Chapter 2: Motion in One Dimension

Section 2.1: Displacement and Velocity

Mechanics

- Mechanics is the branch of physics that studies motion and its causes.
- The study of motion is called kinematics.
- The study of the causes of motion (forces) is called dynamics.

Position and Displacement

--The <u>location</u> of an object is its <u>position</u>, and is indicated by the symbol x.

--The change in position of an object is called <u>displacement</u> (Δx).

$$\Delta X = X_f - X_i$$

(displacement = final position - initial position)

--Displacement does <u>not</u> necessarily equal distance traveled; for example, the straight-line distance between two cities is shorter than the distance traveled over different roads between the two cities.

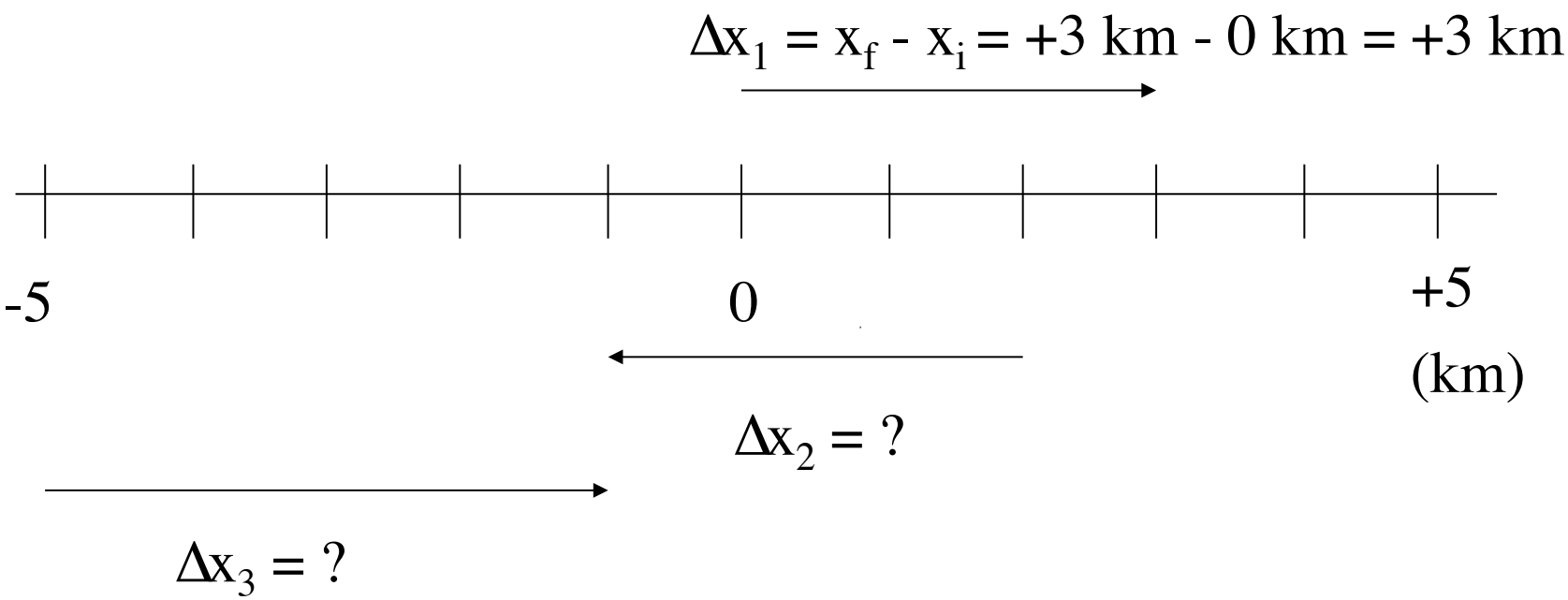
Displacement Along a Line

--Displacement along a line is represented using coordinates.

--A point on the line is chosen as zero (the starting point); displacements to the right are positive and those to the left are negative.

--If $X_f > X_i$, then Δx is positive.

--If $X_f < X_i$, then Δx is negative.


$\Delta x_1 = x_f - x_i = +3$ km - 0 km = +3 km
-5
0
+5
(km)
Δx_2 = ?
Δx_3 = ?

Velocity

--Velocity measures how fast an object moves from one point to another.

--Velocity is a vector quantity; it has both magnitude and direction.

Example: A car has a velocity of 85 km/h, N.

--The <u>average velocity</u> of an object is calculated by dividing the displacement of the object by the time required for the displacement:

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

--An object that is traveling at an average velocity does not necessarily travel at a constant velocity.

--For example, the average velocity of a trip between Slayton and Worthington might be 88 km/h, but the velocity through towns along the way (Avoca and Fulda) will be less that 88 km/h while speeds on the highway will be more than 88 km/h.

--The <u>instantaneous velocity</u> is the velocity of an object at a given point in time.

--For a car, instantaneous velocity is determined by the car's speedometer or by the highway patrol's radar gun!

Velocity and Speed

Velocity is a vector quantity that includes both the magnitude (speed) and direction.

<u>Speed</u> does not include the direction of the motion, it only tells how fast the object is moving. Speed is therefore not a vector quantity.

Velocity from Position versus Time Graphs

--If the position of an object versus time is graphed, the <u>slope of the graph</u> gives the change in position (displacement) divided by the change in time.

Since:

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

and the slope of a position vs. time graph is:

$$slope = \frac{\Delta x}{\Delta t}$$

then the average velocity must equal the slope of the line.

--If the line is a straight line, then the velocity is constant.

--If the line curves, the velocity is changing, and we can calculate the average velocity between two points on the curve by finding the slope of a straight line connecting the two points.

--We can calculate the <u>instantaneous velocity</u> at any point on the curve by finding the slope of a straight line drawn <u>tangent</u> to the curve at that point.