
Motion

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Speed

Speed is a measure of how fast something is moving

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

Can be instantaneous or average

Examples: What is your average speed (in miles/hour) if you drive 34 miles in 45 minutes?

How far do you travel if you have an average speed of 30. miles/hour and you drive for 15 minutes?

How many minutes does it take to travel 17 miles if you are going 45 miles/hour?

Velocity

Velocity is speed in a certain direction

Quantities that have both magnitude and direction are called vectors. A vector can be represented by an arrow. The length of the arrow is the magnitude and where it points is the direction.

Question - A race car on a circular track can have constant speed. Why can it not have constant velocity?

Vectors can be added together "head to tail" to get a resultant vector.

Example - Suppose an airplane going at 150. miles/hour flies into a crosswind at 25 miles/hour. What is the resultant speed?

Acceleration

When the velocity changes we have acceleration.

Acceleration = $\frac{\text{change of velocity}}{\text{change in time}}$

Acceleration can be instantaneous or average over a period of time. The unit for acceleration has 2 time units. (m/s^2 , miles/hour/s or miles/hour-s).

Acceleration can be negative. If the motion is in a straight line, acceleration can be computed from the change in speed divided by the change in time.

Example: In 2.5 s, a car increases from 60. km/hr to 65 km/h. A bicycle goes from rest to 5 km/hr. What is the acceleration of each if the motion is straight?

For straight line motion: Final velocity = initial velocity + acceleration (time)

Example: If the initial velocity is 30. m/s and the acceleration is 5.0 m/s^2 for 5.0 seconds, what is the final velocity?

Free-fall is constant acceleration!

In free-fall gravity gives everything an acceleration of 9.8 m/s^2 (32 ft/s^2). [Sometimes we use an approximation of $10. \text{ m/s}^2$ to make computations easier.] In the absence of air resistance, all objects fall the same because they have the same acceleration.

Example: Suppose we drop a ball from rest from a tall building and it travel for 10. s before it hits the ground. What is the final velocity of the ball? What is the average velocity for its travel?

What if we throw the ball upward? Simply put a negative sign in front of the initial velocity!

How far does an object travel in a certain length of time?

distance traveled = initial velocity (time) + $\frac{1}{2}$ (acceleration) (time)²

Putting it all together - Make a chart of distance traveled, final velocity and average velocity for dropping an object for 5.0 seconds.