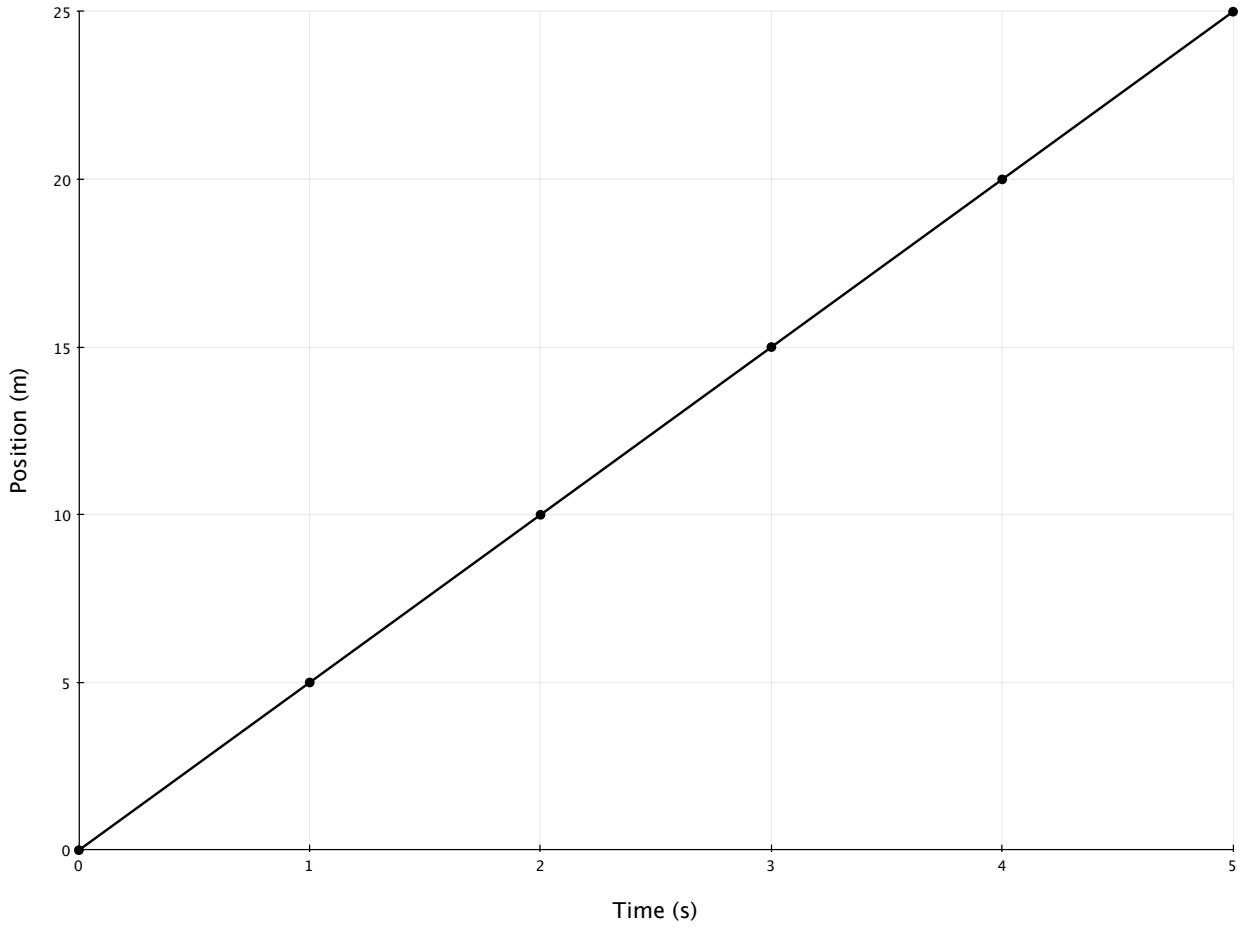
Position-Time Graphs

Suppose that a man is jogging at a constant velocity of $5.0\ m/s$. A data table representing the man's motion is shown below:

Time (s)	Position (m)
0	0
1.0	5.0
2.0	10.0
3.0	15.0
4.0	20.0
5.0	25.0

If we plot this data on a graph, we get:



A graph that shows how position varies with time is known as a **position-time graph**. This type of graph is very useful, as there is a great deal of information you can get from the graph, either directly or indirectly.

Some of the things you can determine directly from a graph of position versus time include:

- describing the motion of the object
    - based on the shape of the graph

- determining the position at a given time
    - by reading the graph

- determine the time when the object was at a given position
    - by reading the graph

Some of the things you can determine indirectly — that is, by doing some calculations — from a position-time graph include:

- determining the distance traveled

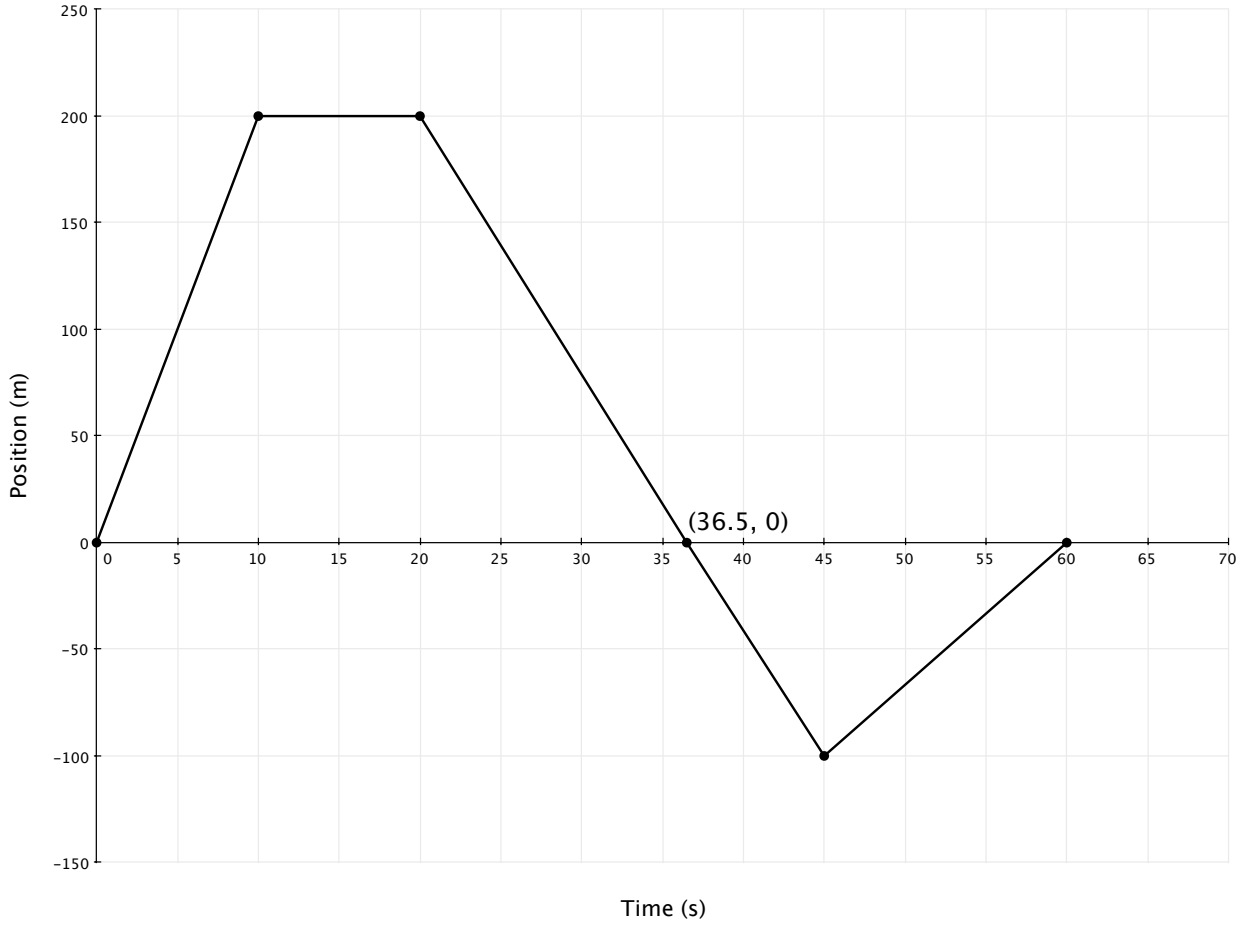
- determining the displacement for an interval of time
    - subtract the starting position from the ending position

- determining the velocity of the object at a given instant (instantaneous velocity)
    - slope of the graph at that instant
    - if the graph is curved, use a **tangent line** to find the slope

- determining the velocity of the object over a given time interval (average velocity)
    - slope of the chord joining the point on the graph at the start of the interval to the point on the graph at the end of the interval

Example 1

Use the position-time graph below to answer the questions. **Note**: Right is the positive direction.



1. Describe the motion of the object.

2. What is the position of the object at $t = 30\ s$?

3. At what time is the object $100\ m$ to the right of the starting position?

4. What is the total distance the object moved?

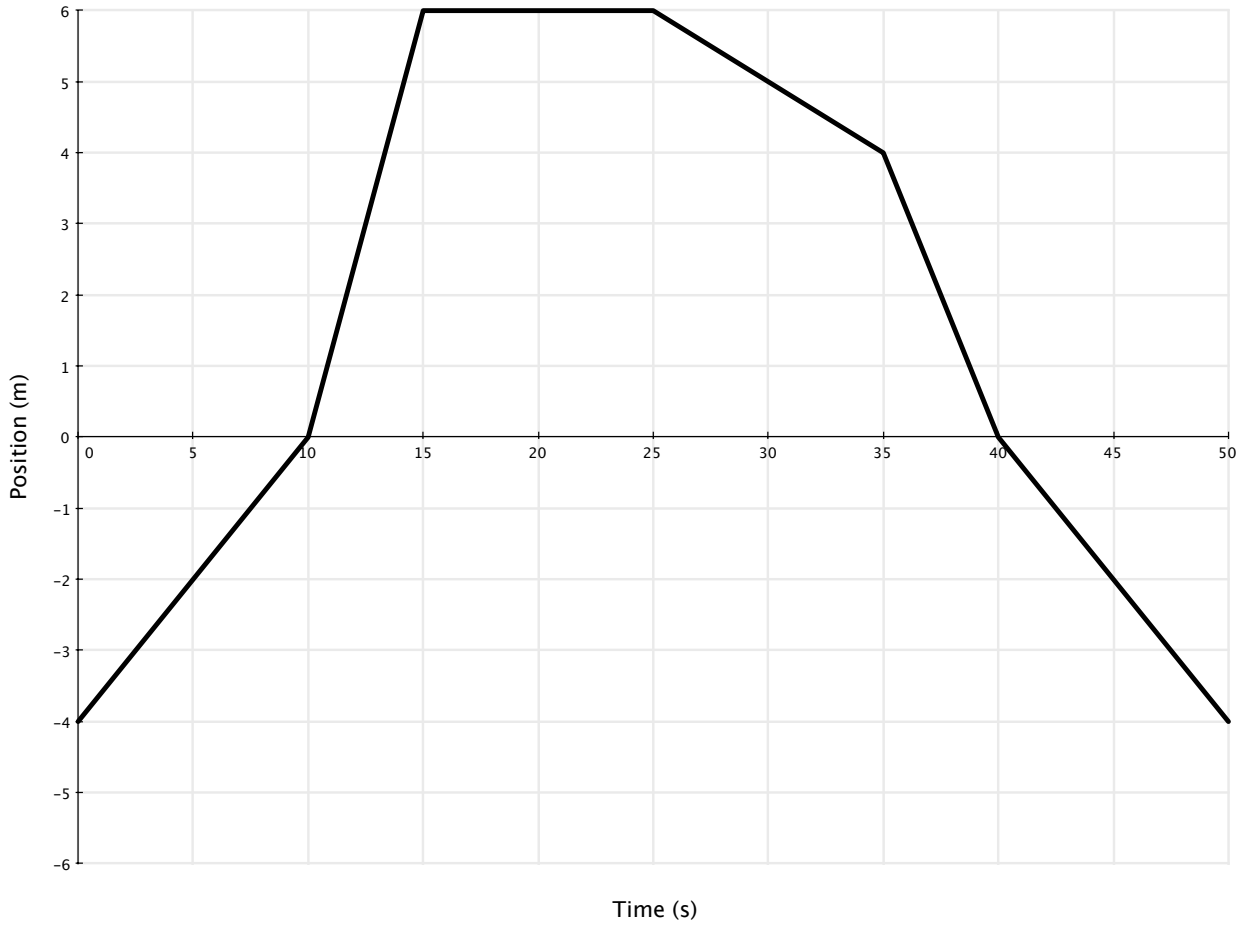
5. What is the object's net displacement?

6. What is the object's velocity at $t = 30\ s$?

7. What is the average velocity of the object from $t = 10\ s$ to $t = 45\ s$?

Position-Time Graph Worksheet

The position-time graph below represents the motion of a remote-controlled toy truck as it moves back and forth along a straight line path. The origin marks the position of the boy who controls the truck. A positive position is to the right of the boy, and a negative position is to the left of the boy.



1. During which time intervals is the truck

   a) to the right of the boy? _____

   _____

   b) to the left of the boy? _____

   _____

   c) moving in the positive direction? _____

   _____

   d) moving in the negative direction? _____

   _____

e) not moving? _____

_____

2. What is the position of the truck at

a) 0 seconds? _____ c) 30 seconds? _____

b) 15 seconds? _____ d) 45 seconds? _____

3. How far did the truck travel during the following time intervals?

a) 0–10 s _____ d) 25–35 s _____

b) 10–15 s _____ e) 35–40 s _____

c) 15–25 s _____ f) 40–50 s _____

4. What was the displacement of the truck during the following intervals?

a) 0–10 s _____ d) 25–35 s _____

b) 10–15 s _____ e) 35–40 s _____

c) 15–25 s _____ f) 40–50 s _____

5. Average speed is given by the distance traveled divided by the time interval. Calculate the average speed for each interval.

a) 0–10 s _____ d) 25–35 s _____

b) 10–15 s _____ e) 35–40 s _____

c) 15–25 s _____ f) 40–50 s _____

6. Average velocity is given by the displacement of the truck divided by the time interval. It can also be determined by calculating the slope of the line segment on a position-time graph. Calculate the average velocity for each time interval by calculating the slope.

Run = Δt **Time Interval**	**Rise =** Δd **Displacement**	**Slope =** v **Velocity**

7. How do the signs of the velocities in #6 compare to the direction of motion in #1?

8. In terms of the truck's motion,

   a) what does a negative velocity mean? _____

   _____

   b) what does a positive velocity mean? _____

   _____

   c) what does a velocity of zero mean? _____

   _____