

Figure 2
In the theory of general relativity, masses distort four-dimensional space-time, as illustrated here. This distortion creates the effect we describe as gravitational attraction.

For example, imagine rolling a tennis ball across a water bed. If the water bed is flat, the tennis ball will roll straight across. If you place a heavy bowling ball in the center, the bowling ball changes the shape of the water bed. As a result, the tennis ball will then follow a curved path, which, in Newton's theory, is due to the gravitational force between the two. In general relativity, the tennis ball is simply following the curved path of space-time, which is distorted by the bowling ball. Unlike Newton's *mathematical* theory of gravitation, Einstein's theory of curved space-time offers a *physical* explanation for gravitational force.

Today, Einstein's theory of general relativity is well accepted. However, scientists have not yet been able to incorporate it with another well-accepted theory that describes things at the microscopic level: quantum mechanics. Many scientists are now working toward a unification of these two theories.