

## Description of Motion (Kinematics)

- Describe the location of an object.

Space-time coordinates (measured)

position: a point in space

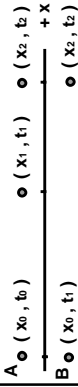
time: a clock reading

Both coordinate systems need

Axis

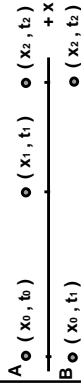
Origin

1 - Dimension (1 space, 1 time)



Describe what happened in words

## What The Diagram Means



Object B starts at same position as object A but at a later time.

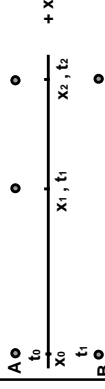
or

By the time object B is at A's initial position, object A is at another, more positive, position.

Still later, the two objects are at the same position at the same time.

## Simplifying the Diagram

Keep the diagram from getting too cluttered



To give a more complete description of what's happening we must also describe the motion of each object.

## Describing Motion

What we can measure about motion.

Change of position.

The time to make that change.

Different ways of describing motion:

- Average speed
- Instantaneous speed
- Average velocity
- Instantaneous velocity

The Difference

Average Speed

Distance traveled  
Time interval of trip

Average Velocity

Displacement  
Time interval of trip

## Finding Speed

Time interval of trip:

Difference between

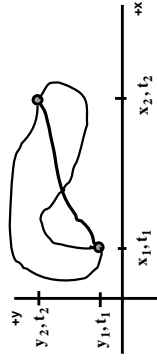
Clock reading at trip's end

Clock reading at trip's start

$$t_2 - t_1 = \Delta t$$

Change of position

Distance = Length of the path of the trip



An object moves from position 1 to position 2

What distance does it move?

Can't tell

## Average speed

If you knew the distance traveled you can get

the average speed

$$\frac{\text{Distance traveled}}{\text{Time interval of trip}}$$

Why is it an AVERAGE speed?

Suppose the object's speed were changing.

For any time interval you can calculate a speed

$$\frac{\text{Distance traveled}}{\text{Time interval of trip}}$$

The object is not moving at that speed.

Then what does  $\frac{\text{Distance traveled}}{\text{Time interval of trip}}$  mean?

It is an imaginary constant speed necessary to get to the same place in the same time.

That is what average means.

## Average Test Score

You get 20 points on your first test and 80 points on your second.

What is your average score for the two tests?

50 points

Is the average a real test score?

No

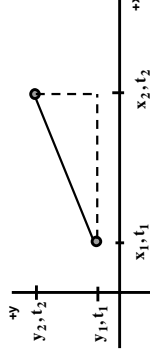
If you did have 2 tests of the same score and And the same total, what would they be?

The constant quantity that gives the same results is the average

## Displacement

Another Change of position

Difference between the object's ending position and its starting position



An object moves from position 1 to position 2

What is its displacement?

x displacement :  $x_2 - x_1$

y displacement :  $y_2 - y_1$

Size of displacement (use triangle)

$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

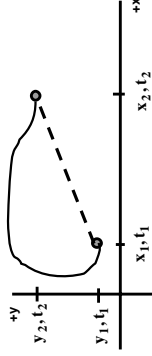
Also direction

## Average Velocity

Displacement

Time interval of trip

The AVERAGE velocity is NOT how fast an object goes



Suppose the object moved along the red line.

Displacement

Time interval of trip

is the constant velocity necessary to go along the blue line in the same time interval.

## Measurements

You can measure (Lab 1)

Time interval

Distance

Displacement

You can calculate

Average speed

Average velocity

Directly from measurements

Neither tells you how fast an object moves.

Average speed requires knowing the path

Average velocity does not

Only need to know start and end of path

## Example

Two objects both move from A to B in the same amount of time.

A ----- B Object 1

A ----- B Object 2

Which object moves faster ?

The average velocity is the same for both objects.

$$\bar{v} = \frac{(x_B - x_A)}{(t_B - t_A)}$$

## Example

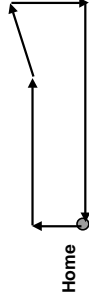
You leave your house and drive 4 miles when you remember that you forgot your gloves. You quickly drive back to get them. When you get back home you find you have been gone for 40 minutes.

What was your average velocity?

What was your average speed?

Home  $\longleftrightarrow$

For any round trip



the average velocity doesn't tell you how fast you were going

