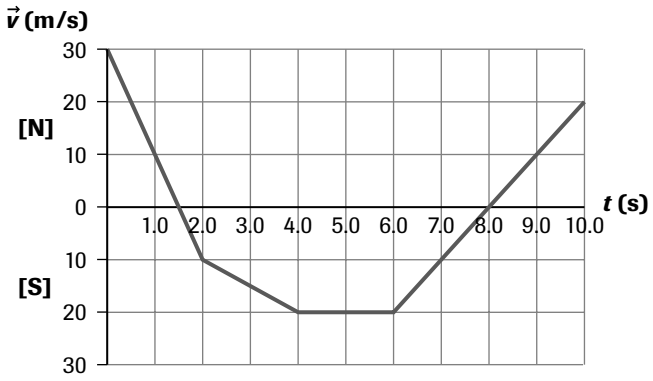
Motion Graphs

The velocity-time graph represents the motion of an object over a time interval.



Use graphical analysis to answer the following questions.

1. What is the object's displacement relative to its starting position after 6.0 s?

(continued)

2. Determine the object's (a) average velocity and (b) average speed during the first 6.0 s.

3. Compare the object's acceleration during the first 2.0 s with its acceleration between 6.0 s and 10.0 s.

(continued)

4. Plot the corresponding position-time graph representing the same motion.

5. Plot the corresponding acceleration-time graph representing the same motion.

Motion Graphs, Solution

1. What is the object's displacement relative to its starting position after 6.0 s?

   The displacement of the object after 6.0 s is determined by taking the area between the graphed line and the time axis over this interval. This can be done using the formulas for the areas of triangles, rectangles, and trapezoids.

   From $t = 0.0$ s to $t = 1.5$ s, $A = 22.5$ m [N]
   From $t = 1.5$ s to $t = 2.0$ s, $A = 2.5$ m [S]
   From $t = 2.0$ s to $t = 4.0$ s, $A = 30.0$ m [S]
   From $t = 4.0$ s to $t = 6.0$ s, $A = 40.0$ m [S]

   The displacement during the first 6.0 s corresponds to the total area of 50.0 m.

2. Determine the object's (a) average velocity and (b) average speed during the first 6.0 s.

   (a) $\vec{d} = 50.0$ m [S]
   $t = 6.0$ s

   $$\vec{v} = \frac{\vec{d}}{t}$$
   $$= \frac{50.0 \text{ m [S]}}{6.0 \text{ s}}$$
   $$\vec{v} = 8.3 \text{ m/s [S]}$$

   The object's average velocity during the first 6.0 s is 8.3 m/s [S].

   (b) $d = 95.0$ m
   $t = 6.0$ s

   $$v = \frac{d}{t}$$
   $$= \frac{95.0 \text{ m}}{6.0 \text{ s}}$$
   $$v = 16 \text{ m/s}$$

   The object's average speed is 16 m/s.

3. Compare the object's acceleration during the first 2.0 s with its acceleration between 6.0 s and 10.0 s.

   Determine the acceleration by taking the slope of the graph.
   During the first 2.0 s:

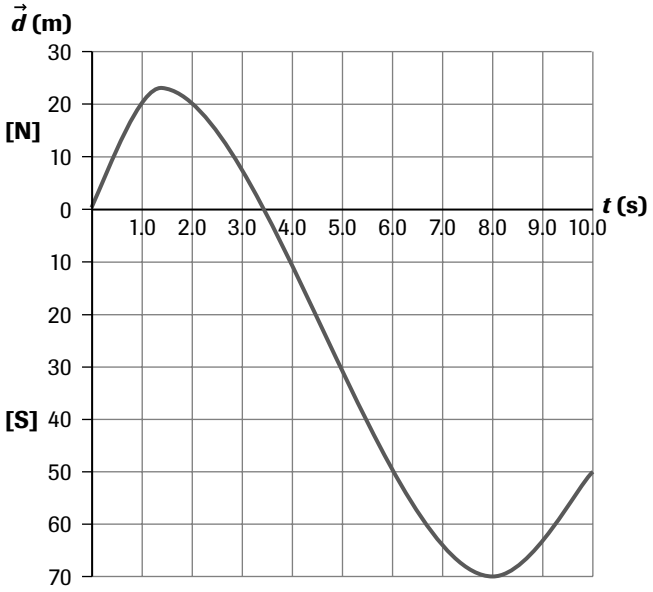
   $$\text{slope} = \frac{40 \text{ m/s [S]}}{2.0 \text{ s}} = 20 \text{ m/s}^2 \text{ [S]}$$

   Between $t = 6.0$ s and $t = 10.0$ s:

   $$\text{slope} = \frac{40 \text{ m/s [S]}}{4.0 \text{ s}} = 10 \text{ m/s}^2 \text{ [N]}$$

(continued)

4. Plot the corresponding position-time graph representing the same motion.



5. Plot the corresponding acceleration-time graph representing the same motion.