PROBLEMS

Section 2.2 Speed and Velocity

1. In 1985, Said Aouita set the world record for the 1500-m race in a time of 3 min, 29.46 s. What was his average speed?

2. Sound travels at a constant speed of 343 m/s in air. Approximately how much time (in seconds) does it take for the sound of thunder to travel 1609 m (one mile)?

3. A car is traveling at a constant speed of 27 m/s. The driver looks away from the road for 2.0 s to tune in a station on the radio. How far does the car go during this time?

4. A plane is sitting on a runway, awaiting takeoff. On an adjacent parallel runway, another plane lands and passes the stationary plane at a speed of 45 m/s. The arriving plane has a length of 36 m. By looking out of a window (very narrow), a passenger on the stationary plane can see the moving plane. For how long a time is the moving plane visible?

5. An 18-year-old runner can complete a 10.0-km course with an average speed of 4.38 m/s. A 50-year-old runner can cover the same distance with an average speed of 4.27 m/s. How much later should the younger runner start in order to finish the course *at the same time* as the older runner?

Section 2.3 Acceleration

11. The Concorde jetliner achieves a lift-off speed of 112 m/s in 20.0 s, starting from rest and traveling due east. What is the magnitude and direction of its average acceleration?

12. A sprinter explodes out of the starting block with an acceleration of 2.3 m/s^2, which she sustains for 2.0 s. Then, her acceleration drops to zero for the rest of the race. What is her speed at (a) $t = 2.0$ s and (b) the end of the race?

13. If a sports car can go from rest to 27 m/s in 9.0 s, what is the magnitude of its average acceleration?

14. The velocity of a train is +26.4 m/s. At an average acceleration of −1.50 m/s^2, how much time is required for the train to decrease its velocity to +9.72 m/s?

15. Starting from rest, a speedboat reaches a speed of 3.2 m/s in 2.0 s. What is the speed of the boat after an additional time of 3.0 s has elapsed, assuming the boat's acceleration remains the same?

16. A runner accelerates to a velocity of 5.36 m/s due west in 3.00 s. His average acceleration is 0.640 m/s^2, also directed due west. What was his velocity when he began accelerating?

*17. A particle is moving with an initial velocity of +112 m/s at $t = 0$. The particle has no acceleration until $t =$ 3.0 s, after which it has an acceleration of −4.0 m/s^2. What is the velocity at $t =$ 16.0 s?

Section 2.4 Equations of Kinematics for Constant Acceleration, Section 2.5 Applications of the Equations of Kinematics

19. A cheetah, the fastest of all land animals over a short distance, accelerates from rest to 26 m/s. Assuming that the acceleration is constant, find the average speed of the cheetah.

21. In getting ready to slam-dunk the ball, a basketball player starts from rest and sprints to a speed of 6.0 m/s in 1.5 s. Assuming that the player accelerates uniformly, determine the distance he runs.

22. A jetliner, traveling northward, is landing with a speed of 69 m/s. Once the jet touches down, it has 750 m of runway in which to reduce its speed to 6.1 m/s. Compute the average acceleration (magnitude and direction) of the plane during landing.

23. A skier, starting from rest, accelerates down a slope at 1.6 m/s^2. How far has she gone at the end of 5.0 s?

24. A soccer player, running at a speed of 2.6 m/s, decides to accelerate. For the next 18 m, he speeds up with an acceleration of 0.45 m/s^2. What is his speed at the end of the run?

25. A truck, traveling at a velocity of 33 m/s due east, comes to a halt by decelerating at 11 m/s^2. How far does the truck travel in the process of stopping?

26. The length of the barrel of a primitive blowgun is 1.2 m. Upon leaving the barrel, a dart has a speed of 14 m/s. Assuming that the dart is uniformly accelerated, how long does it take for the dart to travel the length of the barrel?

27. With the plane standing on the runway, the pilot brings the engines to full thrust before releasing the brakes. The aircraft accelerates at 2.9 m/s^2 and reaches a takeoff speed of 58 m/s. (a) Find the time from rest to takeoff. (b) Determine the displacement of the plane.

Section 2.6 Freely Falling Bodies

37. From the top of a cliff, a person uses a slingshot to fire a pebble straight downward with an initial speed of 9.0 m/s. After 0.50 s, how far beneath the cliff-top is the pebble?

38. The greatest height reported for a jump into an airbag is 99.4 m by stunt-man Dan Koko. In 1984 he jumped from rest from the top of the Vegas World Hotel and Casino. He struck the airbag at a speed of 39 m/s (88 mi/h). To assess the effects of air resistance, determine how fast he would have been traveling on impact had air resistance been absent.

39. A baseball is thrown upward with an initial speed of 35.0 m/s. What is its speed at $t = 2.00$ s?

40. An arrow is fired from ground level straight upward with an initial speed of 15 m/s. How long is the arrow in the air before it strikes the ground?

41. A penny is dropped from rest from the top of the Sears Tower in Chicago. Considering the height of the building is 427 m and ignoring air resistance, find the speed with which the penny strikes the ground.

42. A golf ball rebounds from the floor and travels straight upward with a speed of 5.0 m/s. To what maximum height does the ball rise?

43. Review Conceptual Example 17 before attempting this problem. Two identical pellet guns are fired simultaneously from the edge of a cliff. These guns impart an initial speed of 30.0 m/s to each pellet. Gun *A* is fired straight upward, with the pellet going up and then falling back down, eventually hitting the ground beneath the cliff. Gun *B* is fired straight downward. In the absence of air resistance, how long after pellet *B* hits the ground does pellet *A* hit the ground?

44. Suppose you are visiting a planet in a distant part of the galaxy. To determine the acceleration due to gravity on this planet, you drop a rock from a height of 55 m. The rock strikes the ground 1.9 s later. How many times greater is the acceleration due to gravity on this planet than that on earth?

45. With what initial speed must an arrow be fired straight upward to attain a height of 110 m in 5.4 s?

46. From her bedroom window a girl drops a water-filled balloon to the ground, 6.0 m below. If the balloon is released from rest, how long is it in the air?

47. Suppose a ball is thrown vertically upward. Eight seconds later it returns to its point of release. What is the initial velocity of the ball?

64. A bicycle racer is moving at a speed of 14 m/s. To pass another cyclist, the racer speeds up with an acceleration of 1.2 m/s^2. At the end of 6.0 s, how fast is the racer moving?

66. A jogger accelerates from rest to 3.0 m/s in 2.0 s. A car accelerates from 38 to 41 m/s also in 2.0 s. (a) Find the acceleration (magnitude only) of the jogger. (b) Determine the acceleration (magnitude only) of the car. (c) Does the car travel further than the jogger during the 2.0 s? If so, how much further?

67. Two runners in a 1609-m race (one mile) finish with times of 3:52.46 (3 minutes and 52.46 seconds) and 3:52.72. Assuming that both run at their average speeds during the entire time, what distance separates them at the end of the race?