Acceleration is constant during upward and downward motion

Figure 15 is a strobe photograph of a ball thrown up into the air with an initial upward velocity of +10.5 m/s. The photo on the left shows the ball moving up from its release toward the top of its path, and the photo on the right shows the ball falling back down. Everyday experience shows that when we throw an object up in the air, it will continue to move upward for some time, stop momentarily at the peak, and then change direction and begin to fall. Because the object changes direction, it may seem that the velocity and acceleration are both changing. Actually, objects thrown into the air have a downward acceleration as soon as they are released.

In the photograph on the left, the upward displacement of the ball between each successive image is smaller and smaller until the ball stops and finally begins to move with an increasing downward velocity, as shown on the right. As soon as the ball is released with an initial upward velocity of +10.5 m/s, it has an acceleration of $-9.81\ m/s^2$. After 1.0 s ($\Delta t = 1.0$ s), the ball's velocity will change by −9.81 m/s to 0.69 m/s upward. After 2.0 s ($\Delta t = 2.0$ s), the ball's velocity will again change by −9.81 m/s, to −9.12 m/s.

The graph in **Figure 16** shows the velocity of the ball plotted against time. As you can see, there is an instant when the velocity of the ball is equal to 0 m/s. This happens at the instant when the ball reaches the peak of its upward motion and is about to begin moving downward. Although the velocity is zero at the instant the ball reaches the peak, the acceleration is equal to $-9.81\ m/s^2$ at every instant regardless of the magnitude or direction of the velocity. It is important to note that the acceleration is $-9.81\ m/s^2$ even at the peak where the velocity is zero. The straight-line slope of the graph indicates that the acceleration is constant at every moment.

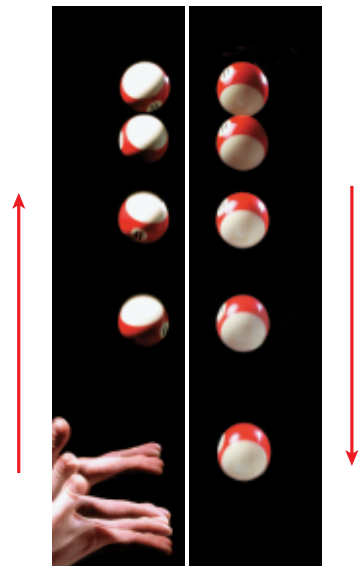

Figure 15
At the very top of its path, the ball's velocity is zero, but the ball's acceleration is $-9.81\ m/s^2$ at every point—both when it is moving up **(a)** and when it is moving down **(b).**

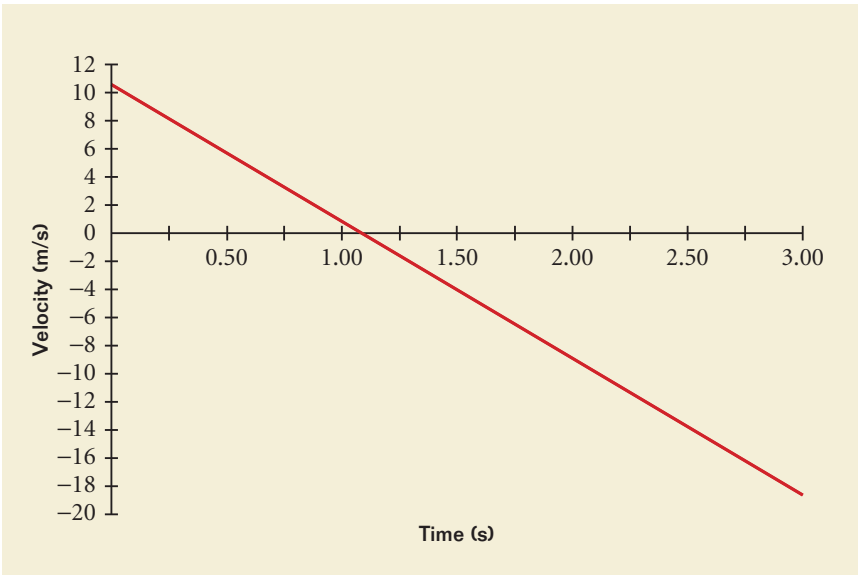

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Figure 16
On this velocity-time graph, the slope of the line, which is equal to the ball's acceleration, is constant from the moment the ball is released ($t = 0.00$) and throughout its motion.