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Module 3, Lesson 1 - Objectives & Standards

In this lesson about Acceleration, you will

- Pb.1: Demonstrate an understanding of the principles of force and motion and relationships between them.
- Pb.2: Apply formulas for velocity or speed and acceleration to one and two-dimensional problems.
- Pb.3: Interpret the velocity or speed and acceleration of one and two-dimensional motion on distance-time, velocity-time or speed-time, and acceleration-time graphs.

As you progress through the lesson think about the following questions:

- What is the difference between average acceleration and instantaneous acceleration?
- How can instantaneous acceleration be determined from a velocity-time graph?
- What is meant by positive acceleration, negative acceleration or zero acceleration?

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Module 3, Lesson 1 - Different Types of Acceleration

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Description: Car at Night
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In **Module 2** we studied different kinds of velocities - average and instantaneous. In **Module 3** the topic is the different kinds of acceleration.

Again, there are two different types - **average and instantaneous**.

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Module 3, Lesson 1: Acceleration and its Units

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Description: Speeding Car
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Module 2 **defined acceleration** as the measure of how fast velocity is changing. Another way to define acceleration is the rate of change of velocity. So, acceleration is a **ratio or fraction** where the numerator is velocity and the denominator is time. Acceleration can have some strange looking units but the units are always velocity divided by time.

Examples of acceleration units are:

- meters per second per second or meters per second squared
- miles per hour per second
- kilometers per hour per second
- miles per hour per minute

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Module 3, Lesson 1: Average Acceleration

Average acceleration measures the **change of velocity** over some time period. Like average velocity, average acceleration is not concerned with the acceleration at any specific time but rather is concerned about the change of velocity over an **extended time period**.

Average acceleration looks at the velocity at some **starting time** and compares it to the velocity at some **ending time**. Average acceleration equals the change in velocity divided by the time interval.

In equation form:

Computation of **average velocity** involves only the values for velocity and time for two specific points on the **velocity-time graph**.

Average Acceleration =
ΔVelocity ÷ ΔTime = (final velocity - initial velocity) ÷ (final time - initial time)

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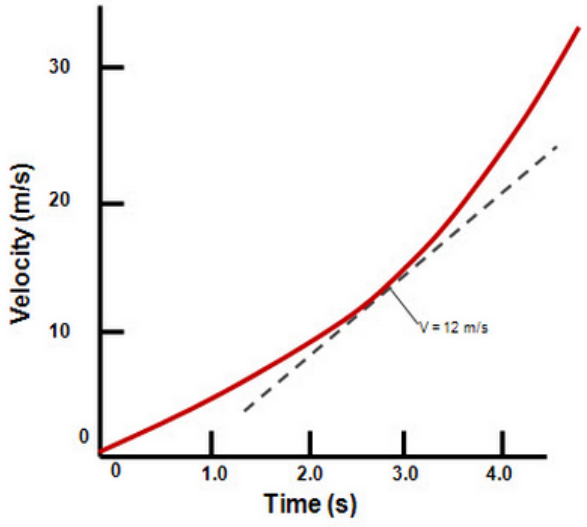
Module 2. Lesson 1: Instantaneous Acceleration



In Module 2 Lesson 4, we learned how to calculate the **instantaneous velocity** of an object from its position-time graph. The instantaneous velocity was the slope of the tangent to the **position-time graph**.

In similar fashion, **instantaneous acceleration** can be determined by calculating the slope of a tangent to the **velocity-time graph** at a specific time.

Photo Attribution
Description: Acceleration Graph
Source: DoDEA

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Module 2. Lesson 1: Instantaneous Acceleration

If **acceleration is constant**, the velocity-time graph is a straight line and the tangent has the same slope as the line. The instantaneous acceleration is the **slope of the line**.

If **velocity is constant**, then the **acceleration is zero** and the tangent to the velocity-time graph has a slope of zero.

If **acceleration is not constant**, the velocity-time graph is a curved line. The instantaneous acceleration is the slope of the tangent to the velocity-time curve. By looking at the tangents at progressive times on the velocity-time graph, you can see how the **slope changes** and how the **instantaneous acceleration** is changing in the same manner.

Remember from Module 2 Lesson 3, the area under the velocity-time graph equals the **displacement of the object** for the time period.

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Module 3, Lesson 1: Positive and Negative Acceleration

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Description: Arrows
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Acceleration is a vector quantity. That means **acceleration has a magnitude** and acts in a specific direction. If acceleration acts in **the same** direction as velocity, then velocity will increase. If acceleration acts in the **opposite** direction from velocity, then velocity will decrease.

The signs of both velocity and acceleration **indicate only the direction**. In a specific problem, you get to choose which direction is positive. If something acts in the opposite direction, then its sign is negative.

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Module 3, Lesson 1: Positive and Negative Acceleration

A **quick table** might help organize the effects of **different accelerations on velocities**:

- If a **positive** acceleration acts on a velocity going in the **positive** direction, then the velocity increases in the positive direction.
- If a **negative** acceleration acts on a velocity going in the **positive** direction, then the velocity decreases.
- If a **positive** acceleration acts on a velocity going in the **negative** direction, then the velocity decreases.
- If a **negative** acceleration acts on a velocity going in the **negative** direction, then the velocity increases in the negative direction.

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Description: Plus and Minus
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