Section 9.2.
Calculating Acceleration.

Textbook pages 392 to 405.

Before You Read.

How do you think a velocity-time graph might differ from the position-time graph you learned about in the previous chapter?

How is acceleration determined on a velocity-time graph?

A **velocity-time graph** represents the motion of an object with changing velocity. The slope of a velocity-time graph gives the object's acceleration, which is measured in meters per second squared. When a best-fit line passes through all data points, the object's velocity is changing at a constant rate and it experiences **constant acceleration**. However, since not all the velocities may be directly on the best-fit line, the slope is referred to as **average acceleration**.

If north is considered positive, for lines above the *x*-axis:

- a positive slope represents the average acceleration of an object that increases speed at a constant rate while travelling north. Acceleration is constant and positive.
- a zero slope represents an object travelling north at a constant speed. It is not accelerating.
- a negative slope represents an object that decreases speed at a constant rate while travelling north. Acceleration is constant and negative. Velocity is positive.

A line below the *x*-axis represents increasing speed at a constant rate toward the south. Acceleration is constant and negative. Velocity is negative.

Next page.

How is acceleration calculated without using a velocity-time graph?

Recall that average acceleration is the slope of a velocity-time graph:

- Slope equals rise divided by run.
- Slope equals the change in velocity divided by the change in time.

This textbook only considers situations where acceleration is constant. This means average acceleration is actually the same as acceleration at any instant.

- Acceleration equals the change in velocity divided by the change in time.

This equation can be rearranged to calculate velocity or time.

- Velocity equals the acceleration multiplied by the change in time.
- The change in time equals the velocity divided by the acceleration.

What is the relationship between gravity and acceleration?

When an object falls near Earth's surface, the force of **gravity** pulls it downward. Consider a ball being thrown straight up into the air, where "up" is positive.

- On the way up, the ball's velocity is decreasing. The ball is slowing down, so its acceleration is negative.
- At its maximum height, the ball's velocity is zero for an instant since the direction of the ball is changing. (Because the ball's velocity is still changing, the ball is accelerating although its velocity is zero for an instant.)
- When the ball starts to come down, its speed increases. However, its velocity is negative because the ball is heading "down." The ball's acceleration is negative.

How does air resistance influence acceleration due to gravity?

Objects fall at different rates because of **air resistance**, a friction-like force. In the absence of air resistance, all objects, regardless of their weight, fall with the same constant acceleration of nine point eight meters per second squared downward. This is **acceleration due to gravity**. In many situations, the air resistance acting on a falling object is so small that we can assume the object has a constant acceleration of negative nine point eight meters per second squared, where up is positive.