Linear Motion

By Jack, Cole, Kate and Linus

What is it?

-Linear Motion is the study of motion, Kinematics, and Dynamics

Motion

Motion is dependent on the reference frame in which you are observing. If you are in a car and throw a ball out in front of the car, to you, the ball is only going as fast as you can throw it. But to a man on the sidewalk the ball is going the speed of the car plus the speed of the throw.

- **Kinematics**
  - Description of ***how*** things move
- **Dynamics**
  - Description of ***why*** things move

Scalars and Vectors

- **Scalars** are quantities which are fully described by a **magnitude** alone.
  - Magnitude refers to the size of a measurement
- **Vectors** are quantities which are fully described by both a **magnitude** and a **direction**
  - Direction can be given as a movement through space (N S E W) or within a coordinate plane (+ or -).
  - Vectors are represented visually with **arrows** pointing in the direction of movement.

Distance VS. Displacement

Distance is the total amount you traveled regardless of direction. Displacement is the distance from the starting point you traveled.

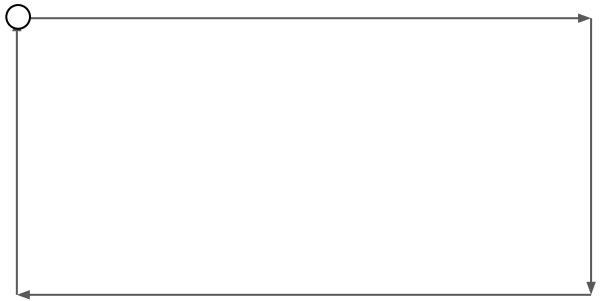
EX: If you go 5 m north and 5m east you have gone 10 meters (distance)

But in displacement you went $5\sqrt{2}$ **meters**. You get this by constructing a line from the starting point to the end point and use the values of the individual distances to construct a right triangle then you use pythagorean theorem to find the length of the line from the start to the end point.

Distance vs. Displacement- Check your understanding:

Example 1: You Walk 4 meters East, 2 meters South, 4 meters West, and finally 2 meters North.

(A) What was your distance traveled?
(B) What was your displacement?



Speed VS. Velocity

Both are the average time it takes to go a certain distance - distance (meters) divided by time (seconds)

Velocity is different in that is also takes into account the displacement of the object (displacement in meters divided by time elapsed in seconds)

If bob took 50 seconds to go 50 meters then his speed is 1 meter per second

If he went 25 meters up and 25 meters to the right in 50 seconds his velocity is 0.7 meters per second.

Average Velocity

- **Average Velocity** is calculated by a total displacement/time ratio, with consideration of **direction.**

$$\text{Average Velocity} = \frac{\Delta \text{ position}}{\text{Time}} = \frac{\text{displacement (m)}}{\text{time (s)}}$$

Instantaneous Speed and Average Speed

- **Instantaneous Speed** is the speed at any given instant in time.
  - What the speedometer reads
- **Average Speed** is the average of all instantaneous speeds
  - The average of an infinite number of speedometer readings during a trip
  - Found simply by a total distance/total time ratio

$$\text{Avg. Speed} = \frac{\text{Distance Traveled (m)}}{\text{Time of Travel (s)}}$$

Acceleration

Acceleration is a change in speed or direction, like hitting the brakes or turning into a parking spot

$a = \Delta v / \Delta t$ (change in velocity and change in time)

a=V2-V1/ T2-T1

Constant Acceleration

This is the relationship between acceleration and change in position

$vf^2 = vi^2 + 2a\Delta x$

Free fall is a constant acceleration by gravity (9.81m/s^2)

Kinematic Equation
(only in constant acceleration)

- $v_f = v_i + a\Delta t$
- $v_f = x_i + v_i\Delta t + \frac{1}{2} a\Delta t^2$
- $v_f^2 = v_i^2 + 2a\Delta x$

Position - Time Graph

- The slope of the line on a position versus time graph is equal to the velocity of the object.

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{rise}}{\text{run}}$$

Freefall

Because of the force of gravity any objects fall/accelerate toward earth.

The accelerating force acts on all object not dependent of their mass.

Air resistance makes it seem like each object travels at a different velocity toward earth. In our class we will neglect air resistance.

Freefall

Again gravity accelerates all objects 9.81 meters per second squared.

This number is unique because it only applies on earth.

The force of gravity on a different objects in space can be greater than or less than earth's.

FRQ STEPS

1.Figure out the info you already know

2. Figure out the info you need to solve for

3. Select the best equation based on this information

4. Make sure all units are in SI

5. Plug into equation and solve