**Acceleration and Average Speed**

**Acceleration**

Acceleration is how fast you change speed OR how much the speed changed in a certain amount of time.

\[
a = \frac{\Delta V}{\Delta T}
\]

\[
\Delta V = V_f - V_i
\]

\[
\Delta T = T_2 - T_1
\]

**Why?** If a car is traveling at 60 m/s for 20 sec, \( S = 60 \text{ m/s, but } \Delta S = 0 \text{ m/s. No change of speed: no acceleration.} \)

**Example:** Calculate Acceleration

Ex. A plane starts at rest and ends up going 200 m/s in 10 secs. Calculate acceleration.

Step 1: Variables

\[ S_1 = 0 \text{ m/s ("starts at rest")} \]
\[ S_2 = 200 \text{ m/s} \]
\[ \Delta T = 10 \text{ seconds} \]
\[ a = ? \]

Step 2: Find \( \Delta S \)

\[
\Delta S = S_2 - S_1
\]
\[ = 200 - 0 = 200 \text{ m/s} \]

Step 3: Formula

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

Step 4: Solve

\[
a = \frac{200 \text{ m/s}}{10 \text{ s}} = 20 \text{ m/s}^2
\]

**Example:** Calculate Deceleration

Ex. A race car starts at 400 m/s and then stops in 20 seconds. Calculate the car’s acceleration.

Step 1: Variables

\[ S_1 = 400 \text{ m/s} \]
\[ S_2 = 0 \text{ m/s ("then stops")} \]
\[ \Delta T = 20 \text{ seconds} \]
\[ a = ? \]

Step 2: Find \( \Delta S \)

\[
\Delta S = S_2 - S_1
\]
\[ = 0 - 400 = -400 \text{ m/s} \]

**NOTICE NEGATIVE \( \Delta S \)**

Step 3: Formula

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

Step 4: Solve

\[
a = \frac{-400 \text{ m/s}}{20 \text{ s}} = -20 \text{ m/s}^2
\]

Deceleration means an object is slowing down and has a negative sign.

**Average Speed**

\[
S_{ave} = \frac{D_{total}}{T_{total}}
\]

Ex. A person walks 4 miles in 2 hours, then stops for an hour for lunch. After lunch they walk 8 miles in 3 hours. Calculate the person’s average speed.

**Speed vs. Velocity**

**Speed** is a Scalar
**Velocity** is a Vector

Speed has no direction; Scalars have no direction.

Velocity has direction; Vectors have direction.

A person walks 4 m/s—speed (no direction).
A person walks 2 m/s north—velocity (direction is given).

A car drives 60 mph toward Dallas—velocity.
A car drives 30 mph—speed.

A 14 newton force pull 30° left of north—vector.
A boat is pulled by a 53 newton force—scalar.

Vectors have magnitude and direction.
Velocity is a vector with magnitude and direction.
### Match the variables with quantities.

<table>
<thead>
<tr>
<th>Speed (S) or Velocity (V)</th>
<th>Scalar (S) or Vector (V)</th>
<th>Match the variables with quantities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ A bike goes 25 m/s toward main street.</td>
<td>___40 mph toward Dallas.</td>
<td>1. a = _________ 23 kilograms</td>
</tr>
<tr>
<td>___ A person walks 4 mph.</td>
<td>___A 25 N force pulls on a wagon.</td>
<td>2. S or v = _________ 23 sec</td>
</tr>
<tr>
<td>___ A plane flies 200 m/s.</td>
<td>___10 meters up the hill.</td>
<td>3. m = _________ 3 m/s²</td>
</tr>
<tr>
<td>___ A bird flies 100 mph due south.</td>
<td>___12 meter per sec².</td>
<td>4. D = _________ 23 meters/sec</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. F = _________ 23 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. T = _________ 23 newtons</td>
</tr>
</tbody>
</table>

### A person starts running from 2 m/s to 6 m/s in 2 seconds. Calculate the person’s acceleration.

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Solve:</th>
</tr>
</thead>
</table>

### A plane stops from 250 mph in 25 seconds. Calculate the planes acceleration.

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Solve:</th>
</tr>
</thead>
</table>

### A guy bikes 15 miles in 1 hour, then rests for an hour. Then he bikes 25 in 2 hours. What was his average speed for the trip?

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Solve:</th>
</tr>
</thead>
</table>

### A dragster’s top acceleration is 60 m/s². If it accelerates for 3 seconds from the starting line, how fast will it be going?

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Solve:</th>
</tr>
</thead>
</table>

### Find the acceleration for the above graph:

<table>
<thead>
<tr>
<th>Speed vs. Time</th>
</tr>
</thead>
</table>

### Which graph segments fit the following:
- Constant speed:
- Deceleration:
- Accelerating:

The slope of a position vs. time graph means:

The slope of a speed vs. time graph means: