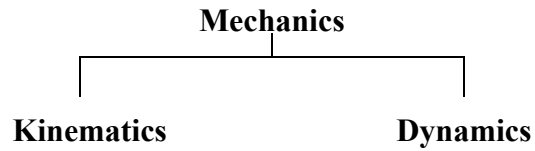


Mechanics

Recall



Kinematics

The description of motion without reference to forces.

Terminology

Distance

- total length of a journey
- scalar

Time

- instant – when an event occurs
- interval – duration of an event

Position

- location relative to a reference point
- vector

Displacement

- change in position
- vector

Velocity

- rate of change of position
- vector

Speed

- how fast an object is moving (also, the magnitude of the velocity)
- scalar

Acceleration

- rate of change of velocity
- vector

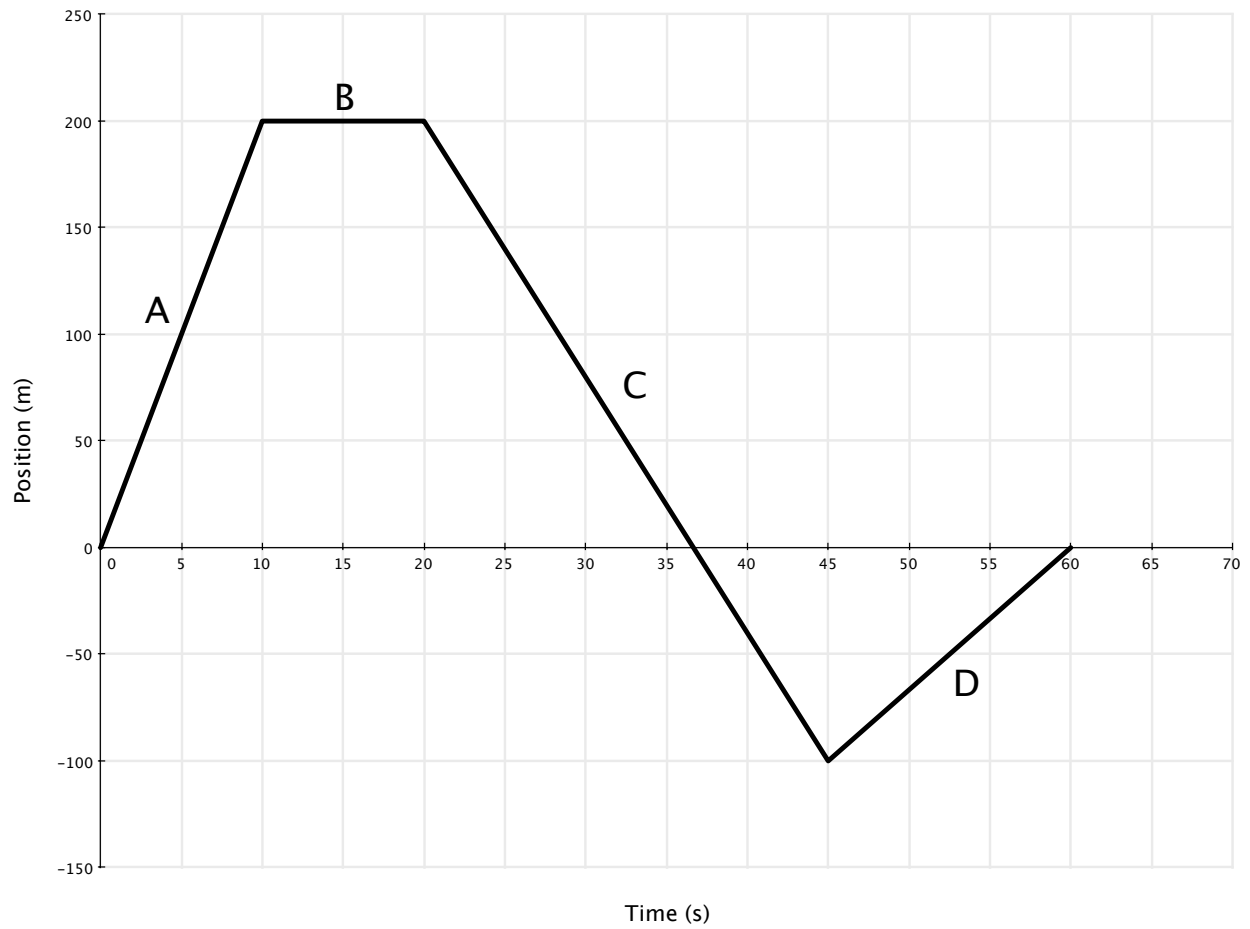
Position-Time Graphs

A position-time graph shows how the position of an object varies with time. By examining a position-time graph we can determine many things about the motion of an object. These include:

- describing the motion of the object
- determining the position at a given time
 - by interpolation (reading the graph)
- determining the distance traveled
- determining the displacement for an interval of time
 - difference between ending position and starting position
- determining the velocity of the object at a given instant (instantaneous velocity)
 - slope of the graph at that instant (tangent line)
- 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 questions 1 to 4.



1. What is the total distance the object moved?

2. What is the object's net displacement?

3. What is the object's velocity at $t = 30 \text{ s}$?

4. What is the average velocity of the object from $t = 10 \text{ s}$ to $t = 45 \text{ s}$?

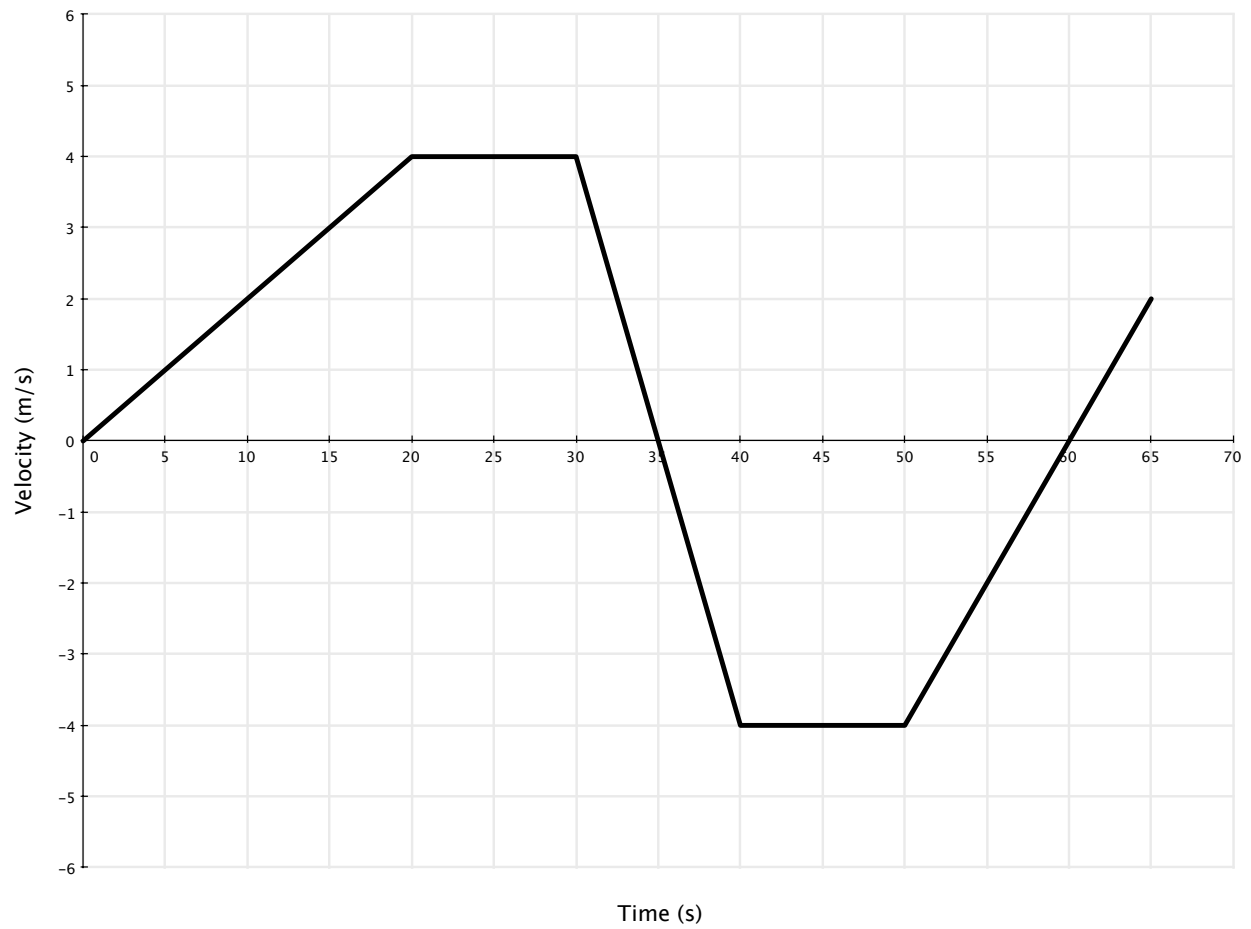
Velocity-Time Graphs

A velocity-time graph shows how the velocity of an object varies with time. By examining a velocity-time graph we can determine many things about the motion of an object. These include:

- describing the motion of the object
- determine the displacement for an interval of time
 - area under the graph (area above axis is positive, below axis is negative)
- determining the velocity of the object at a given time
 - by interpolation
- determining the velocity of the object over a given time interval (average velocity)
 - total displacement (area) during the interval divided by the time interval
- determining the acceleration of the object at a given instant (instantaneous acceleration)
 - slope of the graph at that instant (tangent line)
- determining the acceleration of the object over a given time interval (average acceleration)
 - 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 2

Use the velocity-time graph below to answer questions 5 to 8.



5. What is the net displacement of the object?

6. What is the average velocity of the object for the entire interval?

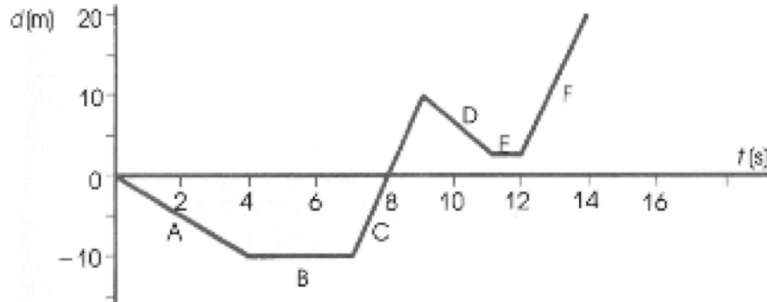
7. What is the object's acceleration at $t = 10 \text{ s}$?

8. What is the average acceleration of the object from $t = 10 \text{ s}$ to $t = 50 \text{ s}$?

Homework
Motion Graphs Worksheet

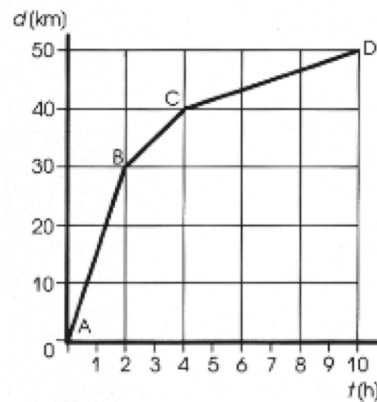
Motion Graphs Worksheet

1. Find the velocity in each section of the following position-time graph. (-2.5 m/s , 0 , 10 m/s , -3.8 m/s , 0 , 8.8 m/s)



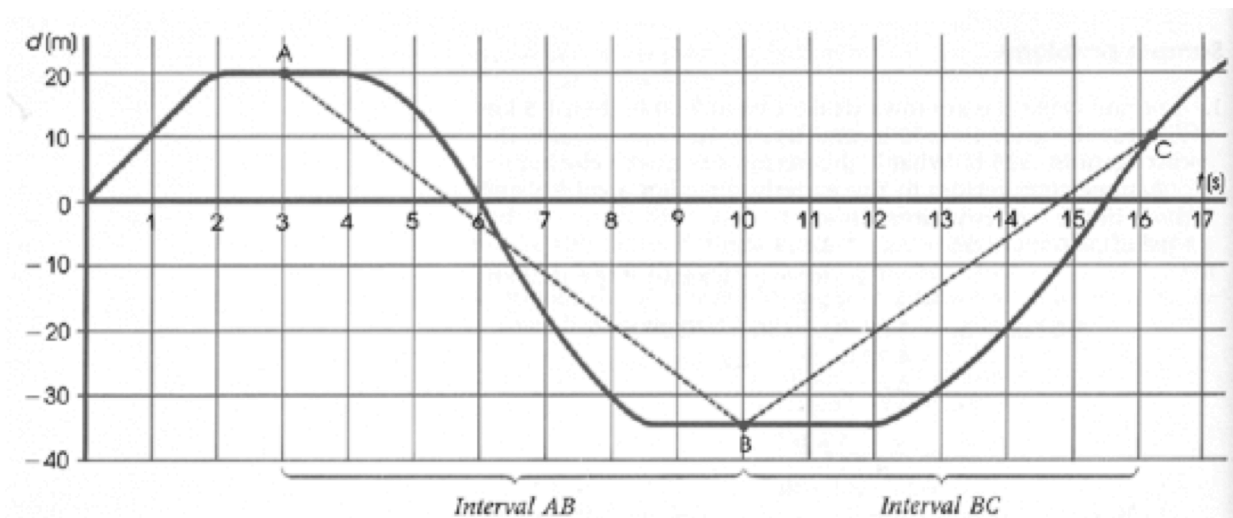
2. Using the graph below, determine the average velocity for these intervals:

- AB (15 km/h)
- AD (5.0 km/h)
- BD (2.5 km/h)

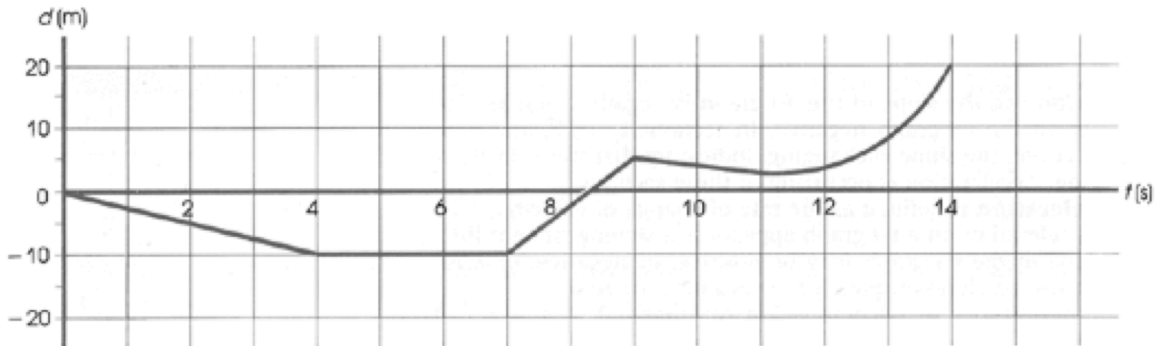


3. Using the graph below, determine the average velocity for each of the following sections.

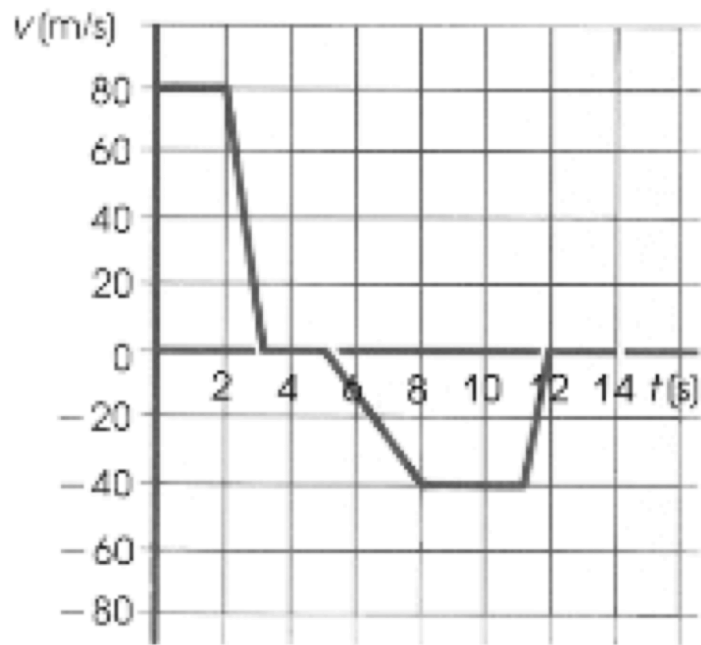
- $t = 0 \text{ s}$ to $t = 2 \text{ s}$ (10 m/s)
- $t = 6 \text{ s}$ to $t = 12 \text{ s}$ (-5.8 m/s)
- $t = 6 \text{ s}$ to $t = 15.5 \text{ s}$ (0)



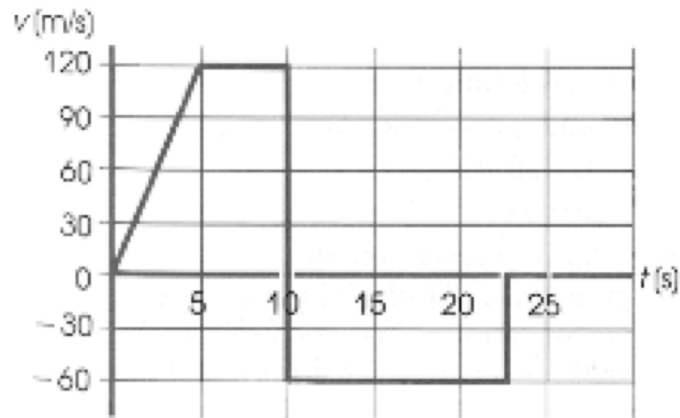
4. The following graph is that of an object moving in a straight line. East is considered as the positive direction.
- Determine the position of the object after 7.0 s. (-10 m)
 - The graph shows five distinct sections. Briefly, and in general terms, describe the motion of the object in each of these sections.
 - Considering the whole journey, calculate the average velocity. (1.4 m/s)
 - Find the instantaneous velocity at $t = 13\text{ s}$. (8 m/s)
 - Using an appropriate scale, draw a velocity-time graph from the position-time graph.



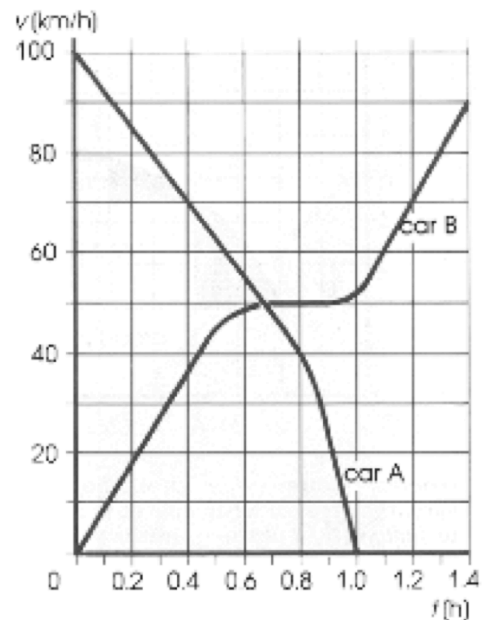
5. This graph below describes the motion of an object moving in a straight line. At the beginning it is going east. From the graph determine each of the following.
- the object's displacement in the first 3.0 s (200 m [E])
 - the object's displacement between $t = 3.0\text{ s}$ and $t = 5.0\text{ s}$ (0)
 - the total displacement of the object in 14 s (0)
 - the average velocity of the object from $t = 0$ to $t = 8.0\text{ s}$ (17.5 m/s [E])



6. Use the following graph of the motion of a car to find the total displacement (north is positive). (150 m [N])



7. The following graph illustrates the motion of two cars traveling due north. Assuming that both cars were at the same position at $t = 0$, answer the following questions.
- At what time do both cars have the same velocity? ($t = 0.68 h$)
 - At $t = 0.4 h$, which car is ahead and by how much? ($26 km$)
 - At $t = 1.0 h$, what is the distance separating the two cars? ($25 km$)



8. From the following graph, determine the acceleration for each interval, using the slopes. ($2.0 m/s^2$, 0 , $-1.8 m/s^2$, 0 , $1.0 m/s^2$)

