Section 1.2: Speed and Velocity

Tutorial 1 Practice, page 15

1. Given: $\Delta d = 3.7$ m; $\Delta t = 1.8$ s

Required: v_{av}

Analysis: $v_{av} = \dfrac{\Delta d}{\Delta t}$

Solution:
$$v_{av} = \frac{\Delta d}{\Delta t} = \frac{3.7 \text{ m}}{1.8 \text{ s}}$$
$$v_{av} = 2.1 \text{ m/s}$$

Statement: The average speed of the paper airplane is 2.1 m/s.

2. Given: $v_{av} = 8.33$ m/s; $\Delta t = 3.27$ s

Required: Δd

Analysis: $v_{av} = \dfrac{\Delta d}{\Delta t}$

$$\Delta d = v_{av} \Delta t$$

Solution:
$$\Delta d = v_{av} \Delta t = \left(8.33 \frac{\text{m}}{\cancel{\text{s}}}\right)(3.27 \cancel{\text{s}})$$
$$\Delta d = 27.2 \text{ m}$$

Statement: A cheetah can run 27.2 m in 3.27 s.

3. Given: $v_{av} = 1.2$ m/s; $\Delta d = 2.8$ m

Required: Δt

Analysis: $v_{av} = \dfrac{\Delta d}{\Delta t}$

$$\Delta t = \frac{\Delta d}{v_{av}}$$

Solution:
$$\Delta t = \frac{\Delta d}{v_{av}} = \frac{2.8 \cancel{\text{m}}}{1.2 \frac{\cancel{\text{m}}}{\text{s}}}$$
$$\Delta t = 2.3 \text{ s}$$

Statement: It will take the rock 2.3 s to fall through 2.8 m of water.

Research This: Searching for Speeders, page 15

Answers may vary. Sample answers:

A. The use of laser speed devices and other methods of monitoring speed decreases the number of automobile collisions and fatalities in Canada. Police are able to go to high-risk areas and even just by their presence, remind drivers to slow down and be careful. If the locations where police often monitor speeds become known, then drivers who want to avoid tickets will obey the speed limits even when there are no police present.

B. The use of laser speed devices may be the preferred way for police to monitor speed because it is accurate, can be operated from the roadside and at a distance, and is probably much more affordable than patrolling or using aircraft to monitor speed.

C. I do not support the use of devices like these because they do nothing to prevent collisions. These devices allow speeders to go as fast as they want, then pay the tickets later when they should be stopped and warned or fined immediately.

Tutorial 2 Practice, page 18

1. Given: $\Delta\vec{d} = 2.17$ m [E]; $\Delta t = 1.36$ s

Required: $\vec{v}_{av}$

Analysis: $\vec{v}_{av} = \dfrac{\Delta\vec{d}}{\Delta t}$

Solution:
$$\vec{v}_{av} = \frac{\Delta\vec{d}}{\Delta t} = \frac{2.17 \text{ m [E]}}{1.36 \text{ s}}$$
$$\vec{v}_{av} = 1.60 \text{ m/s [E]}$$

Statement: The average velocity of the soccer ball is 1.60 m/s [E].

2. Given: $\Delta\vec{d} = 8.2$ m [N]; $\vec{v}_{av} = 3.7$ m/s [N]

Required: Δt

Analysis: $\vec{v}_{av} = \dfrac{\Delta\vec{d}}{\Delta t}$

$$\Delta t = \frac{\Delta\vec{d}}{\vec{v}_{av}}$$

Solution:
$$\Delta t = \frac{\Delta\vec{d}}{\vec{v}_{av}} = \frac{8.2 \cancel{\text{m}} \text{ [N]}}{3.7 \frac{\cancel{\text{m}}}{\text{s}} \text{ [N]}}$$
$$\Delta t = 2.2 \text{ s}$$

Statement: It will take a cat 2.2 s to run 8.2 m.

Mini Investigation: Bodies in Motion, page 20

Answers may vary. Sample answers:

A. I predicted the graphs for slow and fast constant speed would be straight lines, and that slow constant speed would be less steep than fast constant speed, which is true. I predicted the graphs for variable speed (speeding up and slowing down) would be curves, which they are.

B. It is difficult to make most letters because you cannot have two positions for the same time, so for example, you cannot go back and make the little horizontal line in an A. Also, you cannot make vertical lines, so I had to cheat a bit. The easiest letters to make were U, V, and W, and I could make graphs that looked like I, J, L, M, and N.

Section 1.2 Questions, page 20

1. Answers may vary. Sample answer:
When solving a problem, if no direction is provided with the value, then the value is a scalar (speed). If direction is provided, then the value is a vector (velocity).

2. Answers may vary. Sample answer:
Motion with uniform velocity describes an object moving in just one direction at a constant speed.

3. Answers may vary. Sample answer:
Two examples of uniform velocity are an anchor sinking in a lake at a constant speed and a runner travelling in a straight line at 3 m/s.
Two examples of non-uniform velocity are a car slowing down and a speed skater going in laps around a rink.

4. Given: $\Delta\vec{d} = 15$ m [W]; $\Delta t = 5$ s

Required: $\vec{v}_{\text{av}}$

Analysis: $\vec{v}_{\text{av}} = \dfrac{\Delta\vec{d}}{\Delta t}$

Solution:
$$\begin{aligned}\vec{v}_{\text{av}} &= \frac{\Delta\vec{d}}{\Delta t}\\ &= \frac{15\text{ m [W]}}{5\text{ s}}\\ \vec{v}_{\text{av}} &= 3\text{ m/s [W]}\end{aligned}$$

Statement: The average velocity described by the graph is 3 m/s [W].

5.

$\vec{v}_{\text{av}}$	$\Delta\vec{d}$	Δt
0.773 m/s [S]	12.6 m [S]	16.3 s
2.0×10^3 m/s [E]	25 m [E]	**0.01 s**
40 m/s [N]	**10 m [N]**	0.25 s

First Row:

Given: $\Delta\vec{d} = 12.6$ m [S]; $\Delta t = 16.3$ s

Required: $\vec{v}_{\text{av}}$

Analysis: $\vec{v}_{\text{av}} = \dfrac{\Delta\vec{d}}{\Delta t}$

Solution:
$$\begin{aligned}\vec{v}_{\text{av}} &= \frac{\Delta\vec{d}}{\Delta t}\\ &= \frac{12.6\text{ m [S]}}{16.3\text{ s}}\\ \vec{v}_{\text{av}} &= 0.773\text{ m/s [S]}\end{aligned}$$

Statement: The average velocity is 0.773 m/s [S].

Second Row:

Given: $\vec{v}_{\text{av}} = 2.0 \times 10^3$ m/s [E]; $\Delta\vec{d} = 25$ m [E]

Required: Δt

Analysis:
$$\begin{aligned}\vec{v}_{\text{av}} &= \frac{\Delta\vec{d}}{\Delta t}\\ \Delta t &= \frac{\Delta\vec{d}}{\vec{v}_{\text{av}}}\end{aligned}$$

Solution:
$$\begin{aligned}\Delta t &= \frac{\Delta\vec{d}}{\vec{v}_{\text{av}}}\\ &= \frac{25\ \cancel{\text{m}}\text{ [E]}}{2000\ \dfrac{\cancel{\text{m}}}{\text{s}}\text{ [E]}}\\ \Delta t &= 0.01\text{ s}\end{aligned}$$

Statement: The time required is 0.01 s.

Third Row:

Given: $\vec{v}_{\text{av}} = 40$ m/s [N]; $\Delta t = 0.25$ s

Required: $\Delta\vec{d}$

Analysis:
$$\begin{aligned}\vec{v}_{\text{av}} &= \frac{\Delta\vec{d}}{\Delta t}\\ \Delta\vec{d} &= \vec{v}_{\text{av}}\,\Delta t\end{aligned}$$

Solution:
$$\begin{aligned}\Delta\vec{d} &= \vec{v}_{\text{av}}\,\Delta t\\ &= \left(40\ \frac{\text{m}}{\cancel{\text{s}}}\text{ [N]}\right)\left(0.25\ \cancel{\text{s}}\right)\\ \Delta\vec{d} &= 10\text{ m [N]}\end{aligned}$$

Statement: The displacement is 10 m [N].

6. Given: $\vec{v}_{\text{av}} = 3.2$ m/s [S]; $\Delta t = 12$ s

Required: $\Delta\vec{d}$

Analysis:
$$\begin{aligned}\vec{v}_{\text{av}} &= \frac{\Delta\vec{d}}{\Delta t}\\ \Delta\vec{d} &= \vec{v}_{\text{av}}\,\Delta t\end{aligned}$$

Solution:
$$\begin{aligned}\Delta\vec{d} &= \vec{v}_{\text{av}}\,\Delta t\\ &= \left(3.2\ \frac{\text{m}}{\cancel{\text{s}}}\text{ [S]}\right)\left(12\ \cancel{\text{s}}\right)\\ \Delta\vec{d} &= 38\text{ m [S]}\end{aligned}$$

Statement: The displacement of the horse is 38 m [S].

7. Given: v_{av} = 100.0 km/h; Δd = 16 m [E]
Required: Δt

Analysis: $v_{av} = \frac{\Delta d}{\Delta t}$

$$\Delta t = \frac{\Delta d}{v_{av}}$$

Solution: Convert the units from kilometres per hour to metres per second:

$$v_{av} = \left(100.0\ \frac{\cancel{\text{km}}}{\cancel{\text{h}}}\right)\left(\frac{1\ \cancel{\text{h}}}{60\ \cancel{\text{min}}}\right)\left(\frac{1\ \cancel{\text{min}}}{60\ \text{s}}\right)\left(\frac{1000\ \text{m}}{1\ \cancel{\text{km}}}\right)$$

$$= 27.7778\ \text{m/s (two extra digits carried)}$$

$$\Delta t = \frac{\Delta d}{v_{av}}$$

$$= \frac{16\ \cancel{\text{m}}}{27.7778\ \frac{\cancel{\text{m}}}{\text{s}}}$$

$$\Delta t = 0.58\ \text{s}$$

Statement: The car will take 0.58 s to travel 16 m.

8. Given: $\Delta \vec{d}$ = 8.864 km [S]; Δt = 0.297 min
Required: $\vec{v}_{av}$

Analysis: $\vec{v}_{av} = \frac{\Delta \vec{d}}{\Delta t}$

Solution: Convert the units from kilometres to metres and from minutes to seconds:

$$\Delta \vec{d} = \left(8.864\ \cancel{\text{km}}\ [\text{S}]\right)\left(\frac{1000\ \text{m}}{1\ \cancel{\text{km}}}\right)$$

$$= 8864\ \text{m [S]}$$

$$\Delta t = \left(0.297\ \cancel{\text{min}}\right)\left(\frac{60\ \text{s}}{1\ \cancel{\text{min}}}\right)$$

$$= 17.82\ \text{s (one extra digit carried)}$$

$$\vec{v}_{av} = \frac{\Delta \vec{d}}{\Delta t}$$

$$= \frac{8864\ \text{m [S]}}{17.82\ \text{s}}$$

$$\vec{v}_{av} = 497\ \text{m/s [S]}$$

Statement: The velocity of the fighter jet is 497 m/s [S].