Understanding Gravity and Microgravity

Isaac Newton
In his "thought experiment," Isaac Newton hypothesized that by placing a cannon at the top of a very tall mountain and firing a cannonball at a high enough velocity, the cannonball could be made to orbit the Earth.

Gravity is such an accepted part of our lives that we rarely think about it even though it affects everything we do. Any time we drop or throw something and watch it fall to the ground, we see gravity in action. Although gravity is a universal force, there are times when it is not desirable to conduct scientific research under its full influence. In these cases, scientists perform their experiments in microgravity - a condition in which the effects of gravity are greatly reduced, sometimes described as "weightlessness."

Any object in freefall experiences microgravity conditions, which occur when the object falls toward the Earth with an acceleration equal to that due to gravity alone (approximately 9.8 meters per second squared [m/s2], or 1 g at Earth's surface).

Brief periods of microgravity can be achieved on Earth by dropping objects from tall structures. Longer periods are created through the use of airplanes, rockets, and spacecraft. The microgravity environment associated with the space shuttle is a result of the spacecraft being in orbit, which is a state of continuous freefall around the Earth.

Newton offered a thought experiment to explain how an object could stay in orbit while falling toward the Earth. He imagined a cannon at the top of a tall mountain that fired cannonballs. Each cannonball was acted upon by two forces: the force from the explosion and the force of gravity. The combination of the two forces would cause the cannonballs to travel in an arc. If the cannonballs were fired with more and more energy, they would hit the ground farther and farther away from the cannon. If the cannonball was fired with enough energy, it would fall entirely around the Earth and return to its starting point, completing an orbit.

Instead of being fired from a cannon atop a mountain, a spacecraft is launched in a trajectory that arcs above the Earth. When a particular speed and altitude are attained, the craft's falling path will be parallel to the curvature of the Earth, and a microgravity environment is established.

This microgravity environment gives researchers a unique opportunity to study the fundamental states of matter - solids, liquids, and gases - and the forces that affect them. In microgravity, researchers can isolate and study the influence of gravity on physical processes, as well as phenomena that are normally masked by gravity and thus difficult, if not impossible, to study on Earth.