

Linear Motion



Motion

- All motion is relative or dependent upon a point of view.
- A rock thrown from the hand may appear to be traveling away from you at 3m/s .
- An ant on the rock would think you were moving away from it at $(-)\text{3m/s}$.
- The negative is demonstrating movement in the opposite direction.
- **THE SIGN MATTERS!!!**
- Most of the time speed is given relative to the Earth. Is the Earth stationary???

Speed

- Speed is a measure of distance divided by time. (m/s)
- Instantaneous speed is the speed at any instant. A speedometer gives instantaneous speed.
- Average speed is given by measuring the total distance traveled by the time it took.

Velocity

- In physics we measure velocities not speeds.
- The difference is velocity not only has a speed, but also a specific direction.
- Constant velocity requires both a constant speed and a constant direction.
- If either the speed or the direction change, then the velocity is no longer constant.

Acceleration

- Any change in velocity requires an acceleration.
- Acceleration is the rate at which the velocity is changing. $\Delta V/t$
- Acceleration can describe a change in speed or direction.
- Units for acceleration is m/s^2 $((m/s)/s)$

Free fall

- All objects on Earth are ***always*** experiencing gravity.
- This means that any object not resting on the Earth is experiencing an acceleration due to gravity which is 9.8m/s^2 .
- We will round to $10.\text{m/s}^2$ for ease of calculation.
- An object dropped from rest that experiences no air resistance is said to be in free fall.
- Air resistance will counteract the force of gravity and therefore slow the acceleration. More covered later!

Free fall velocities

- Since the acceleration due to gravity is always down, it is considered to be a negative number.
- The equation used to determine the velocity of a falling object at a moment in time under the acceleration due to gravity is....
- $v = v_0 + at$
- v is the velocity at time t
- v_0 is the initial velocity
- a is the acceleration due to gravity

Free fall distance

- The distance that an object has fallen can also be determined using the formula....
- $x = v_0t + \frac{1}{2}at^2$
- Where x = the position of the object relative to where it started.
- If an object is thrown up, its initial velocity would be positive.
- If an object is dropped, its initial velocity is 0
- If an object is thrown down, its v_0 is negative.
- Acceleration is always -10m/s.

Kinematic equations

- There are three kinematic equations (equations of motion)
- $v = v_o + at$
- $x = v_o t + \frac{1}{2}at^2$
- And combining those leads to a third
- $v_f^2 = v_o^2 + 2ax$
- Where $v_f^2 =$ final velocity

Graphing

- All equations can be described graphically.
- Time always goes on the x axis. Why?
- On a distance vs time graph, how can the velocity be determined?
- On a velocity vs time graph, how can the acceleration be determined?
- Remember, slope = $\Delta y / \Delta x$
- Also remember that slopes can be negative!!

Complex graphs

- If the graph is not linear, the slope at a specific time can be determined by drawing a tangent line to the curve and finding the slope of that tangent line. That would give an instantaneous reading.
- Calculus can be used to determine the slopes for more complex graphs which is why Newton invented it, but we won't need that here.