# 9.3.5: Average Acceleration

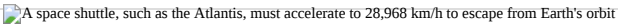


Figure 2.4.1

To escape from Earth's orbit, space shuttles such as the Atlantis shown here must accelerate to 28,968 kilometers per hour, called the shuttle's *escape velocity*.

## Average Acceleration

An object whose velocity is changing is said to be accelerating. **Average acceleration**, a, is defined as the rate of change of velocity, or the change in velocity per unit time. The units of acceleration are distance over time squared. A symbol with a bar over it is read as average – so a-bar is average acceleration.

## Examples

Example 2.4.1

A car accelerates along a straight road from rest to +60.0 km/h in 5.00 s. What is the magnitude of its average acceleration?

**Solution**

The acceleration in this problem is read as kilometers per hour per second. In general, it is undesirable to have two different units for the same quantity in a unit expression. In this case, it is undesirable to have both hours and seconds. To eliminate this problem, we convert the hour units to seconds. Converting the original 60.0 km/h to m/s, gives 17.0 m/s.

$$(17.0 \text{ m/s})/(5.00 \text{ s})=3.40 \text{ m/s}^2$$

The acceleration is 3.40 $\text{m/s}^2$.

✔ Example 2.4.2

An automobile is moving along a straight highway in the positive direction and the driver steps on the brakes. If the initial velocity is +15.0 m/s and 5.0 s is required to slow down to +5.0 m/s, what was the car's acceleration?

**Solution**

$$a=\Delta v/\Delta t=(-10.0 \text{ m/s})/(5.0 \text{ s})=-2.0 \text{ m/s}^2$$

Note that an acceleration is merely a change in velocity. This change can be either positive or negative. A negative change, such as that in the example problem above, is sometimes called negative acceleration or deceleration.

Velocity-time graphs and acceleration-time graphs can depict the motion of any object and can also be used to derive the object's average acceleration. Use the following PLIX Interactive to predict what the velocity-time graph and acceleration-time graph will look like to accurately describe Roger's bike ride to school:

## Summary

- Average acceleration is the rate of change of velocity, or the change in velocity per unit time.

## Review

1. The velocity of a car increases from +2.0 m/s to +16.0 m/s in a time period of 3.5 s. What was the average acceleration?
2. If an automobile slows from +26 m/s to +18 m/s in a period of 4.0 s, what was the average acceleration?
3. If a runner increases his velocity from 0 m/s to +20 m/s in 2.0 s, what was his average acceleration?
4. If a runner decreases his velocity from +20 m/s to +10 m/s in 2.0 s, what was his average acceleration?

## Additional Resources

Study Guide: Motion Study Guide

Real World Application: Falling From Space

Interactives: Irwin and Ruthie, Model Rocket

Video:

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