3.4 Describing Motion with Graphs

STANDARDS

3.2 I can interpret, analyze, and create acceleration vs. time graphs for objects moving with constant acceleration.

NUMERICAL EXAMPLE
Position-time information are shown in the data table. Assume that the motion is uniform and fill in the blanks of the table.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Position (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>12.5</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>1.5</td>
<td>37.5</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>2.5</td>
<td>62.5</td>
</tr>
<tr>
<td>3</td>
<td>75.0</td>
</tr>
</tbody>
</table>

Interpreting Graphs

Key Concepts
- A motion diagram shows the position of an object at successive times.
- In the particle model, the object in the motion diagram is replaced by a series of single points.
- Change in position is displacement, which has both magnitude and direction.

\[ \Delta x = x_f - x_i \]

- The slope of an object’s position-time graph is the average velocity of the object’s motion.

\[ v = \frac{\Delta x}{t} = \frac{x_f - x_i}{t} \]

- The average acceleration of an object is the slope of its velocity-time graph.

\[ a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i} \]
### Interpreting Graphs

**Position vs. Time**

The slope of the line on a position vs. time graph reveals information about an object's velocity. The magnitude (numerical value) of the slope is equal to the object's speed and the direction of the slope (upward or downward) is the same as the direction of the velocity vector. Apply this understanding to answer the following questions:

a. A horizontal line means **stationary**.

b. A straight diagonal line means **constant**.

c. A curved line means **accelerating**.

d. A gradually sloped line means **small acceleration**.

e. A steeply sloped line means **large acceleration**.

**Slope**

The slope of a line on a position-time graph for a given time interval is the average velocity.

\[ \text{velocity} = \frac{\Delta x}{\Delta t} \]

**Velocity vs. Time**

The slope of the line on a velocity vs. time graph reveals information about an object's acceleration. The magnitude (numerical value) of the slope is equal to the object's displacement. Apply this understanding to answer the following questions:

a. A horizontal line means **constant**.

b. A straight diagonal line means **constant**.

[c. A gradually sloped line means **small acceleration**.

d. A steeply sloped line means **large acceleration**.

**Slope**

The slope of a line on a velocity-time graph for a given time interval is the average acceleration.

### Velocity-Time Graph

- **Velocity** range: 0 to 50 m/s
- **Time** range: 0 to 5 s
- **Displacement**: 150 m
- **Initial Velocity**: 30 m/s
- **Final Velocity**: 40 m/s

**Graph Details**

- Graph shows velocity vs. time for an object.
- The object starts at 30 m/s and ends at 40 m/s after 5 seconds.
- The displacement during this time is 150 m.
The displacement of an object moving with constant acceleration can be found by computing the area under the v-t graph.

\[ A = \frac{1}{2}bh = \frac{1}{2}(4s)(50m) \]

\[ A = 100m \]