Speed

Speed is how fast something is moving. Precisely, it is how far an object travels in a certain amount of time. The standard metric units are meters per second (m/s), but any units of distance divided by time will work (like miles per hour [mph] or cm per sec [cps], etc).

\[ S = \frac{\Delta D}{\Delta T} \]

Where \( \Delta D = D_{\text{final}} - D_{\text{initial}} \)

Ex. A plane flies 200 meters in 5 sec. Calculate its speed.

<table>
<thead>
<tr>
<th>Step 1: Variables</th>
<th>Step 2: Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>( S = )</td>
<td>( S = \frac{\Delta D}{\Delta T} )</td>
</tr>
<tr>
<td>( \Delta D = 200 \text{ m} )</td>
<td>( \Delta D = 200 \text{ m} )</td>
</tr>
<tr>
<td>( \Delta T = 5 \text{ sec} )</td>
<td>( \Delta T = 5 \text{ sec} )</td>
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<table>
<thead>
<tr>
<th>Step 3: Put in numbers and solve</th>
<th>Step 4: Check units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( S = \frac{\Delta D}{\Delta T} )</td>
<td>( S = \frac{200}{5} )</td>
</tr>
<tr>
<td></td>
<td>( S = 40 \text{ m/sec} )</td>
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</tbody>
</table>

Why we use change of distance:
A tree 4 m away for 2 sec has a speed of zero — it hasn’t moved.
That’s why we have to use \( \Delta D \) (change of distance) distance (D).
An object has to be moving to have speed.

Physics Explains Mathematics:
If \( \Delta T = 0 \) (in \( S = \frac{\Delta D}{\Delta T} \)), then an object is in two places at once, which is impossible. This is why dividing by zero is undefined; it makes no physical sense!

Speed is proportional to distance:
A faster object goes farther, in the same amount of time.

\[
\begin{align*}
100 \text{m in 10 sec} & \quad S_1 = \frac{100}{10} = 10 \text{ m/s} \\
200 \text{m in 10 sec} & \quad S_2 = \frac{200}{10} = 20 \text{ m/s}
\end{align*}
\]

Doubling the distance, doubles the speed.

Speed is indirectly proportional to time:
A faster object travels the same distance in less time.

\[
\begin{align*}
200 \text{m in 20 sec} & \quad S_1 = \frac{200}{20} = 10 \text{ m/s} \\
200 \text{m in 10 sec} & \quad S_2 = \frac{200}{10} = 20 \text{ m/s}
\end{align*}
\]

Doubling the time, halves the speed.

A slower object can travel the same distance as a faster object, it just takes more time. A fast object travels the same distance faster.

Constant Speed

If an object moves at constant speed, it travels the same amount of distance each second. Notice that there is equal space between each dot.

<table>
<thead>
<tr>
<th>Fast object</th>
<th>Slow object</th>
</tr>
</thead>
<tbody>
<tr>
<td>⋯ ⋯ ⋯ ⋯ ⋯ ⋯</td>
<td>⋯ ⋯ ⋯ ⋯ ⋯ ⋯</td>
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Measuring Speed

To measure speed you must measure the distance traveled and the elapsed time.

Measure distance in meters using a meter stick or measuring tape.

Measure time with a stopwatch or with photogates.

Photogates (which start and stop when an object breaks beams of light) are a very accurate and precise method of measuring time.

\[
S = \frac{\Delta D}{\Delta T} = \frac{25 \text{ m}}{5 \text{ sec}} = 5 \text{ m/s}
\]
All sections marked with a "△" are considered essential concepts and must be completed to receive full credit on WS.

### Questions

1. **Speed**
   - A. How far an object moves between two positions.
   - B. When an object covers equal amounts of time each second.
   - C. The rate of how fast an object travels a particular distance.
   - D. How many seconds it takes for an event to occur.
   - E. Delta: means "change of".

2. **Distance Traveled**

3. **Elapsed Time**

4. **\( \Delta \)**

5. **Constant Speed**

### Will Speed Increase or Decrease?

- Distance is constant and time increases.  
- Time is constant and distance decreases.  
- Time is constant and distance increases.  
- Distance is constant and time decreases.

### Mark these as Speed, Distance, Time, or Other

- 5 mm/sec
- 20 meters/sec
- 15 ft/min
- 10 inches
- 228 meters
- 78 sec
- 50 m/s²
- 8 minutes
- 6 Newtons

### True or false (and why): "A fast car goes farther."

Can a slow object travel as far as a fast object? Explain.

Why do we have to use change of distance (\( \Delta D \)) instead of just distance (\( D \))?

### A bike moves 50 m in 10 seconds. Calculate the speed of the bike.

**Step 1: Variables:**
- \( S = \)
- \( \Delta D = \)
- \( \Delta T = \)

**Step 2: Formula:**

**Step 3: Plug in numbers and solve:**

**Step 4: Give answer with units:**

### A car travels 200 miles in 4 hours. Calculate the car’s speed.

**Step 1: Variables:**
- \( S = \)
- \( \Delta D = \)
- \( \Delta T = \)

**Step 2: Formula:**

**Step 3: Plug in numbers and solve:**

**Step 4: Give answer with units:**

### A car travels 60 m/s for 10 secs. Calculate how far it traveled.

**Step 1:**

**Step 2:**

**Step 3:**

**Step 4:**

### On holiday, a family travels from Meyerville (10 miles away) to Sprytown (70 miles away), in 3 hours. Find their speed.

**Step 1:**

**Step 2:**

**Step 3:**

**Step 4:**