Introduction to Physical Science

Velocity and Acceleration

Presented by Robert Wagner

Time

- One of the fundamental physical quantities
  - In physics, it is the interval over which change occurs.
  -
  -
  -
  - For our purposes, , and t itself represents elapsed time.

Velocity

- Average velocity
  - Change in velocity divided by change in time
  - Velocity is a vector ; SI unit meter/second
  - Ex: If we travel -20 meters in 5 seconds
  - Negative sign indicates the direction of motion
  - Velocity can be negative, speed cannot be negative

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_o}{t_f - t_o}$$

$$\bar{v} = \frac{-20\ meters}{5\ seconds}$$

$$\bar{v} = -4\ m/s$$

Average Velocity

- only tells us the average motion during that time.
  - Velocity could vary
- Instantaneous velocity
  - Velocity that occurs at a particular instant - (i.e. speedometer)

Example

- A trip to the store and back
  - Displacement = 0 since we end up where we started!
  - If a trip takes 30. minutes (half an hour)
  -
  - Average speed: (   )
- Why is   equal to 0 km/hr?
  - Velocity is positive in one direction and negative in the other.

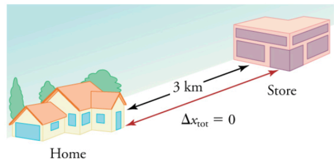


Figure 2.10 During a 30-minute round trip to the store, the total distance traveled is 6 km. The average speed is 12 km/h. The displacement for the round trip is zero, since there was no net change in position. Thus the average velocity is zero.

Image Credit: OpenStax College Physics Figure 2.10 CC BY 4.0

Acceleration

- Average Acceleration
  - Change in velocity divided by the change in time
  - Acceleration is a vector quantity
  - SI units are
  - Ex: Going from 0 to 10. m/s in 5.0 seconds
- Acceleration occurs when velocity changes
  - Can increase, decrease, or change direction
- Instantaneous acceleration

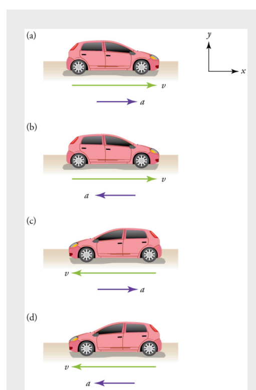
$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_o}{t_f - t_o}$$

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{10.m/s}{5.0s}$$

$$\bar{a} = 2.0m/s^2$$

Deceleration

- Acceleration opposite to the direction of motion
  - (a) has a positive acceleration and is speeding up
  - (b) has a negative acceleration and is slowing down
  - (c) has a positive acceleration but is slowing down
  - (d) has a negative acceleration and is speeding up
- Deceleration   Negative acceleration



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Example : Train Slowing

- Train accelerates from 30.0 km/hr in the first 20.0 s of its motion
  - Start with a sketch
  - What do we know?
  - Calculate Δv
  - Solve for
  - Convert to get rid of mixed units - Use SI units

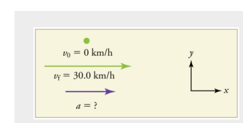

Figure 2.19

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Example : Train Slowing

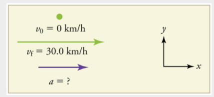

Figure 2.19

- Train accelerates from 30.0 km/hr in the first 20.0 s of its motion
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$v_o = 0\, km/hr\ ;\ v_f = 30.0\, km/hr\ ;\ \Delta t = 20.0\, s$

$\Delta v = v_f - v_o = +30.0\, km/hr - 0\, km/hr = 30.0\, km/hr$

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{+30.0\, km/hr}{20.0\, s} = 1.5 km/hr/s$$

$$\bar{a} = \frac{+30.0\, km/hr}{20.0\, s} x \frac{1000\, m}{1\, km} x \frac{1\, hr}{3600\, s}$$

$$\bar{a} = 0.417\, m/s^2$$

Summary

- Acceleration and velocity are both vectors
- Deceleration is not necessarily the same as a negative acceleration
- In physics, acceleration occur when an object increases speed, decreases speed or changes direction