PHYSICS 1, CHAPTER 1
ADDITIONAL PROBLEMS

1. A jet lands on an aircraft carrier at 63 m/s.
(a) What is its acceleration if it stops in 2.0 s?
(b) What is the displacement of the plane while it is stopping?

ANSWER: (a) -31 m/s^2 (b) 63 m

2. A person walks first at a constant speed of 5.00 m/s along a straight line from point *A* to point *B* and then back along the line from *B* to *A* at a constant speed of 3.00 m/s. What are
(a) her average speed over the entire trip and
(b) her average velocity over the entire trip?

ANSWER: (a) 3.75 m/s (b) 0

3. A 50.0-g superball traveling at 25.0 m/s bounces off a brick wall and rebounds at 22.0 m/s. A high-speed camera records this event. If the ball is in contact with the wall for 3.50 ms, what is the magnitude of the average acceleration of the ball during this time interval?

ANSWER: 1.34 $\times 10^4$ m/s^2

4. A particle moves along the *x* axis according to the equation $x = 2.00 + 3.00t - t^2$ where *x* is in meters and *t* is in seconds. At *t* = 3.00 s, find
(a) the position of the particle,
(b) its velocity, and
(c) its acceleration.

ANSWER: (a) 2.00 m (b) - 3.00 m/s (c) - 2.00 m/s^2

5. A particle moves along the *x* axis. Its position is given by the equation $x = 2.00 + 3.00t - t^2$ with *x* in meters and *t* in seconds. Determine
(a) its position at the instant it changes direction and
(b) its velocity when it returns to the position it had at *t* = 0.

ANSWER: (a) 2.56 m (b) -3.00 m/s

6. A jet plane lands with a speed of 100 m/s and can accelerate at a maximum rate of -5.00 m/s^2 as it comes to rest.
(a) From the instant the plane touches the runway, what is the minimum time it needs before it can come to rest?
(b) Can this plane land at a small tropical island airport where the runway is 0.800 km long?

ANSWER: (a) 20.0 s (b) no

7. A particle moves according to the equation $x = 10t^2$, where *x* is in meters and *t* is in seconds.
(a) Find the average velocity for the time interval from 2.00 s to 3.00 s.
(b) Find the average velocity for the time interval from 2.00 to 2.10 s.
(c) Find the instantaneous velocity at *t* = 2.00 s.

ANSWER: (a) 50.0 m/s (b) 41.0 m/s (c) 40.0 m/s

8. A particle moves along the *x* axis according to the equation $x = 2.00 + 3.00t - 1.00t^2$, where *x* is in meters and *t* is in seconds. At *t* = 3.00 s, find (a) the position of the particle, (b) its velocity, and (c) its acceleration. *ANSWER: (a) 2.00 m (b) -3.00 m/s (c) -2.00 m/s^2*

9. A truck on a straight road starts from rest, accelerating at 2.00 m/s^2 until it reaches a speed of 20.0 m/s. Then the truck travels for 20.0 s at constant speed until the brakes are applied, stopping the truck in a uniform manner in an additional 5.00 s. (a) How long is the truck in motion?
(b) What is the average velocity of the truck for the motion described?

ANSWER: (a) 10.0 s (b) 15.7 m/s

10. A speedboat moving at 30.0 m/s approaches a no-wake buoy marker 100 m ahead. The pilot slows the boat with a constant acceleration of 23.50 m/s^2 by reducingthe throttle. (a) How long does it take the boat to reach the buoy? (b) What is the velocity of the boat when it reaches the buoy?

ANSWER: (a) 4.53 s (b) 14.1 m/s

11. A student throws a set of keys vertically upward to her sister, who is in a window 4.00 m above. The keys are caught 1.50 s later by the sister.
(a) With what initial velocity were the keys thrown?
(b) What was the velocity of the keys just before they were caught?

ANSWER: (a) 10.0 m/s up (b) 4.68 m/s down

12. A ball is thrown vertically upward from the ground with an initial speed of 15.0 m/s.
(a) How long does it take the ball to reach its maximum altitude?
(b) What is its maximum altitude?
(c) Determine the velocity and acceleration of the ball at t = 2.00 s.

ANSWER: (a) 1.53 s (b) 11.5 m (c) -4.60 m/s, -9.80 m/s^2

13. A baseball is hit so that it travels straight upward after being struck by the bat. A fan observes that it takes 3.00 s for the ball to reach its maximum height. Find (a) the ball's initial velocity and (b) the height it reaches.

ANSWER: (a) 29.4 m/s (b) 44.1 m

14. The height of a helicopter above the ground is given by $h = 3.00t^3$, where h is in meters and t is in seconds. At t = 2.00 s, the helicopter releases a small mailbag. How long after its release does the mailbag reach the ground?

ANSWER: 7.96 s

15. A ball is thrown directly downward with an initial speed of 8.00 m/s from a height of 30.0 m. After what time interval does it strike the ground?

ANSWER: 1.79 s

16. A ball is thrown upward from the ground with an initial speed of 25 m/s; at the same instant, another ball is dropped from a building 15 m high. After how long will the balls be at the same height above the ground?

ANSWER: 0.6 s

17. At t = 0, a particle moving in the xy plane with constant acceleration has a velocity of $\vec{v}_i = 3.00\vec{i} - 2.00\vec{j}\ m/s$ when it is at the origin. At t = 3.00 s, the particle's velocity is $\vec{v} = 9.00\vec{i} + 7.00\vec{j}\ m/s$. Find
(a) the acceleration of the particle and
(b) its coordinates at any time t .

ANSWER: (a) $2.00\vec{i} + 3.00\vec{j}\ m/s^2$ *(b)* $(3.00t + t^2)\vec{i} + (1.50t^2 - 2.00t)\vec{j}\ m$

18. An artillery shell is fired with an initial velocity of 300 m/s at 55.0° above the horizontal. It explodes on a mountainside 42.0 s after firing. What are the x and y coordinates of the shell where it explodes, relative to its firing point?

ANSWER: x = 7.23 km; y = 1.68 km

19. A projectile is fired in such a way that its horizontal range is equal to three times its maximum height. What is the angle of projection? Give your answer to three significant figures.

ANSWER: 53.1°

20. A cannon with a muzzle speed of 1 000 m/s is used to start an avalanche on a mountain slope. The target is 2 000 m from the cannon horizontally and 800 m above the cannon. At what angle, above the horizontal, should the cannon be fired?

ANSWER: 22.4° or 89.4°

21. A placekicker must kick a football from a point 36.0 m from the goal, and hopes the ball will clear the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a speed of 20.0 m/s at an angle of 53.0° to the horizontal.
(a) By how much does the ball clear or fall short of clearing the crossbar?
(b) Does the ball approach the crossbar while still rising or while falling?

ANSWER: (a) The ball clears by 0.889 m (b) while descending

22. A tire 0.500 m in radius rotates at a constant rate of 200 rev/min. Find the speed and acceleration of a small stone lodged in the tread of the tire (on its outer edge).
(*Hint:* In one revolution, the stone travels a distance equal to the circumference of its path, $2\pi r$.)

ANSWER: 10.5 m/s; 219 m/s^2

23. A train slows down as it rounds a sharp horizontal curve, slowing from 90.0 km/h to 50.0 km/h in the 15.0 s that it takes to round the curve. The radius of the curve is 150 m. Compute the acceleration at the moment the train speed reaches 50.0 km/h. Assume that the train slows down at a uniform rate during the 15.0-s interval.

ANSWER: 1.48 m/s^2 inward at 29.9° behind the radius

24. A bomber is flying horizontally over level terrain, with a speed of 275 m/s relative to the ground, at an altitude of 3 000 m. Neglect the effects of air resistance.
(a) How far will a bomb travel horizontally between its release from the plane and its impact on the ground?
(b) If the plane maintains its original course and speed, where will it be when the bomb hits the ground?

ANSWER: (a) 6.80 km (b) 3.00 km vertically above the impact point

25. A river has a steady speed of 0.500 m/s. A student swims upstream a distance of 1.00 km and swims back to the starting point. If the student can swim at a speed of 1.20 m/s in still water, how long does the trip take? Compare this with the time the trip would take if the water were still.

ANSWER: 2.02×10^3 s; 21.0% longer

26. The pilot of an airplane notes that the compass indicates a heading due west. The airplane's speed relative to the air is 150 km/h. If there is a wind of 30.0 km/h toward the north, find the velocity of the airplane relative to the ground.

ANSWER: 153 km/h at 11.3° north of west