Chapter 2

1. An airplane travels at a constant speed, relative to the ground, of 900.0 km/h.

a. How far has the airplane traveled after 2.0 h in the air?

$d = vt$

$= (900.0 \text{ km/h})(2.0 \text{ h})$

$= 1800 \text{ km}$

b. How long does it take for the airplane to travel between City A and City B if the cities are 3240 km apart?

$t = \frac{d}{v}$

$= \frac{3240 \text{ km}}{900.0 \text{ km/h}}$

$= 3.600 \text{ h}$

c. If a second plane leaves 1 h after the first, and travels at 1200 km/h, which flight will arrive at City B first?

$t = \frac{d}{v}$

$= \frac{3240 \text{ km}}{1200 \text{ km/h}}$

$= 2.7 \text{ h}$

The second plane arrives 3.7 h after the first plane departs, so the first plane arrives before the second.

2. You and your friend start jogging around a 2.00×10^3-m running track at the same time. Your average running speed is 3.15 m/s, while your friend runs at 3.36 m/s. How long does your friend wait for you at the finish line?

$t = \frac{d}{v}$

$t_1 = \frac{2.00 \times 10^3 \text{ m}}{3.15 \text{ m/s}} = 635 \text{ s (your time)}$

$t_2 = \frac{2.00 \times 10^3 \text{ m}}{3.36 \text{ m/s}} = 595 \text{ s (friend's time)}$

Your friend's wait time is:

$635 \text{ s} - 595 \text{ s} = 4.0 \times 10^1 \text{ s}$

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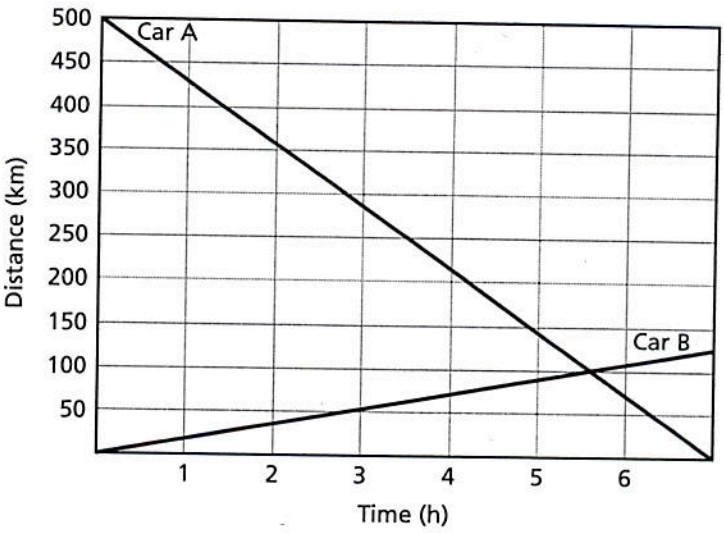
3. The graph to the right shows the distance versus time for two cars traveling on a straight highway.



a. What can you determine about the relative direction of travel of the cars?

The cars are traveling in opposite directions.

b. At what time do they pass one another?

They pass 5 h after starting.

c. Which car is traveling faster? Explain.

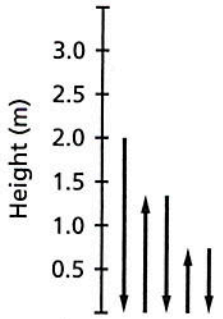
Car A is traveling faster because the slope of its line has a larger magnitude. The slope represents $\frac{\Delta d}{\Delta t}$, or speed.

d. What is the speed of the slower car?

The speed is equal to the slope of the line $\frac{\Delta d}{\Delta t}$, which is calculated from two points on the graph as 20 km/h.

4. You drop a ball from a height of 2.0 m. It falls to the floor, bounces straight upward 1.3 m, falls to the floor again, and bounces 0.7 m.

a. Use vector arrows to show the motion of the ball.



b. At the top of the second bounce, what is the total distance that the ball has traveled?

$$d = d_1 + d_2 + d_3 + d_4$$
$$= 2.0\text{ m} + 1.3\text{ m} + 1.3\text{ m} + 0.7\text{ m}$$
$$= 5.3\text{ m}$$

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c. At the top of the second bounce, what is the ball's displacement from its starting point?

$\Delta d = d_1 + (-d_2) + d_4 + (-d_4)$

$= 2.0\text{ m} - 1.3\text{ m} + 1.3\text{ m} - 0.7\text{ m}$

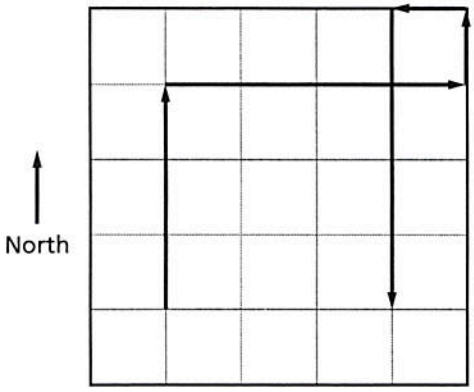
$= 1.3\text{ m downward}$

d. At the top of the second bounce, what is the ball's displacement from the floor?

0.7 m upward

5. You are making a map of some of your favorite locations in town. The streets run north–south and east–west and the blocks are exactly 200 m long. As you map the locations, you walk three blocks north, four blocks east, one block north, one block west, and four blocks south.

a. Draw a diagram to show your route.



b. What is the total distance that you traveled while making the map?

$d_{total} = d_1 + d_2 + d_3 + d_4 + d_5$

$= 3\text{ blocks} + 4\text{ blocks} +$

$1\text{ block} + 1\text{ block} + 4\text{ blocks}$

$= 13\text{ blocks}$

$13\text{ blocks} \times 200\text{ m/block} = 2600\text{ m}$

c. Use your diagram to determine your final displacement from your starting point.

$3\text{ blocks} \times 200\text{ m/block} = 600\text{ m}$

The displacement is 600 m east from the starting point.

d. What vector will you follow to return to your starting point?

600 m toward the west.

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6. An antelope can run 90.0 km/h. A cheetah can run 117 km/h for short distances. The cheetah, however, can maintain this speed only for 30.0 s before giving up the chase.

a. Can an antelope with a 150.0-m lead outrun a cheetah?

$d = vt$

$t = 30\ \text{s}$

$$v_{\text{antelope}} = (90.0\ \text{km/h})\left(\frac{1\ \text{h}}{3600\ \text{s}}\right)\left(\frac{1000\ \text{m}}{1\ \text{km}}\right)$$

$$= 25.0\ \text{m/s}$$

$$v_{\text{cheetah}} = (117\ \text{km/h})\left(\frac{1\ \text{h}}{3600\ \text{s}}\right)\left(\frac{1000\ \text{m}}{1\ \text{km}}\right)$$

$$= 32.5\ \text{m/s}$$

$$d_{\text{antelope}} = 25.0\ \text{m/s} \times 30.0\ \text{s}$$

$$= 750\ \text{m}$$

$$d_{\text{cheetah}} = 32.5\ \text{m/s} \times 30.0\ \text{s}$$

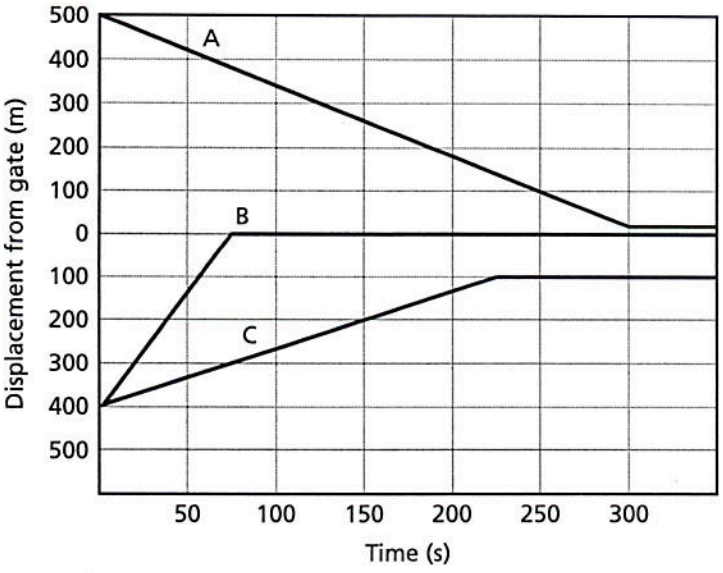
$$= 975\ \text{m}$$

The cheetah can run 225 m farther than the antelope in 30.0 s, so a 150.0-m lead is not sufficient.

b. What is the closest that the antelope can allow a cheetah to approach and remain likely to escape?

226 m

7. The position-time graph to the right represents the motion of three people in an airport moving toward the same departure gate.



a. Which person travels the farthest during the period shown?

person A

b. Which person travels fastest by riding a motorized cart? How can you tell?

person B. The magnitude of the slope is largest for line B when the person is traveling.

c. Which person starts closest to the departure gate?

Person B and person C start 400 m from the gate.

d. Which person appears to be going to the wrong gate?

person C

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8. A radio signal takes 1.28 s to travel from a transmitter on the Moon to the surface of Earth. The radio waves travel at 3.00×10^8 m/s. What is the distance, in kilometers, from the Moon to Earth?

$d = vt$

$= (3.00\times10^8 \text{ m/s}) \times 1.28 \text{ s}$

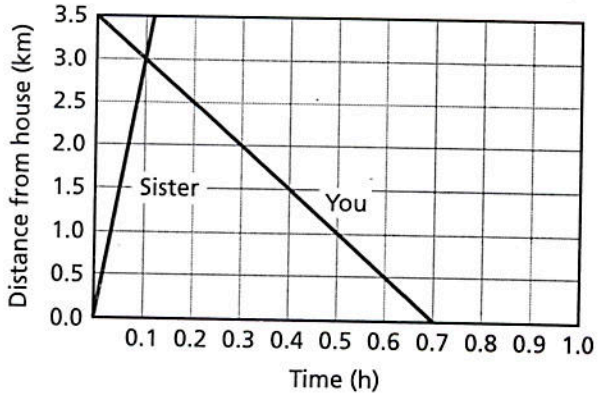
$= 3.84\times10^8 \text{ m}$

$= (3.84\times10^8 \text{ m}) \times \left(\frac{1 \text{ km}}{1000 \text{ m}}\right)$

$= 3.84\times10^5 \text{ km}$

9. You start to walk toward your house eastward at a constant speed of 5.0 km/h. At the same time, your sister leaves your house, driving westward at a constant speed of 30.0 km/h. The total distance from your starting point to the house is 3.5 km.

a. Draw a position-time graph that shows both your motion and your sister's motion.



b. From the graph, determine how long you travel before you meet your sister.

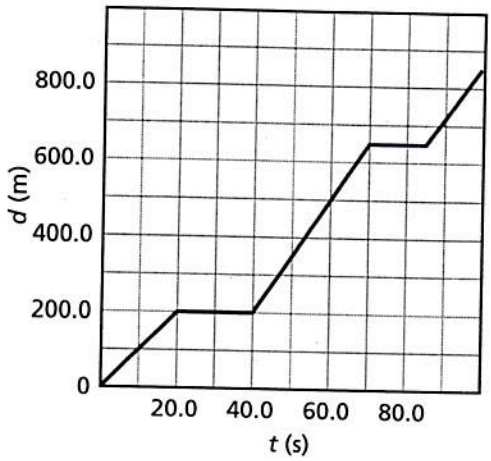
0.1 h

c. How far do you travel in that time?

0.5 km

10. A bus travels on a northbound street for 20.0 s at a constant velocity of 10.0 m/s. After stopping for 20.0 s, it travels at a constant velocity of 15.0 m/s for 30.0 s to the next stop, where it remains for 15.0 s. For the next 15.0 s, the bus continues north at 15.0 m/s.

a. Construct a *d*-*t* graph of the motion of the bus.



b. What is the total distance traveled?

$d = v_1t_1 + v_2t_2 + v_3t_3 + v_4t_4 + v_5t_5$

$= (10.0 \text{ m/s})(20.0 \text{ s}) +$
$(0.00 \text{ m/s})(20.0 \text{ s}) +$
$(15.0 \text{ m/s})(30.0 \text{ s}) +$
$(0.00 \text{ m/s})(15.0 \text{ s}) +$
$(15.0 \text{ m/s})(15.0 \text{ s})$

$= 875 \text{ m}$

c. What is the average velocity of the bus for this period?

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

$v_{ave} = \frac{875 \text{ m}}{100.0 \text{ s}}$

$= 8.75 \text{ m/s}$