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**Free Fall**

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What forces are acting on the diver in Figure 1? Gravity is pulling the diver down. A frictional force is opposing the diver’s fall. But the force is too small to slow the diver down. When the diver hits the water, however, the diver slows down and stops before hitting bottom. How does water break a fall?

Fig. 1 – Air Friction Acts Upward on the Diver

Recall that all objects within 300,000 km of the earth are pulled to the earth by gravity. But notice what happens to the speed of an object the closer it falls to the earth’s surface. See Figure 2. Objects speed up, or accelerate, as they fall.

The ball has a greater mass than the sheet of paper. Because of its greater mass, the ball is pulled by a greater force of gravity than the paper. Yet both objects have the same acceleration. Both speed up the same amount each second and reach the ground at the same time [1].

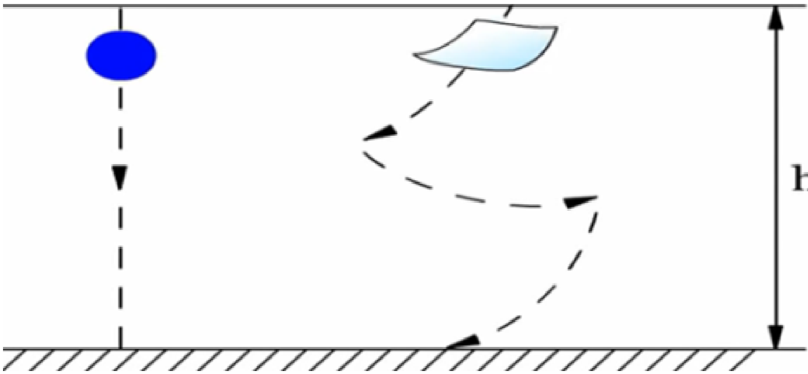


Fig. 2 – Both Objects Will Reach the Ground at the Same Time

A greater pull of gravity acting on a large mass produces the same acceleration as a smaller pull of gravity on a small mass. All objects near the earth's surface fall with the same acceleration due to gravity – 9.8 m/s/s. That is, the speed of any falling object increases by 9.8 m/s each second [2].

The diver in Figure 1 is accelerating by 9.8 m/s each second. But suppose the diver had on a parachute. Then the diver would slow down, or decelerate. A parachute provides a wide area for air resistance to act on a person. Air resistance is a force that opposes the motion of objects in air. Air provides an upward force along the bottom surface of a parachute.

See Figure 3. Air resistance is acting on these sky divers even before they open their parachutes. These divers are falling from a great height. Their speed increases 9.8 m/s each second they fall. As their speed increases, so does the air resistance acting on them. In time, the air resistance becomes great enough to balance the downward pull of gravity. From Newton's first law, we know that balanced forces produce no acceleration. When the forces are balanced, the sky divers fall at a constant speed. Meteorites, spacecraft, and other objects reach a constant speed as they fall to earth. The constant speed a falling object reaches when air resistance balances gravity is called terminal speed [3].

Fig. 3 – Falling Sky Divers

References:


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