at an average speed of 2092 mi/h (i.e., 935.1 m/s). How long in time was that flight? Draw a diagram.

15. [II] A driver covered 42.0 km in 6.0 h (during that time she stopped for 30.0 min for lunch). She then speeds up, traversing another 56.0 km in 4.0 h. What was her average speed for the entire journey? What was her average speed while actually drving?

16. [II] The evil Dr. X secretly leaves Space Port L4 in a warship capable of traveling at an average speed of $(v_{av})_X$. Two hours later her escape is noticed and our hero blasts off after her at a speed that will effect rendezvous in 6.4 hours. Write an expression for his speed, $(v_{av})_H$, in terms of hers, $(v_{av})_X$. Draw a diagram.

17. [II] The bad guys come roaring onto a highway at 100 km/h headed for the Mexican border 300 km away. The cops, in hot pursuit, arrive at the highway entrance one-half hour later. What must be their minimum average speed if they are to intercept the crooks this side of the border? Draw a diagram.

18. [II] Having traveled halfway to the end of a journey at an average speed of 15 km/h, how fast must you traverse the rest of the trip in order to average 20 km/h? Draw a diagram.

19. [III] A swimmer crosses a channel at an average speed of 10 km/h and returns at half that rate. What was his overall average speed for the round trip? Draw a diagram. [*Hint: Let L be the one-way distance. Write expressions for the time-out and time-back. The overall average speed is 2L divided by the total time.*]

20. [III] To test a small rocket motor it's fired up a long vertical tube. It rises to a height of 100 m in 5.0 s and then falls back to the ground at an average speed of 10.0 m/s. How long did the whole trip take, and what was the net average speed? Draw a diagram.

21. [III] A three-lap relay race is run at average speeds for each lap of 10 km/h, 12 km/h, and 14 km/h. What is the average speed for the entire race? Guess at the answer and then calculate it. Draw a diagram. Redo the problem changing 10 km/h to 1.0 km/h.

SECTION 2.2: CONSTANT SPEED

SECTION 2.4: INSTANTANEOUS SPEED

22. [I] You know how you close your eyes when you sneeze? Suppose you are driving along at a constant 96.5 km/h (i.e., 60 mi/h) and you experience a 1.00-s-long, eyes-closed, giant sneeze. How many meters does the car travel while you are out of control?

23. [I] THIS PROBLEM DEALS WITH THE GRAPHIC REPRESENTATION OF SPEED. Figure P23 depicts a speed versus time curve for a toy airplane. (a) Approximately, over which time intervals did the speed increase? (b) Approximately, over which time intervals did the speed decrease? (c) What was its average speed over the interval from 10 s to 15 s?

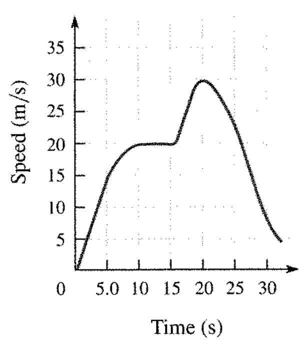

Figure P23

24. [I] THIS PROBLEM DEALS WITH THE GRAPHIC REPRESENTATION OF SPEED. Figure P23 depicts a speed versus time curve for a toy airplane (a) When did the speed reach its maximum value? (b) What's the plane's instantaneous speed at 20 s? (c) What's the plane's instantaneous speed at 0 s? (d) What's the plane's instantaneous speed at 12 s?

25. [I] Light travels in vacuum at a fixed speed of roughly 2.998×10^8 m/s, and its speed in air is only negligibly (0.03%) slower than that. (a) How long does it take light to traverse 1.0 ft? (b) That means that when you look at something 1000 m away, you are seeing it as it was ________ second (s) back in time.

26. [I] If an alien power straight out of a comic book were to cause the Sun to vanish *now*, we would still be bathed in sunshine for the next 8.3 min. We would see our star blazing in the sky as usual for all that time. Taking the speed of light to be roughly 3.0×10^8 m/s, compute the average Earth–Sun distance in meters.

SOLUTION: $v_{av} = \Delta l/\Delta t$. We need the time in seconds: (8.3 min)(60 s/min) = 498 s. $\Delta l = v_{av}\,\Delta t = (3.0 \times 10^8\ \text{m/s})(498\ \text{s}) = 1.49 \times 10^{11}\ \text{m} = 1.5 \times 10^{11}\ \text{m}$.

27. [I] Figure P27 is a plot of the speed of a cat versus time. How far did the cat travel during the third second of its journey? What were its maximum and minimum speeds? When, if ever, was its speed nonzero and constant?

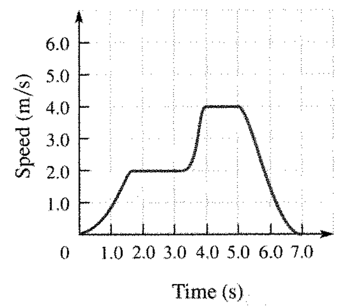

Figure P27

28. [I] The Earth rotates once around its spin axis in 23 h 56 min, and its equatorial diameter is 1.276×10^7 m (i.e., 7927 mi). At what speed would you be traveling with respect to the stationary stars while sitting still in Mbandaka, Zaire, on the Equator? Draw a diagram.

29. [I] Use Fig. 2.5 (p. 25) to calculate the distance traveled by the bee (whose speed-time graph is plotted) in the time interval from 1.33 s to 2.83 s.

30. [I] The driver of a car sets a tripmeter to zero and starts a stopwatch while en route along a highway. The following are a series of pairs of readings taken during the run: 6.0 min, 2.75 km; 30 min, 13.8 km; 45 min, 20.6 km; 1.0 h, 27.5 km; 1.00 h 15 min, 34.4 km; 1.00 h 30 min, 41.3 km. Draw a distance-time graph and describe the car's speed.

31. [I] Figure P31 shows the distance traveled versus time curve for a toy car. What was the toy car's average speed during the time interval from t = 2.0 s to 8.0 s?

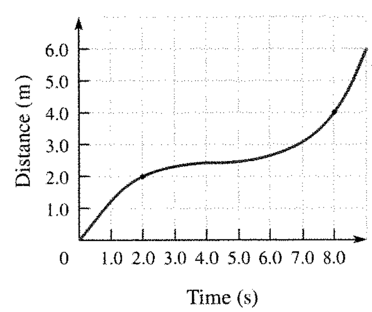

Figure P31

32. [II] Suppose you fire a rifle bullet (1600 m/s) in a shooting gallery and hear the gong on the target ring 0.731 s later. Taking the speed of sound to be 330 m/s and assuming the bullet travels straight downrange at a constant speed, how far away is the target? Draw a diagram.

33. [II] The speed of sound in air (at 0 °C) is a constant 3.3×10^2 m/s, while the speed of light (i.e., all electromagnetic radiation) is about 3.0×10^8 m/s. If you see a flash of lightning and then 5.0 s later hear its roll of thunder, how far away did the bolt strike? [*Hint:*