

$a = 9.80 \text{ m/s}^2$   
 $x_0 = 0$   
 $v_0 = 0$   
 $x_f = \text{av. dist.}$

$t = ?$   
 $x = x_0 + v_0 t + \frac{1}{2} a t^2$   
 $x = \frac{1}{2} g t^2$

$\sqrt{\frac{2x}{g}} = t$

$t = 0.18 \text{ s}$   
 $v = 15.6 \text{ m/s}$   
 $x = vt = 3 \text{ m}$

# 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.

### 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.

$$\Delta x = x_f - x_0$$

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

$$\bar{v} = \frac{\Delta \bar{x}}{t} = \frac{x_f - x_0}{t}$$

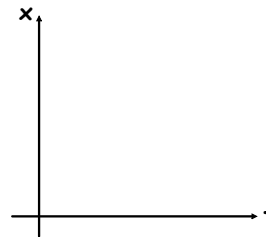
- The average acceleration of an object is the slope of its velocity-time graph.

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

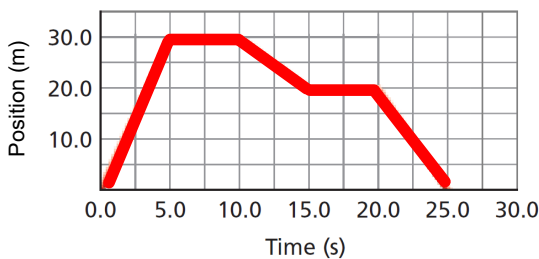
### NUMERICAL EXAMPLE

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

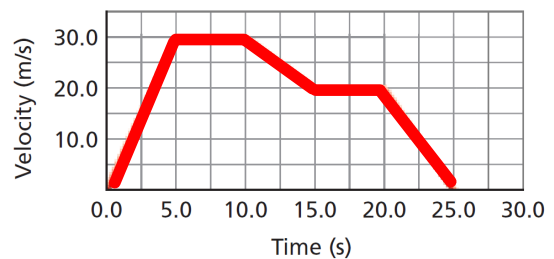
Time (s)	Position (m)
0	0
0.5	12.5
1	25
1.5	37.5
2	50
2.5	62.5
3	75.0



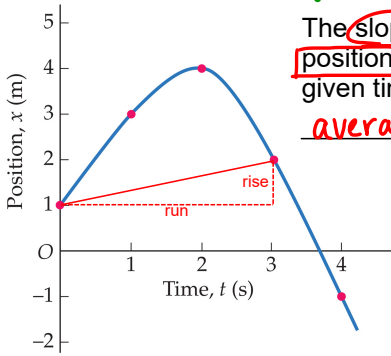
### Interpreting Graphs



### Interpreting Graphs



### Slope

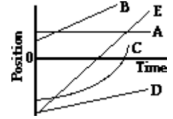


The slope of a line on a position-time graph for a given time interval is the average velocity.

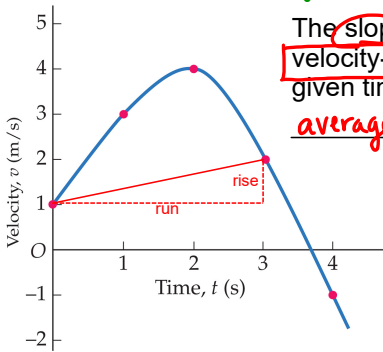
### Position vs. Time

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 at rest
- b. A straight diagonal line means constant v
- c. A curved line means acceleration
- d. A gradually sloped line means small v slow
- e. A steeply sloped line means large v fast



### Slope

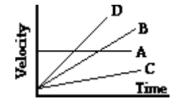


The slope of a line on a velocity-time graph for a given time interval is the average acceleration.

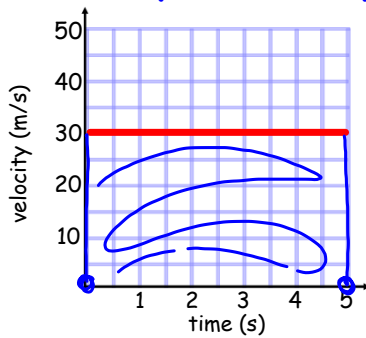
### Velocity vs. Time

The slope of the line on a velocity vs. time graph reveals information about an object's acceleration. Furthermore, the area under the line is equal to the object's displacement. Apply this understanding to answer the following questions.

- a. A horizontal line means constant v
- b. A straight diagonal line means constant a
- c. A gradually sloped line means small a
- d. A steeply sloped line means large a

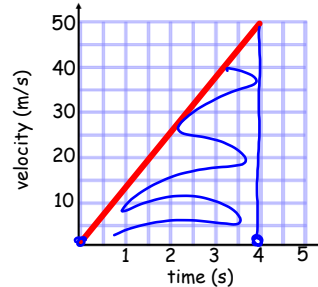


### Velocity-Time Graph



$$\Delta x = vt = 150 \text{ m}$$

### Velocity-Time Graph

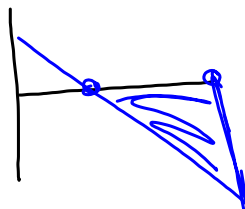
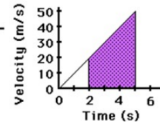
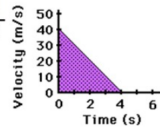
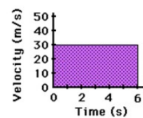
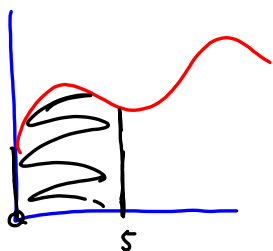


$$A = \frac{1}{2}bh = \frac{1}{2}(4\text{s})(50\text{ m/s})$$

$$\Delta x = 100 \text{ m}$$

### Velocity-Time Graph

The displacement of an object moving with constant acceleration can be found by computing the area under the v-t graph.



## PRACTICE

- Unit 3 Practice Problems (10-13)
- Worksheet