

**Concept-Development  
Practice Page** **4-2**

**Hang Time**

Some athletes and dancers have great jumping ability. When leaping, they seem to momentarily “hang in the air” and defy gravity. The time that a jumper is airborne with feet off the ground is called hang time. Ask your friends to estimate the hang time of the great jumpers. They may say two or three seconds. But surprisingly, the hang time of the greatest jumpers is most always less than 1 second! A longer time is one of many illusions we have about nature.

To better understand this, find the answers to the following questions:

1. If you step off a table and it takes one-half second to reach the floor, what will be the speed when you meet the floor?

$$v = gt = 10 \text{ m/s}^2 \times \frac{1}{2} \text{ s} = 5 \text{ m/s}$$

2. What will be your average speed of fall?

$$v = \frac{0 + 5 \text{ m/s}}{2} = 2.5 \text{ m/s}$$

3. What will be the distance of fall?

$$d = vt = 2.5 \text{ m/s} \times \frac{1}{2} \text{ s} = 1.25 \text{ m}$$

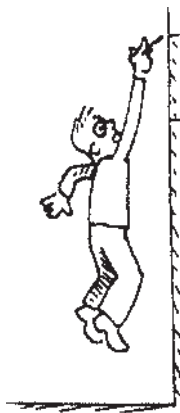
4. So how high is the surface of the table above the floor? \_\_\_\_\_

1.25 m

Speed of free fall = acceleration × time  
= 10 m/s<sup>2</sup> × number of seconds  
= 10t

Average speed =  $\frac{\text{initial speed} + \text{final speed}}{2}$

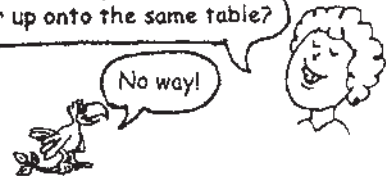
Distance = average speed × time.



Jumping ability is best measured by a standing vertical jump. Stand facing a wall with feet flat on the floor and arms extended upward. Make a mark on the wall at the top of your reach. Then make your jump, and at the peak make another mark. The distance between these two marks measures your vertical leap. If it's more than 0.6 meters (2 feet), you're exceptional.

5. What is your vertical jumping distance? \_\_\_\_\_ (varies)
6. Calculate your personal hang time using the formula  $d = 1/2 gt^2$ . (Remember that hang time is the time that you move upward + the time you return downward.)

Almost anybody can safely step off a 1.25-m (4-foot) high table. Can anybody in your school jump from the floor up onto the same table?



There's a big difference in how high you can reach and how high you raise your "center of gravity" when you jump. Even basketball star Michael Jordan in his prime couldn't quite raise his body 1.25 meters high, although he could easily reach higher than the more-than-3-meter high basket.

Here we're talking about vertical motion. How about running jumps? We'll see in Chapter 5 that the height of a jump depends only on the jumper's vertical speed at launch. While airborne, the jumper's horizontal speed remains constant while the vertical speed undergoes acceleration due to gravity. While airborne, no amount of leg or arm pumping or other bodily motions can change your hang time.

**CONCEPTUAL PHYSICS**