Preview

- Objectives
- One Dimensional Motion
- Displacement
- Average Velocity
- Velocity and Speed
- Interpreting Velocity Graphically

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Objectives

- **Describe** motion in terms of frame of reference, displacement, time, and velocity.
- **Calculate** the displacement of an object traveling at a known velocity for a specific time interval.
- **Construct** and **interpret** graphs of position versus time.

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One Dimensional Motion

- To simplify the concept of motion, we will first consider motion that takes place in **one direction.**
- One example is the motion of a commuter train on a straight track.
- To measure motion, you must choose a **frame of reference.** A frame of reference is a system for specifying the precise location of objects in space and time.

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Frame of Reference

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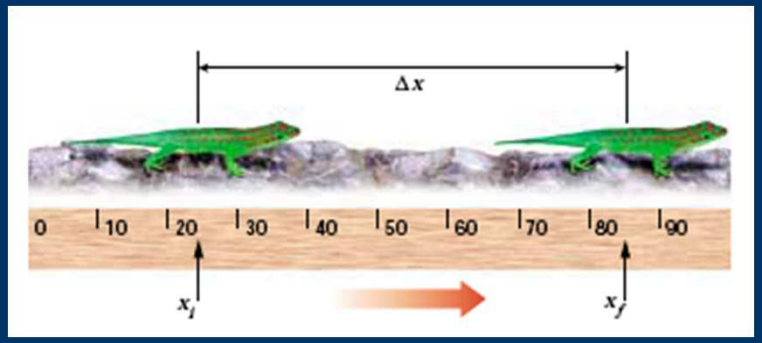
Displacement

- **Displacement** is a **change in position.**
- Displacement is not always equal to the distance traveled.
- The SI unit of displacement is the **meter, m.**



$$\Delta x = x_f - x_i$$

displacement = final position – initial position

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Displacement

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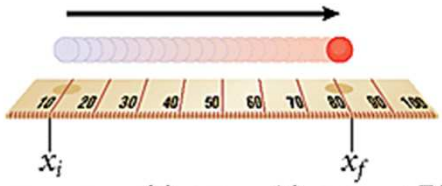
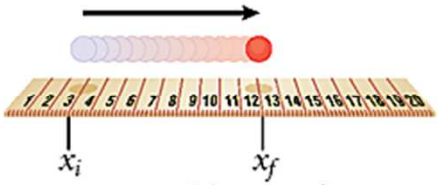
Positive and Negative Displacements

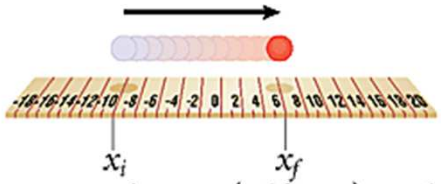
Positive



$\Delta x = x_f - x_i = 80\ \text{cm} - 10\ \text{cm} = +70\ \text{cm}$

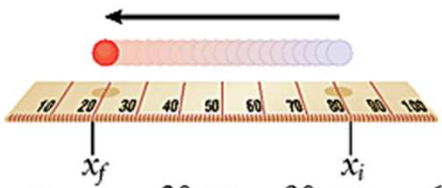


$\Delta x = x_f - x_i = 12\ \text{cm} - 3\ \text{cm} = +9\ \text{cm}$

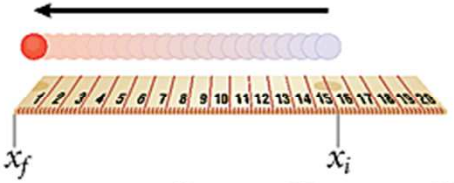


$\Delta x = x_f - x_i = 6\ \text{cm} - (-10\ \text{cm}) = +16\ \text{cm}$

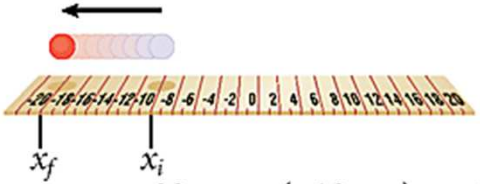
Negative



$\Delta x = x_f - x_i = 20\ \text{cm} - 80\ \text{cm} = -60\ \text{cm}$



$\Delta x = x_f - x_i = 0\ \text{cm} - 15\ \text{cm} = -15\ \text{cm}$



$\Delta x = x_f - x_i = -20\ \text{cm} - (-10\ \text{cm}) = -10\ \text{cm}$

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Average Velocity

- **Average velocity** is the total **displacement** divided by the **time interval** during which the displacement occurred.

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

$$\text{average velocity} = \frac{\text{change in position}}{\text{change in time}} = \frac{\text{displacement}}{\text{time interval}}$$

- In SI, the unit of velocity is **meters per second,** abbreviated as **m/s.**

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Average Velocity

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Velocity and Speed

- **Velocity** describes motion with both a **direction** and a **numerical value** (a magnitude).
- **Speed** has no direction, only magnitude.
- **Average speed** is equal to the total **distance traveled** divided by the **time interval.**

$$\text{average speed} = \frac{\text{distance traveled}}{\text{time of travel}}$$

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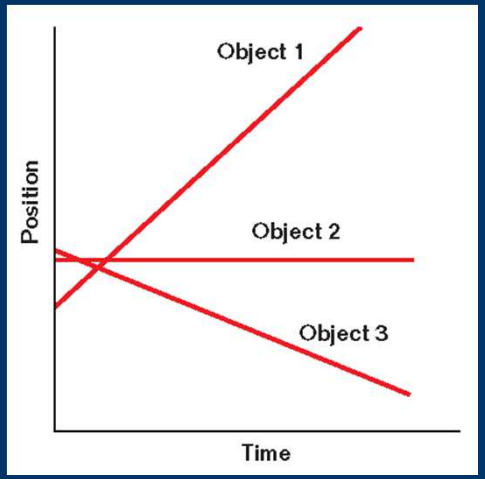
Interpreting Velocity Graphically

- For any **position-time graph,** we can determine the **average velocity** by drawing a straight line between any two points on the graph.

- If the velocity is **constant**, the graph of position versus time is a **straight line.** The slope indicates the velocity.
  - **Object 1:** positive slope = positive velocity
  - **Object 2:** zero slope= zero velocity
  - **Object 3:** negative slope = negative velocity



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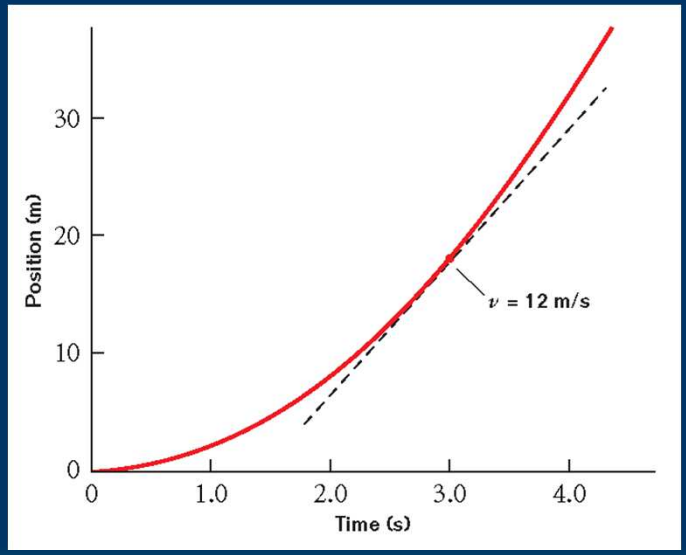
Interpreting Velocity Graphically, *continued*

The **instantaneous velocity** is the velocity of an object at some instant or at a specific point in the object's path.

The instantaneous velocity at a given time can be determined by measuring the slope of the line that is tangent to that point on the position-versus-time graph.



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Sign Conventions for Velocity

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