PhyzGuide: Notes on Acceleration

THE DIFFERENCE BETWEEN VELOCITY AND ACCELERATION

The first truly challenging concept you meet in a physics class is the concept of acceleration. Many students continue to think of *velocity* and *acceleration* as the same thing, or at least as being directly proportional. But they are not! *Velocity and acceleration are quite unrelated!*

For example: A Lamborghini heads down a straight Italian road at 200mph. What is its acceleration during this time? **Zero!** If an object maintains a constant speed in the same direction, it has zero acceleration. The car must have accelerated to get to 200mph from 0 mph, but that was not the question (hint: always answer the question that's actually been asked, not the one you think should've been asked).

Another example: A rock is thrown straight up into the air. At the very top of its flight, its velocity is zero. What is its acceleration? No, not zero. I'd better say that again, because you're thinking "the acceleration is too zero; the rock has no speed up at the tippy-top of its flight." The acceleration of a rock throughout its entire flight is an acceleration downward due to gravity ($9.8 m/s^2$ on earth). Gravity slowed the rock's upward motion and will continue to accelerate the rock downward. Gravity does not shut down just because a rock is at the top of its flight somewhere. If it did, *the rock would remain suspended in mid-air and never come back down!*

Remember that acceleration is defined as change in velocity per change in time. If speed changes, an acceleration is obviously occurring. But velocity is the speed *and direction* of motion. Consider a car driving around a circular track at a constant speed. Is there acceleration?

Yes! The *speed* is constant, but the *direction* of motion is constantly changing. So the *velocity* is changing. Changing velocity means that acceleration is occurring. (We will examine this further when we study circular motion.)

Here's another tricky one: Can a car with an *eastward* velocity be accelerating to the *west*?

Yes! Suppose you're heading east on Arden Way and you approach a red light at Watt. You apply the brakes and decelerate. The value of your *eastward* acceleration is negative; your velocity in the *westward* direction actually increased (perhaps from –30 mph *up* to 0 mph).

If I told you the **velocity** of a car, could you tell me its **position?** No. An object's position is independent of its velocity.

If I tell you only the **acceleration** of a car, can you tell me its **velocity?** No. An object's velocity is independent of its acceleration (many velocities are possible for a given acceleration).

If I tell you only the **velocity** of a car, can you tell me its **acceleration?** No. An object's acceleration is the *rate of change* in velocity, which is independent of the actual velocity at a given instant.

