3.2.5: Average Acceleration

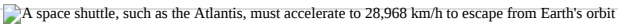

Figure 2.4.1

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 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: