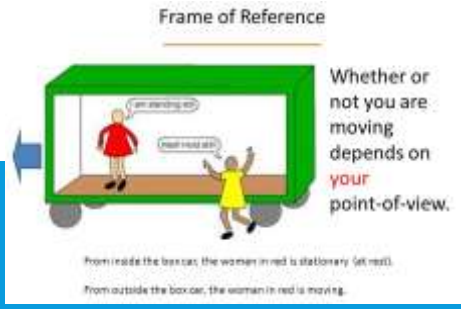
UNIT 1 - KINEMATICS

AP Physics – Mr Allan

OBJECTIVES – KINEMATICS PART 1

- **Describe** motion in terms of frame of reference, displacement, time, and velocity
  - Learn to represent motion – both uniform and accelerating
    - Using narrative, graphical, and mathematical forms and from different frames of reference
- Be able to show the motion of objects in one & two-dimensions is described using words, diagrams, numbers, graphs, and equations

ONE DIMENSIONAL KINEMATICS



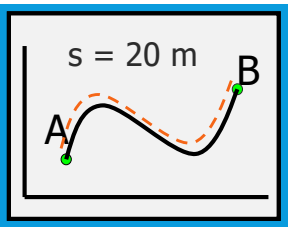
- **Kinematics** is the science of motion
  - How far? = **Distance and displacement**
  - How Fast? = **Speed and Velocity**
  - How fast does that *How Fast* change? = **Acceleration**
  - 1 dimension Kinematics - Objects moving in a straight line
  - 2 dimension Kinematics – Objects moving in a curve path (example projectile)
  - Changes in motion result from a **CONSTANT force** producing uniform acceleration.
  - The cause of motion will be discussed later. Here we only treat the changes.

- To measure motion, you must choose a **frame of reference**. A frame of reference is a system for specifying the precise location of objects in space and time

MOTION QUANTITIES DIVIDED INTO 2 TYPES

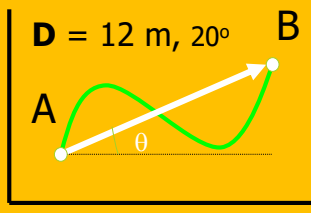
1. Scalars

- Quantities described by a ***Magnitude*** alone
- **Distance (d)** – is the length of the actual path taken by an object
- **Speed(s)** – how fast an object is moving; Distance/time
  - Ex: 14m or 76mph

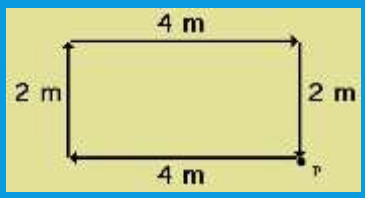


2. Vectors

- Quantities described by both a ***Magnitude*** and ***Direction***
- **Displacement (D) – straight-line distance btwn 2 points**
- **Velocity ($\bar{V}$) – Displacement/Time**
- Ex: 12m to the right or 32mph east.



DISTANCE VS DISPLACEMENT



- The person, according to a pedometer has walked a total of 12m. That is the distance traveled.
- The person walking stops where she started, so her **displacement is zero**.

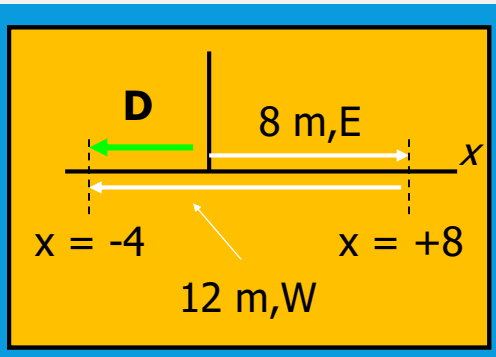
DISTANCE AND DISPLACEMENT

- For motion along x or y axis, the displacement is determined by the x or y coordinate of its final position.
- Example: Consider a car that travels 8 m, E then 12 m, W.

Net displacement D is from the origin to the final position:

Diplacement (D) = 4 m, W

What is the *distance* traveled?
20 m !!

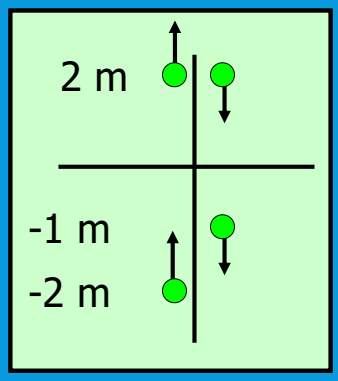


THE SIGNS OF DISPLACEMENT

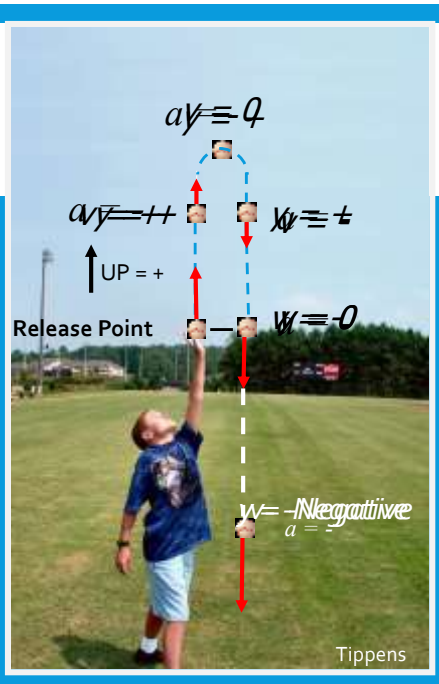
- Displacement is positive (+) or negative (-) based on **LOCATION**.

Examples:

The displacement is the y-coordinate. Whether motion is up or down, + or - is based on **LOCATION**.



The direction of motion does not matter!



SIGN CONVENTION: A BALL THROWN VERTICALLY UPWARD

- **Displacement** is positive (+) or negative (-) based on **LOCATION.**
- **Velocity** is positive (+) or negative (-) based on **direction of motion**.
- **Acceleration** is (+) or (-) based on **direction of force** (weight).

MEASURING HOW FAST YOU ARE GOING

- Speed → S
- Scalar
- Standard unit is m/s

$$S = \frac{distance}{time} = \frac{d}{t}$$

- Velocity → $\bar{V}$
- Vector
- Standard unit is m/s, plus direction

$$\bar{v} = \frac{displacement}{time} = \frac{D}{t}$$

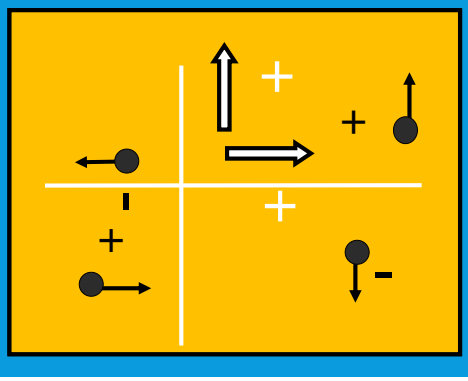
VELOCITY VS SPEED

- If it take the person 4 seconds to walk around the square, what is her average speed and average velocity?

- **For speed: d = 12m and t = 4s, so s = 3m/s**
- **For velocity: D = 0 and t = 4s, so $\bar{V}$ = 0m/s**

THE SIGNS OF VELOCITY

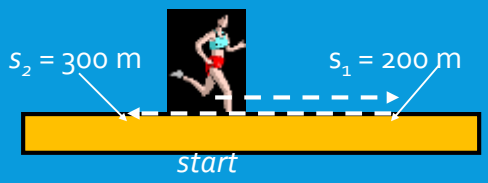
- Velocity is positive (+) or negative (-) based on direction of motion.



First choose + direction; then *v* is positive if motion is with that direction, and negative if it is against that direction.

EXAMPLE 1. A RUNNER RUNS 200 M, EAST, THEN CHANGES DIRECTION AND RUNS 300 M, WEST. IF THE ENTIRE TRIP TAKES 60 S, WHAT IS THE AVERAGE SPEED AND WHAT IS THE AVERAGE VELOCITY?

Recall that average speed is a function only of total distance and total time:



Total distance: s = 200 m + 300 m = 500 m

$$Average\ speed = \frac{total\ path}{time} = \frac{500\ \text{m}}{60\ \text{s}}$$

=Avg. speed 8.33 m/s

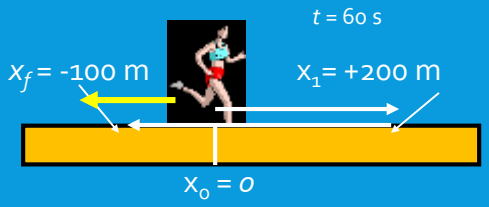
Direction does not matter!

EXAMPLE 1 (CONT.) NOW WE FIND THE AVERAGE VELOCITY, WHICH IS THE NET DISPLACEMENT DIVIDED BY TIME. IN THIS CASE, THE DIRECTION MATTERS.

$$\bar{v} = \frac{x_f - x_0}{t}$$

x_0 = 0 m; x_f = -100 m

$$\bar{v} = \frac{-100\ \text{m} - 0}{60\ \text{s}} = -1.67\ \text{m/s}$$

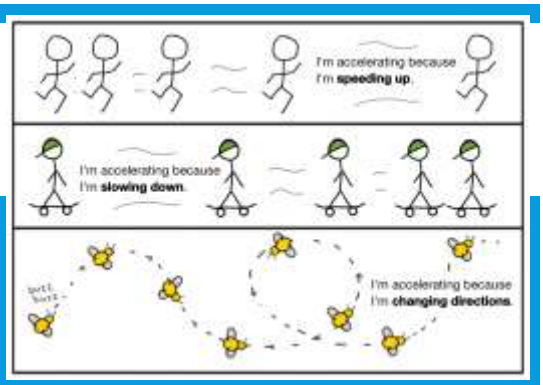


Direction of final displacement is to the left as shown.

Average velocity: $\bar{v} = 1.67$ m/s, West

Note: Average velocity is directed to the west.

ACCELERATION



$$a = \text{acceleration} = \frac{\Delta v}{t} = \frac{v_f - v_i}{t}$$

- Δ→delta
- Means "change in" and is calculated by subtracting the initial value from the final value.

- Tells us how fast Velocity is changing.
- Either hitting the gas or hitting the break counts as acceleration.
- Units are m/s²
- Notice NOT on Equation Sheet

ACCELERATION POSITIVE OR NEGATIVE

- Acceleration is a vector that points in the same direction as the ***change in velocity***.
- That means that the direction of the acceleration determines whether you will be adding to or subtracting from the velocity

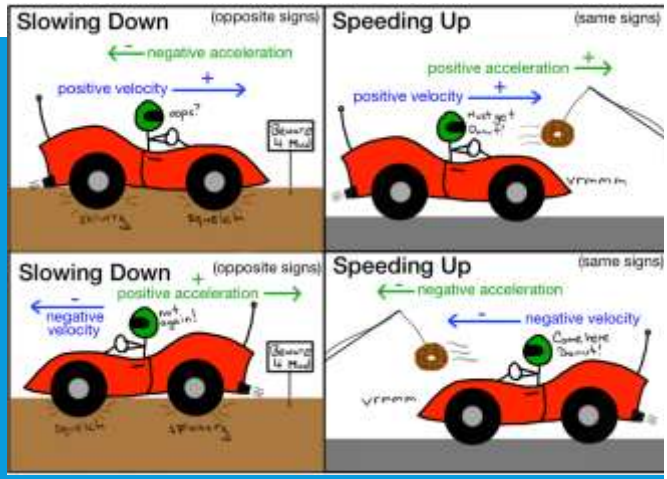
1st Determine V
+ Velocity if to right (or up)
- Velocity if to left (or down)

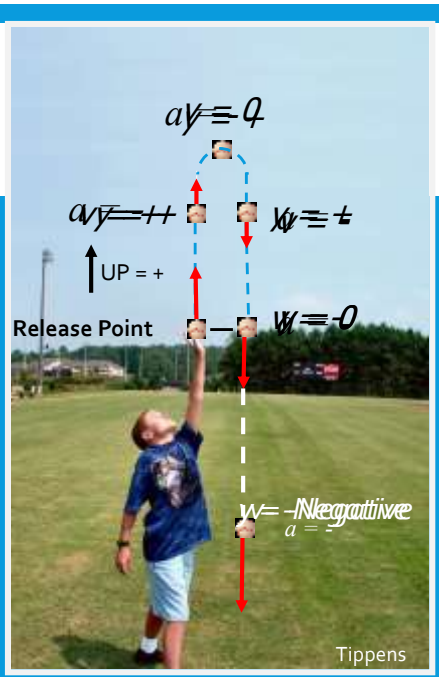
2nd is object slowing up or down ?

3rd

+V +a
- V - a
} Object Speed ↑

+V - a
- V + a
} Object Speed ↓





REVIEW SIGN CONVENTION:
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- **Acceleration** is (+) or (-) is a vector points in the same direction as the ***change in velocity***