• Refer students to Figure 5 on page 362 of the Student Book. Explain how to calculate average velocity using the displacement divided by the time interval. Demonstrate how to find the instantaneous velocity at a point by drawing a tangent line. Using this graph as a reference, emphasize that velocity always has a direction and that velocity can be negative.

• Sample Problem 3—Practice Problem

Let the direction east be positive. The initial position is 0 m. We know that the final position is 100 km + 50 km = 150 km, which is the same as 150 km [E]. Substitute the values into the velocity equation.

\[
\vec{v}_{av} = \frac{\Delta \vec{r}}{\Delta t} = \frac{150 \text{ km}}{2 \text{ h} + 1 \text{ h}} = \frac{150 \text{ km}}{3 \text{ h}}
\]

\[
\vec{v}_{av} = +50 \text{ km/h}
\]

The velocity of the driver is + 50 km/h, or 50 km/h [E]. The answer is C.

3 Consolidate and Extend

• Ask students to explain why speed is always positive, but velocity can be positive or negative. They should understand that speed has no direction associated with it. It depends only on distance and time. Velocity can be positive or negative because it depends on direction.

• Have students complete WS 12.4.3 Analyzing a Position–Time Graph to give them practice in determining average velocity and instantaneous velocity from a graph.

• Have students complete the Check Your Understanding questions.

CHECK YOUR UNDERSTANDING—SUGGESTED ANSWERS

1. Sample answer: a number value of a variable
2. (a) yes; (b) no; (c) no; (d) yes
3. (a) Distance is how far an object travels along a path from a reference point. Position is the location of an object relative to a reference point. (b) Position is the location of an object relative to a reference point. Displacement is the change in position of an object.
4. Sample answer: A car is travelling at a speed of 60 km/h along a road. Its velocity is 60 km/h west. A horse runs at a speed of 30 km/h across a field. Its velocity is 30 km/h south. In both examples, the speed has just magnitude, but the velocity has magnitude and direction.
5. (a) The distance is 200 m. The displacement is 141 m [NE]. (b) The distance is 400 m. The displacement is 0 m.
6. (a) \(v_{av} = 0.023 \text{ m/s} \); (b) \(v_{av} = 0.0080 \text{ m/s} \); (c) \(c = \sqrt{a^2 + b^2} = 141 \text{ m} \)
7. (a) between about 220 s and 255 s; (b) between about 220 s and 255 s; (c) at 110 s and at about 190 s; (d) about 3.4 m/s [N]; (e) about 3.6 m/s; (f) about 5.5 m/s [S]; (g) yes; momentarily stopped and changed direction at \( t = 155 \text{ s} \); (h) 1.4 m/s [N]; (i) 0 m/s

Strategies for Success

Summarizing and Making Notes

• Students must focus on vocabulary during their reading of text. Engage students in a discussion on how they would assess their vocabulary comprehension. Possible answers include: Do I know what this word means? Do I know how to use this word in a sentence? Do I know if this word has more than one meaning?