Distance and Displacement

Put simply, **distance** is the total amount something traveled (measured in centimeters, meters, or kilometers) and **displacement** is only how far away it ended from its starting point (simpifies to $X^F - X^I$, or final position minus initial position.)

Distance and displacement are NOT the same thing, and most problems later on in physics will be asking you about *displacement*. Make sure you know which one you're looking for!

Average Speed vs. Average Velocity

Average speed is the total *distance* traveled divided by the total *time* traveled over a certain interval. **Speed is a scalar measurement**, which means it has no direction, only a magnitude.

Average velocity is the total *displacement* traveled divided by the total *time* traveled over a certain interval. **Velocity is a vector measurement**, which means it has a magnitude and a direction. It is often written as **Δx / Δt**, or *change in position over change in time*.

Slope And Its Meanings

On a position vs. time graph:

Positive slope	Object moving forward
line going up slowly	*object moving forward slowly*
line going up quickly	*object moving forward quickly*
Negative slope	Object moving backward
line going down slowly	*object moving backward slowly*
line going down quickly	*object moving backward quickly*

Slope And Its Meanings (cont)

Zero slope	Object not moving

To find velocity from a graph like this, find the total displacement over the time traveled during the interval.

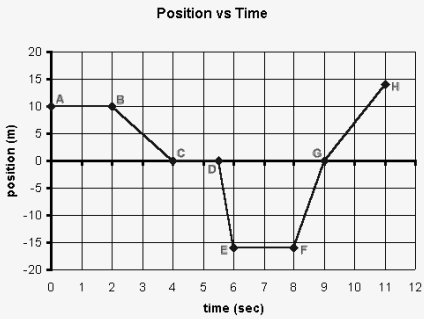
Special Cases

If an object stops in the exact same place it starts (for example, it travels in a circle or a square), **the displacement is 0**.

Remember, the displacement is only the difference between the final position and the initial position, so if they are the same point, there is no difference.

If the distance is a straight line, the displacement and the distance will be the **same.**

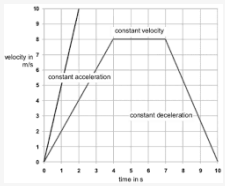
Interpreting Position vs. Time Graphs



A **position vs. time graph** will have position on the y-axis and time on the x-axis. These graphs can be used to find **instantaneous speed** (the speed the object is going at a specific time) and **average speed** (about how fast the object was going overall).

Remember that position is measured in m and time is measured in s, so this graph is describing changes in m/s. Since you know that m/s is the unit for velocity, you know that the line is really showing changes in **velocity.**

Interpreting Velocity vs. Time Graphs



In a **velocity vs. time graph,** velocity will be plotted on the y-axis and time will be plotted on the x-axis. Remember that velocity is measured in m/s and time is measured in s; therefore, this graph truly shows us a changes in m/s^2. This means that the graph is really describing a change in **acceleration**.

Example Problems

Andrew drives 7 kilometers north, then drives 5 kilometers east. What distance did he cover? What was his displacement?

When solving for **distance**, we can just add the 7 km and the 5 km because distance looks for the **total** kilometers she traveled.

When solving for **displacement** we need to find how far away from his starting point he ended. To find this, make a straight line from the beginning point to the end point. This will create a triangle, and then you can use $a^2 + b^2 = c^2$ to solve for c, which will be the displacement.

So, the answers to this problem:

Distance: 12 km

Displacement: √74 km, or about 8.6 km.

Tips and Tricks

Note: Having graph paper can be extremely helpful when dealing with distance problems. (For problems like these, it's okay to give your answer in the same unit you're given.)