CHAPTER 2- USE YOUR KINEMATICS EQUATIONS. SHOW ALL WORK ON SEPARATE SHEET OF PAPER. NO WORK NO CREDIT

1. A ball is pushed with an initial velocity of 4.0 m/s. The ball rolls down a hill with a constant acceleration of 1.6 m/s^2. The ball reaches the bottom of the hill in 8.0 s. What is the ball's velocity at the bottom of the hill?
   a. 10 m/s
   b. 12 m/s
   c. 16 m/s
   d. 17 m/s

2. A cart is given an initial velocity of 5.0 m/s and experiences a constant acceleration of 2.0 m/s^2. What is the magnitude of the cart's displacement during the first 6.0 s of its motion?
   a. 10 m
   b. 55 m
   c. 66 m
   d. 80 m

3. A rock is thrown straight down with an initial velocity of 14.5 m/s from a cliff. What is the rock's displacement after 2.0 s? (Acceleration due to gravity is 9.80 m/s^2.)

   a. 28 m
   b. 49 m
   c. 55 m
   d. 64 m

4. A rock is thrown straight up with an initial velocity of 24.5 m/s.What maximum height will the rock reach before starting to fall downward? (Take acceleration due to gravity as 9.80 m/s^2.)

   a. 9.80 m
   b. 19.6 m
   c. 24.5 m
   d. 30.6 m

5. A rock is thrown straight up with an initial velocity of 19.6 m/s. What time interval elapses between the rock's being thrown and its return to the original launch point? (Acceleration due to gravity is 9.80 m/s^2.)

   a. 4.00 s
   b. 5.00 s
   c. 8.00 s
   d. 10.0 s

6. A vehicle designed to operate on a drag strip accelerates from zero to 30 m/s while undergoing a straight line path displacement of 45 m. What is the vehicle's acceleration if its value may be assumed to be constant?
   a. 2.0 m/s^2
   b. 5.0 m/s^2
   c. 10 m/s^2
   d. 15 m/s^2

7. When a drag strip vehicle reaches a velocity of 60 m/s, it begins a negative acceleration by releasing a drag chute and applying its brakes. While reducing its velocity back to zero, its acceleration along a straight line path is a constant -7.5 m/s^2. What displacement does it undergo during this deceleration period?
   a. 40 m
   b. 80 m
   c. 160 m
   d. 240 m

8. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the average velocity?
   a. 1.7 m/s
   b. 2.5 m/s
   c. 3.4 m/s
   d. zero

9. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the final velocity after 11 s?
   a. 1.8 m/s
   b. 3.2 m/s
   c. 5.1 m/s
   d. zero

10. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is its acceleration?
    a. 0.21 m/s^2
    b. 0.46 m/s^2
    c. 0.64 m/s^2
    d. 0.78 m/s^2

CHAPTER 2- USE YOUR KINEMATICS EQUATIONS. SHOW ALL WORK ON SEPARATE SHEET OF PAPER. NO WORK NO CREDIT

11. Two objects of different mass are released simultaneously from the top of a 20-m tower and fall to the ground. If air resistance is negligible, which statement best applies?
    a. The greater mass hits the ground first.
    b. Both objects hit the ground together.
    c. The smaller mass hits the ground first.
    d. No conclusion can be made with the information given.

12. A baseball catcher throws a ball vertically upward and catches it in the same spot when it returns to his mitt. At what point in the ball's path does it experience zero velocity and non-zero acceleration at the same time?
    a. midway on the way up
    b. at the top of its trajectory
    c. the instant it leaves the catcher's hand
    d. the instant before it arrives in the catcher's mitt

13. A European sports car dealer claims that his car will accelerate at a constant rate from rest to 100 km/hr in 8.00 s. If so, what is the acceleration? (*Hint:* First convert speed to m/s.)
    a. 3.47 m/s^2
    b. 6.82 m/s^2
    c. 11.4 m/s^2
    d. 17.4 m/s^2

14. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What distance will the sports car travel during the 8-s acceleration period? (*Hint:* First convert speed to m/s.)
    a. 55.5 m
    b. 77.7 m
    c. 111 m
    d. 222 m

15. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What is the speed after the first 5.00 s of acceleration? (First convert the speed to m/s.)
    a. 34.7 m/s
    b. 44.4 m/s
    c. 28.7 m/s
    d. 17.4 m/s

16. A baseball is released at rest from the top of the Washington Monument. It hits the ground after falling for 6.0 s. What was the height from which the ball was dropped? (g = 9.8 m/s^2 and assume air resistance is negligible)
    a. 1.5×10^2 m
    b. 1.8×10^2 m
    c. 1.1×10^2 m
    d. 2.1×10^2 m

17. A rock, released at rest from the top of a tower, hits the ground after 1.5 s. What is the speed of the rock as it hits the ground? (g = 9.8 m/s^2 and air resistance is negligible)
    a. 15 m/s
    b. 20 m/s
    c. 31 m/s
    d. 39 m/s

18. Omar throws a rock down with speed 12 m/s from the top of a tower. The rock hits the ground after 2.0 s. What is the height of the tower? (air resistance is negligible)
    a. 20 m
    b. 24 m
    c. 44 m
    d. 63 m

19. Gwen releases a rock at rest from the top of a 40-m tower. If g = 9.8 m/s^2 and air resistance is negligible, what is the speed of the rock as it hits the ground?
    a. 28 m/s
    b. 30 m/s
    c. 56 m/s
    d. 784 m/s

20. John throws a rock down with speed 14 m/s from the top of a 30-m tower. If g = 9.8 m/s^2 and air resistance is negligible, what is the rock's speed just as it hits the ground?
    a. 12 m/s
    b. 28 m/s
    c. 350 m/s
    d. 784 m/s

23. Jeff throws a ball straight up. For which situation is the vertical velocity zero?
    a. on the way up
    b. at the top
    c. on the way back down
    d. none of the above

24. Human reaction time is usually about 0.20 s. If your lab partner holds a ruler between your finger and thumb and releases it without warning, how far can you expect the ruler to fall before you catch it? The nearest value is:

    a. 4.0 cm
    b. 9.8 cm
    c. 16 cm
    d. 20 cm

27. An x vs. t graph is drawn for a ball moving in one direction. The graph starts at the origin and at $t = 5$ s the velocity of the ball is zero. We can be positive that at $t = 5$ s,

    a. the slope of the curve is non-zero.
    b. the ball has stopped.
    c. the acceleration is constant.
    d. the curve is at $x = 0$, $t = 0$.

28. A v vs. t graph is drawn for a ball moving in one direction. The graph starts at the origin and at $t = 5$ s the acceleration of the ball is zero. We know that at $t = 5$ s,

    a. the slope of the curve is non-zero.
    b. the velocity of the ball is not changing.
    c. the curve is not crossing the time axis.
    d. the curve is at $v = 0$, $t = 0$.

29. Mt. Everest is more than 8 000 m high. How fast would an object be moving if it could free fall to sea level after being released from the top of Mt. Everest? (Ignore air resistance).

    a. 396 m/s
    b. 120 m/s
    c. 1 200 m/s
    d. 12 000 m/s

30. Norma releases a bowling ball from rest; it rolls down a ramp with constant acceleration. After half a second it has traveled 0.75 m. How far has it traveled after two seconds?

    a. 1.2 m
    b. 4.7 m
    c. 9.0 m
    d. 12 m

31. A railroad train travels forward along a straight track at 80.0 m/s for 1 000 m and then travels at 50.0 m/s for the next 1 000 m. What is the average velocity?

    a. 65.0 m/s
    b. 61.5 m/s
    c. 63.7 m/s
    d. 70.0 m/s

32. The value of an object's acceleration may be characterized in equivalent words by which of the following?

    a. displacement
    b. rate of change of displacement
    c. velocity
    d. rate of change of velocity

33. An automobile driver puts on the brakes and decelerates from 30.0 m/s to zero in 10.0 s. What distance does the car travel?

    a. 150 m
    b. 196 m
    c. 336 m
    d. 392 m

34. The distance of the Earth from the sun is 93 000 000 miles. If there are 3.15×10^7 s in one year, find the speed of the Earth in its orbit about the sun.

    a. 9.28 miles/s
    b. 18.6 miles/s
    c. 27.9 miles/s
    d. 37.2 miles/s

35. A 50-g ball traveling at 25.0 m/s is bounced 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 average acceleration of the ball during this time interval?

    a. 13 400 m/s^2

b. 6 720 m/s^2
c. 857 m/s^2
d. 20 m/s^2

37. A basketball player can jump 1.6 m off the hardwood floor. With what upward velocity did he leave the floor?

a. 1.4 m/s
b. 2.8 m/s
c. 4.2 m/s
d. 5.6 m/s

38. A Cessna aircraft has a lift-off speed of 120 km/hr. What minimum constant acceleration does this require if the aircraft is to be airborne after a take-off run of 240 m?

a. 2.31 m/s^2
b. 3.63 m/s^2
c. 4.63 m/s^2
d. 5.55 m/s^2

39. A water rocket, launched from the ground, rises vertically with acceleration of 30 m/s^2 for 1.0 s when it runs out of "fuel." Disregarding air resistance, how high will the rocket rise?

a. 15 m
b. 31 m
c. 61 m
d. 120 m

41. An object is dropped from a height. Once it is moving, which of the following statements is true, at least at one point?

a. Its velocity is more than its acceleration.
b. Its velocity is less than its acceleration.
c. Its velocity is the same as its acceleration.
d. Its velocity is never equal to its acceleration.

42. The slope of the acceleration vs. time curve represents

a. the velocity
b. the rate of change of acceleration
c. the rate of change of displacement
d. the area under the position vs. time curve

43. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average velocity is

a. 19.6 m/s
b. 9.80 m/s
c. 4.90 m/s
d. not given

44. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average speed is

a. 19.6 m/s
b. 9.80 m/s
c. 4.90 m/s
d. not given

46. Changing the positive direction in a reference frame to the opposite direction does not change the sign of which of the following quantities:

a. velocity
b. average velocity
c. speed
d. displacement

47. In the case of constant acceleration, the average velocity equals the instantaneous velocity

a. at the beginning of the time interval
b. at the end of the time interval
c. half-way through the time interval
d. three-fourths of the way through the time interval

Additional Problems

24. The French National Railroad holds the world's speed record for passenger trains in regular service. A TGV (*tres grand vitesse,* or very great speed) train traveling at a speed of 300 km/h requires 1.20 km to come to an emergency stop. Find the braking acceleration for this train, assuming constant acceleration.

25. Jules Verne in 1865 proposed sending men to the Moon by firing a space capsule from a 220-m-long cannon with final speed of 10,970 m/s. What would have been the unrealistically large acceleration experienced by the space travelers during launch? (A human can stand an acceleration of 15*g* for a short time.) Compare your answer with the freefall acceleration, 9.80 m/s^2.

26. A truck covers 40.0 m in 8.50 s while smoothly slowing down to final speed 2.80 m/s. (a) Find its original speed. (b) Find its acceleration.

27. The minimum distance required to stop a car moving at 35.0 mi/h is 40.0 ft. What is the minimum stopping distance for the same car moving at 70.0 mi/h, assuming the same rate of acceleration?

28. A racing car reaches a speed of 40 m/s. At this instant, it begins a uniform negative acceleration, using a parachute and a braking system, and comes to rest 5.0 s later. (a) Determine the acceleration of the car. (b) How far does the car travel after the acceleration starts?

29. A Cessna aircraft has a lift-off speed of 120 km/h. (a) What minimum constant acceleration does this require if the aircraft is to be airborne after a takeoff run of 240 m? (b) How long does it take the aircraft to become airborne?

30. A truck on a straight road starts from rest and accelerates at 2.0 m/s^2 until it reaches a speed of 20 m/s. Then the truck travels for 20 s at constant speed until the brakes are applied, stopping the truck in a uniform manner in an additional 5.0 s. (a) How long is the truck in motion? (b) What is the average velocity of the truck for the motion described?

31. A drag racer starts her car from rest and accelerates at 10.0 m/s^2 for the entire distance of 400 m (¼ mile). (a) How long did it take the race car to travel this distance? (b) What is the speed of the race car at the end of the run?

32. 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 needed before it can come to rest? (b) Can this plane land on a small tropical island airport where the runway is 0.800 km long?

33. A driver in a car traveling at a speed of 60 mi/h sees a deer 100 m away on the road. Calculate the minimum constant acceleration that is necessary for the car to stop without hitting the deer (assuming that the deer does not move in the meantime).

34. A record of travel along a straight path is as follows.

1. Start from rest with constant acceleration of 2.77 m/s^2 for 15.0 s
2. Constant velocity for the next 2.05 min
3. Constant negative acceleration –9.47 m/s^2 for 4.39 s
(a) What was the total displacement for the complete trip?
(b) What were the average speeds for legs 1, 2, and 3 of the trip as well as for the complete trip?

Section 2.7 Freely Falling Objects

43. A ball is thrown vertically upward with a speed of 25.0 m/s. (a) How high does it rise? (b) How long does it take to reach its highest point? (c) How long does it take to hit the ground after it reaches its highest point? (d) What is its velocity when it returns to the level from which it started?

53. A truck tractor pulls two trailers, one behind the other, at a constant speed of 100 km/h. It takes 0.600 s for the big rig to completely pass onto a bridge 400 m long. For what duration of time is all or part of the truck-trailer combination on the bridge?

54. 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 $-3.50\ m/s^2$ by reducing the 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?

55. A bullet is fired through a board 10.0 cm thick in such a way that the bullet's line of motion is perpendicular to the face of the board. If the initial speed of the bullet is 400 m/s and it emerges from the other side of the board with a speed of 300 m/s, find (a) the acceleration of the bullet as it passes through the board and (b) the total time the bullet is in contact with the board.

1. In 1993, Ileana Salvador of Italy walked 3.0 km in under 12.0 min. Suppose that during 115 m of her walk Salvador is observed to steadily increase her speed from 4.20 m/s to 5.00 m/s. How long does this increase in speed take?

2. In a scientific test conducted in Arizona, a special cannon called HARP (High Altitude Research Project) shot a projectile straight up to an altitude of 180.0 km. If the projectile's initial speed was 3.00 km/s, how long did it take the projectile to reach its maximum height?

3. The fastest speeds traveled on land have been achieved by rocketpowered cars. The current speed record for one of these vehicles is about 1090 km/h, which is only 160 km/h less than the speed of sound in air. Suppose a car that is capable of reaching a speed of 1.09 _____ 10^3 km/h is tested on a flat, hard surface that is 25.0 km long. The car starts at rest and just reaches a speed of 1.09 _____ 10^3 km/h when it passes the 20.0 km mark.

a. If the car's acceleration is constant, how long does it take to make the 20.0 km drive?

b. How long will it take the car to decelerate if it goes from its maximum speed to rest during the remaining 5.00 km stretch?

4. In 1990, Dave Campos of the United States rode a special motorcycle called the *Easyrider* at an average speed of 518 km/h. Suppose that at some point Campos steadily decreases his speed from 100.0 percent to 60.0 percent of his average speed during an interval of 2.00 min.What is the distance traveled during that time interval?

5. A German stuntman named Martin Blume performed a stunt called "the wall of death." To perform it, Blume rode his motorcycle for seven straight hours on the wall of a large vertical cylinder. His average speed was 45.0 km/h. Suppose that in a time interval of 30.0 s Blume increases his speed steadily from 30.0 km/h to 42.0 km/h while circling inside the cylindrical wall. How far does Blume travel in that time interval?

6. An automobile that set the world record for acceleration increased speed from rest to 96 km/h in 3.07 s. How far had the car traveled by the time the final speed was achieved?

7. In a car accident involving a sports car, skid marks as long as 290.0 m were left by the car as it decelerated to a complete stop. The police report cited the speed of the car before braking as being "in excess of 100 mph" (161 km/h). Suppose that it took 10.0 seconds for the car to stop. Estimate the speed of the car before the brakes were applied. (REMINDER: Answer should read, "speed in excess of . . .")

8. Col. Joe Kittinger of the United States Air Force crossed the Atlantic Ocean in nearly 86 hours. The distance he traveled was 5.7 _____ 10^3 km. Suppose Col. Kittinger is moving with a constant acceleration during most of his flight and that his final speed is 10.0 percent greater than his initial speed. Find the initial speed based on this data.

9. The polar bear is an excellent swimmer, and it spends a large part of its time in the water. Suppose a polar bear wants to swim from an ice floe to a particular point on shore where it knows that seals gather. The bear dives into the water and begins swimming with a speed of 2.60 m/s. By the time the bear arrives at the shore, its speed has decreased to 2.20 m/s. If the polar bear's swim takes exactly 9.00 min and it has a constant deceleration, what is the distance traveled by the polar bear?

1. A device at Sandia Laboratories in Albuquerque, New Mexico, uses highly compressed air to accelerate small metal disks to supersonic speeds. Suppose the disk, which is initially at rest, undergoes a uniform acceleration for 0.910 s, at which point it reaches its top speed. If the disk travels 7.19 km in that time, what is its final speed?

2. Despite their size and awkward appearance, polar bears can run at respectable speeds for short distances. Suppose a polar bear running with an initial speed of 4.0 m/s accelerates uniformly for 18 s.What is the bear's maximum speed if the bear travels 135 m during the 18 s of acceleration? Give the answer in both meters per second and kilometers per hour?

3. A hockey puck slides 55.0 m along the length of the rink in just 1.25 s. The slight friction between the puck and the ice provides a uniform acceleration. If the puck's final speed is 43.2 m/s, what is its initial speed?

4. A child sleds down a snow-covered hill with a uniform acceleration. The slope of the hill is 38.5 m long. If the child starts at rest and reaches the bottom of the hill in 5.5 s, what is the child's final speed?

5. The longest stretch of straight railroad tracks lies across the desolate Nullarbor Plain, between the Australian cities of Adelaide and Perth. The tracks extend a distance of 478 km without a curve. Suppose a

train with an initial speed of 72 km/h travels along the entire length of straight track with a uniform acceleration. The train reaches the end of the straight track in 5 h, 39 min.What is the train's final speed?

6. A golf ball at a miniature golf course travels 4.2 m along a carpeted green.When the ball reaches the hole 3.0 s later, its speed is 1.3 m/s. Assuming the ball undergoes constant uniform acceleration, what is the ball's initial speed?

7. A speedboat uniformly increases its velocity from 25 m/s to the west to 35 m/s to the west. How long does it take the boat to travel 250 m west while undergoing this acceleration?

8. Airplane racing, like horse and auto racing, uses a "track" of a specific length. Unlike the horse or auto tracks, the racing area for airplanes is bounded on the inside by tall columns, or pylons, around which the pilots must fly, and by altitude limitations that the pilots must monitor using their instruments. Different types of races use different arrangements of pylons to make the length of the race longer or shorter. In one particular race, a pilot begins the race at a speed of 755.0 km/h and accelerates at a constant uniform rate for 63.21 s. The pilot crosses the finish line with a speed of 777.0 km/h. From this data, calculate the length of the course.

9. A hovercraft, also known as an air-cushion vehicle, glides on a cushion of air, allowing it to travel with equal ease on land or water. Suppose a hovercraft undergoes constant uniform acceleration, which causes the hovercraft to move from rest to a speed of 30.8 m/s. How long does the hovercraft accelerate if it travels a distance of 493 m?

10. A spaceship travels 1220 km with a constant uniform acceleration. How much time is required for the acceleration if the spaceship increases its speed from 11.1 km/s to 11.7 km/s?

1. The John Hancock Center in Chicago is the tallest building in the United States in which there are residential apartments. The Hancock Center is 343 m tall. Suppose a resident accidentally causes a chunk of ice to fall from the roof.What would be the velocity of the ice as it hits the ground? Neglect air resistance.

2. Brian Berg of Iowa built a house of cards 4.88 m tall. Suppose Berg throws a ball from ground level with a velocity of 9.98 m/s straight up. What is the velocity of the ball as it first passes the top of the card house?

3. The Sears Tower in Chicago is 443 m tall. Suppose a book is dropped from the top of the building.What would be the book's velocity at a point 221 m above the ground? Neglect air resistance.

4. The tallest roller coaster in the world is the Desperado in Nevada. It has a lift height of 64 m. If an archer shoots an arrow straight up in the air and the arrow passes the top of the roller coaster 3.0 s after the arrow is shot, what is the initial speed of the arrow?

5. The tallest *Sequoia sempervirens* tree in California's Redwood National Park is 111 m tall. Suppose an object is thrown downward from the top of that tree with a certain initial velocity. If the object reaches the ground in 3.80 s, what is the object's initial velocity?

6. The Westin Stamford Hotel in Detroit is 228 m tall. If a worker on the roof drops a sandwich, how long does it take the sandwich to hit the ground, assuming there is no air resistance? How would air resistance affect

the answer?

7. A man named Bungkas climbed a palm tree in 1970 and built himself a nest there. In 1994 he was still up there, and he had not left the tree for 24 years. Suppose Bungkas asks a villager for a newspaper, which is thrown to him straight up with an initial speed of 12.0 m/s.When Bungkas catches the newspaper from his nest, the newspaper's velocity is 3.0 m/s, directed upward. From this information, find the height at which the nest was built. Assume that the newspaper is thrown from a height of 1.50 m above the ground.

8. Rob Colley set a record in "pole-sitting"when he spent 42 days in a barrel at the top of a flagpole with a height of 43 m. Suppose a friend wanting to deliver an ice-cream sandwich to Colley throws the ice cream straight up with just enough speed to reach the barrel. How long does it take the ice-cream sandwich to reach the barrel?

9. A common flea is recorded to have jumped as high as 21 cm. Assuming that the jump is entirely in the vertical direction and that air resistance is insignificant, calculate the time it takes the flea to reach a height of 7.0 cm.

1. Suppose a safety net at one of the floors of the International Financial Center catches the wrench in Problem 2F. The wrench falls into the net with a velocity of 49.5 m/s downward. How far above the ground is the safety net located?

2. A gumdrop is released from rest at the top of the Empire State Building, which is 381 m tall. Disregarding air resistance, calculate the displacement of the gumdrop after 1.00, 2.00, and 3.00 s.

3. A small sandbag is dropped from rest from a hovering hot-air balloon. After 2.0 s, how far below the balloon is the sand bag?

4. A physics student throws a softball straight up into the air with a speed of 17.5 m/s. The ball is in the air for a total of 3.60 s before it is caught at its original position. How high does the ball rise?

5. A surface probe lands on a highland region of the planet Mercury. A few hours later the ground beneath the probe gives way and the probe falls, landing below its original position with a velocity of 11.2 m/s downward. If the free-fall acceleration near Mercury's surface is 3.70 m/s^2 downward, what is the probe's displacement?

6. A ball thrown vertically is caught by the thrower after 5.1 s. Find the maximum height the ball reaches.

7. Find the initial velocity with which the ball in problem 6 is thrown.

8. An archer fires an arrow directly upward, then quickly runs from the launching spot to avoid being struck by the returning arrow. If the arrow's initial velocity is 85.1 m/s upward how long does the archer have to run away before the arrow lands?

9. A popular scene in recent action films shows a character in free-fall speed up to catch a freely falling parachute. Suppose a packed parachute is dropped from rest from an airplane and that a daredevil is launched straight down from the plane 3.00 s later. Neglecting air resistance, the daredevil catches up to the parachute 4.00 s after the daredevil leaves the plane.What are the daredevil's initial and final velocities?

10. The elevators in the Landmark Tower in Yokohama, Japan, are among the fastest in the world. They accelerate upward at 3.125 m/s^2 for 4.00 s to reach their maximum speed. Suppose an empty elevator is moving

upward with its maximum speed when the cable breaks, so that the elevator slows down, comes to a stop, and then begins to fall freely.What will the elevator's velocity be 0.00 s, 1.00 s, 2.00 s, and 3.00 s after the cable breaks?

1. The flight speed of a small bottle rocket can vary greatly, depending on how well its powder burns. Suppose a rocket is launched from rest so that it travels 12.4 m upward in 2.0 s.What is the rocket's net acceleration?
2. The shark can accelerate to a speed of 32.0 km/h in a few seconds. Assume that it takes a shark 1.5 s to accelerate uniformly from 2.8 km/h to 32.0 km/h.What is the magnitude of the shark's acceleration?
3. In order for the Wright brothers' 1903 flyer to reach launch speed, it had to be accelerated uniformly along a track that was 18.3 m long. A system of pulleys and falling weights provided the acceleration. If the flyer was initially at rest and it took 2.74 s for the flyer to travel the length of the track, what was the magnitude of its acceleration?

4. A certain roller coaster increases the speed of its cars as it raises them to the top of the incline. Suppose the cars move at 2.3 m/s at the base of the incline and are moving at 46.7 m/s at the top of the incline.What is the magnitude of the net acceleration if it is uniform acceleration and takes place in 7.0 s?
5. A ship with an initial speed of 6.23 m/s approaches a dock that is 255 m away. If the ship accelerates uniformly and comes to rest in 82 s, what is its acceleration?
6. Although tigers are not the fastest of predators, they can still reach and briefly maintain a speed of 55 km/h. Assume that a tiger takes 4.1 s to reach this speed from an initial speed of 11 km/h.What is the magnitude of the tiger's acceleration, assuming it accelerates uniformly?
7. Assume that a catcher in a professional baseball game catches a ball that has been pitched with an initial velocity of 42.0 m/s to the southeast. If the catcher uniformly brings the ball to rest in 0.0090 s through a distance of 0.020 m to the southeast, what is the ball's acceleration?
8. A crate is carried by a conveyor belt to a loading dock. The belt speed uniformly increases slightly, so that for 28.0 s the crate accelerates by 0.035 m/s2. If the crate's initial speed is 0.76 m/s, what is its final speed?
9. A plane starting at rest at the south end of a runway undergoes a uniform acceleration of 1.60 m/s2 to the north. At takeoff, the plane's velocity is 72.0 m/s to the north.
a.What is the time required for takeoff?
b. How far does the plane travel along the runway?
10. A cross-country skier with an initial forward velocity of ___+4.42 m/s accelerates uniformly at ↕0.75 m/s2.
a. How long does it take the skier to come to a stop?
b.What is the skier's displacement in this time interval?
1. A dumptruck filled with sand moves 1.8 km/h when it begins to accelerate uniformly at a constant rate. After traveling 4.0 _____ 102 m, the truck's speed is 24.0 km/h.What is the magnitude of the truck's acceleration?
2. One of the most consistent long-jumpers is Jackie Joyner-Kersee of the United States. Her best distance in this field and track event is 7.49 m. To achieve this distance, her speed at the point where she started the jump was at least 8.57 m/s. Suppose the runway for the long jump was 19.53 m, and that Joyner-Kersee's initial speed was 0 m/s.What was

the magnitude of her acceleration if it was uniform acceleration?

3. Although ungraceful on land, walruses are fine swimmers. They normally swim at 7 km/h, and for short periods of time are capable of reaching speeds of nearly 35 km/h. Suppose a walrus accelerates from 7.0 km/h to 34.5 km/h over a distance of 95 m.What would be the magnitude of the walrus's uniform acceleration?

4. Floyd Beattie set an unofficial speed record for a unicycle in 1986. He rode the unicycle through a 2.00 _____ 10^2 m speed trap, along which his speed was measured as being between 9.78 m/s and 10.22 m/s. Suppose that Beattie had accelerated at a constant rate along the speed trap, so that his initial speed was 9.78 m/s and his final speed was 10.22 m/s. What would the magnitude of his acceleration have been?

5. A fighter jet lands on an aircraft carrier's flight deck. Although the deck is 300 m long, most of the jet's acceleration occurs within a distance of 42.0 m. If the jet's velocity is reduced uniformly from ___+153.0 km/h to 0 km/h as it moves through 42.0 m, what is the jet's acceleration?

6. Most hummingbirds can fly with speeds of nearly 50.0 km/h. Suppose a hummingbird flying with a velocity of 50.0 km/h in the forward direction accelerates uniformly at 9.20 m/s^2 in the backward direction until it comes to a hovering stop.What is the hummingbird's displacement?

7. A thoroughbred racehorse accelerates uniformly at 7.56 m/s^2, reaching its final speed after running 19.0 m. If the horse starts at rest, what is its final speed?

8. A soccer ball moving with an initial speed of 1.8 m/s is kicked with a uniform acceleration of 6.1 m/s^2, so that the ball's new speed is 9.4 m/s. How far has the soccer ball moved?

9. A dog runs with an initial velocity of 1.50 m/s to the right on a waxed floor. It slides to a final velocity of 0.30 m/s to the right with a uniform acceleration of 0.35 m/s^2 to the left.What is the dog's displacement?

10. A hippopotamus can run up to 30 km/h, or 8.33 m/s. Suppose a hippopotamus uniformly accelerates 0.678 m/s^2 until it reaches a top speed of 8.33 m/s. If the hippopotamus has run 46.3 m, what is its initial speed?

1. A ball is thrown straight up at 39.4 m/s from the ground. How long does it take to reach 10 meters and how fast will it be moving?

2. A ball is thrown straight up with an initial speed of 45 m/s. How high does the ball go and how long does it take to get there?

3. A ball is thrown vertically upward from the top of a building 40 m high, with an initial velocity of 25 m/s. Find the total time the ball stays in the air Find the maximum height the ball reaches. Find the velocity of the ball when it hits the ground.

4. A baseball player begins to slide with an initial speed of 8 m/s and comes to a stop 5 meters later. How long did it take him/her to come to a stop and what was his/her acceleration?]

5. A car starts from rest and accelerates at a constant rate of 3 m/s^2 until it is moving at 18 m/s. The car then decreases its acceleration to .5 m/s^2 and continues moving for an additional distance of 250 m. Find the total time taken.

6. A car traveling at 27 m/s (60mph) can stop in 30 m during an emergency. How long does it take for the car to stop and what would be its acceleration?

7. A flower pot gets dropped out of a window which is 20 meters above the ground. How long does it take to hit the ground and how fast will it be moving?

8. A kid on a skateboard rolling down a hill speeds up from 5 m/s to 10 m/s in 2 seconds. What is the kid's acceleration and how far does he travel?

9. Romeo throws a rose straight up toward Juliet with an initial speed of 19.6 m/s, at the same time Juliet who is angry with Romeo drops a flower pot from a height of 15m. When and where do the flower pot and rose meet?

Constant Velocity

10. A point object travels in one dimension with constant velocity. Its initial position is at the origin, its final displacement is 33 m, and it travels for a total of 5.5 s. What is the object's velocity?
11. A point object travels in one dimension with constant velocity. Its initial position is at the origin, its velocity is 12 m/s, and it travels for a total of 5.5 s. What is the object's final displacement?
12. A point object travels in one dimension with constant velocity of 22 m/s. Its final displacement is 33 m, and it travels for a total of 5.5 s. What was the object's initial displacement?
13. A point object travels in one dimension with a constant velocity of 22 m/s. Its initial displacement at time t = 0 is at the origin, and its final displacement is 45 m. At what time does the object reach its final displacement at 45 m?
14. A point object travels in one dimension with constant velocity. Its initial displacement 100 m, and its final displacement is at the origin. The object travels for a total of 3.6 s. What is the velocity of the object?
15. A point object travels in one dimension with a constant velocity of -32 m/s. Its initial displacement 10 m, and it travels for a total of 2.4 s. What is the final displacement of the object?

Constant Acceleration

16. A point object moves along the x-axis with constant acceleration. Its initial velocity at time t = 0 is -20 m/s, and its final velocity at time t = 10 s is 32 m/s. What is the object's acceleration during the 10 s time interval?
17. An initially stationary point object moves along the x-axis for 8 s with constant acceleration of 1.5 m/s^2. What is the object's final velocity at the end of the 8 s time interval?
18. A point object moves along the x-axis for 10 s with a constant acceleration of -1.5 m/s^2. Its initial displacement at time t = 0 is 5 m, and its initial velocity is 5 m/s. What is the object's final displacement?

19. A point object moves along the x-axis with a constant acceleration of -1.5 m/s^2. Its initial displacement at time t = 0 is 5 m, and its final displacement is -35 m. Its initial velocity is 5 m/s. What is the final time at which the object reaches its final displacement?
20. A point object moves along the x-axis with a constant acceleration of -1.5 m/s^2. Its initial displacement at time t = 0 is 25 m, and its final displacement at time t = 4 s is -50 m. What was the object's initial velocity ?
21. A point object moves along the x-axis with constant acceleration. Its initial displacement at time t = 0 is -15 m, its final displacement at time t = 12 s is 50 m, and its initial velocity is -15 m/s. What is the object's acceleration?

1. A golf ball rolls *up* a hill toward a miniature-golf hole. If the ball starts with a speed of 2.0 m/s and slows at a constant rate of 0.50 m/s^2:

a) What is its **velocity** after 2.0 sec?

b) If the constant acceleration continues for 6.0 sec, what will its **velocity** be then?

2. A bus, traveling at 30 km/h, speeds up at a constant rate of 3.5 m/s^2.

a) What **velocity** does it reach 6.8 sec later?

b) What **displacement** does it undergo in that time interval?

3. A bike rider accelerates uniformly to a velocity of 7.5 m/s during 4.5 sec. The bike's displacement during the acceleration was 19 m. What was the **initial velocity** of the bike?

4. A tennis ball is thrown straight up with an initial speed of 22.5 m/s. It is caught at the same height above the ground.

a) **How high** does the ball rise with respect to its release point?

b) **How long** does the ball remain in the air?

5. A spaceship far from any star or planet accelerates uniformly from 65.0 m/s to 162.0 m/s in 10.0 sec.

a) **How far** does it move?

b) Convert both of these speeds into miles per hour (**remember**: 1 mile per hour = 0.447 m/s)

6. Police find skid marks 60 m long on a highway showing where a car made an emergency stop.

a) Assuming the acceleration was about – 10 m/s^2 (about the maximum for dry pavement), **how fast** was the car going?

b) Was the car exceeding the 80 km/h speed limit?

7. A platform diver jumps vertically with a velocity of 4.2 m/s. The diver enters the water below 2.5 sec later. **<u>How high</u>** is the platform above the water?

8. During a baseball game, a batter hits a high infield pop-up. Assume the infielder catches the ball at exactly the same height where the batter hit the ball. If the ball remains in the air for 6.0 sec:

a) **<u>How high</u>** does it rise?

b) What is the ball's **<u>velocity</u>** (v_y) as the fielder catches it?

9. Highway safety engineers build soft barriers so that cars hitting them will slow down at a safe rate. A person wearing a seat belt can withstand an acceleration of – 300 m/s^2 (≈ 31 g's !!). **<u>How thick</u>** should barriers be to safely stop a car that hits a barrier at 110 km/h (≈ 68 miles/hr)?

Multiple Interval Problems:

10. The driver of a car going 90.0 km/h suddenly sees the lights of a barrier 40.0 m ahead. It takes the driver 0.75 sec to apply the brakes, and the average acceleration during braking is – 10.0 m/s^2.

a) Determine whether the car hits the barrier.

b) What is the **maximum speed** at which the car could be moving and not hit the barrier 40.0 m ahead. Assume the same acceleration.

11. Rocket-powered sleds are used to test the responses of humans to acceleration. Starting from rest, one sled can reach a speed of 444 m/s in 1.80 sec, and can be brought to a stop again in 2.15 sec.

a) Calculate the **acceleration** and **displacement** of the sled when starting.

b) **How many g's** (how many times the acceleration due to gravity) is this when starting?

c) Calculate the **acceleration** and **displacement** of the sled when braking.

d) **How many g's** (how many times the acceleration due to gravity) is this when braking?

12. An unmarked police car, traveling at a constant speed of 90 km/h, is passed by a person with leadfoot disorder, traveling at 140 km/h. Precisely 1.00 sec after the speeder passes, the policeman steps on the accelerator. If the police car's acceleration is 2.00 m/s^2, **how much time** elapses from when the police car was passed until it overtakes the speeder (assuming the speeder is moving at constant speed)?

13. An express train, traveling at 36.0 m/s, is accidentally sidetracked onto a local train track. The express engineer spots a local train exactly 100 m ahead on the same track and traveling in the same direction. The local engineer is unaware of the situation.

The express engineer jams on the brakes and slows the express train at a constant rate of 3.00 m/s^2. If the speed of the local train is 11.0 m/s, will the express train be able to stop in time to avoid a collision?

(HINT 1: Take the position of the express train when it first sights the local train as your origin. HINT 2: keeping in mind that the local train has exactly a 100 m lead, calculate how far each train is from the origin at the end of the 12.0 sec it would take the express train to stop.)

14. As a traffic light turns green, a waiting car starts moving with a constant acceleration of 6.0 m/s2. At the instant the car begins to accelerate, a truck with a constant velocity of 21 m/s passes in the next lane.

a) **How far** will the car travel before it overtakes the truck?

b) **How fast** will the car be traveling when it overtakes the truck?

15. Superman™ is flying in Metropolis when he sees the elevator of the Daily Planet building start to fall (the cable had snapped). His x-ray vision tells him that Lois Lane is inside. If Superman is 1 km away from the tower, and the elevator falls from a height of 240 m:

a) **<u>How long</u>** does Superman have to save Lois?

b) What must his **<u>average velocity</u>** be in miles per hour? [HINT: 1 m/s = 2.24 miles per hour]

16. **<u>Vector Review</u>.** Calculate the following and report your answer in both **<u>rectangular</u>** and **<u>polar</u>** forms.

$-\mathbf{A} + 2\mathbf{B} - 3\mathbf{C}$ if: $\mathbf{A} = (-2.0\,\mathbf{i} + 3.5\,\mathbf{j})$, $\mathbf{B} = (4\,\mathbf{i} - 10\,\mathbf{j})$, and $\mathbf{C} = (-5\,\mathbf{i} - 13\,\mathbf{j})$.

ADDITIONAL

1. The movie ***<u>The Gods Must Be Crazy</u>*** begins with a pilot dropping a bottle out of an airplane. It is recovered by a surprise native below, who thinks it is a message from the gods. If the plane from which the bottle was dropped was flying at an altitude of 500 m, and the bottle lands 400 m horizontally from the initial dropping point, how fast was the plane flying when the bottle was released?

2. A cherry pit is dropped out the car window 1.0 m above the ground while traveling down the road at 18 m/s.

a) How far, horizontally, from the initial dropping point will the pit hit the ground?

b) Draw a sketch of the situation.

c) If the car continues to travel at the same velocity, where will the car be in relation to the pit when it lands.

3. Jimmy Hoppa the frog is hopping from lily pad to lily pad in search of a good fly for lunch. If the lily pads are spaced 2.4 m apart, and Jimmy jumps with a velocity of 5.0 m/s, taking 0.60 sec to go from lily pad to lily pad, at what angle must Jimmy make each of his jumps?

4. A world record motorcycle jump occurred on 31 August 1986 when Chris Bromham took off on his Yamaha and jumped a horizontal distance of 74.0 m across a row of cars. Assuming that he started and landed at the same level and was airborne for only
1.3 sec, what height from his starting point did this daredevil achieve?

5. Emanuel Zacchini, the famous human cannonball of the ***Ringling Bros. And Barnum and Bailey Circus***, was fired out of a cannon with a speed of 24.0 m/s at an angle of 40˚ to the horizontal. If he landed in a net 56.6 m away at the same height from which he was fired, how long was Zacchini in the air?

6. In a physics lab (sound familiar?), a physics student rolls a 10-g marble down a ramp and off the table with a horizontal velocity of
1.2 m/s. The marble falls in a cup placed 0.51 m from the table's edge. How high is the table?

7. Bert and Ernie™ are standing on a ladder picking apples in Mr. Hooper's™ orchard. As they pull each apple off the tree, they toss it into a basket that sits on the ground 3.0 m below at a horizontal distance 2.0 m from them. How fast must Bert and Ernie throw the apples (horizontally) in order for them to land in the basket?

8. At her wedding, Jennifer lines up all the single females in a straight line away from her in preparation for the tossing of the bridal bouquet. She stands Kelly at 1.0 m, Kendra at 1.5 m, Mary at 2.0 m, Kristen at 2.5 m, and Lauren at 3.0 m. Jennifer turns around and tosses the bouquet behind her with a speed of 3.9 m/s at an angle of 50.0˚ to the horizontal, and it is caught at the same height 0.60 s later.

a) Who catches the bridal bouquet? Prove this mathematically.
b) Who might have caught it if she had thrown it more slowly?

9. Jack be nimble, Jack be quick, Jack jumped over the candlestick with a velocity of 5.0 m/s at an angle of 30.0˚ to the horizontal. Did Jack burn his feet on the 0.25-m high candle?

10. At a meeting of physics teachers in Montana, the teachers were asked to calculate where a sack of flour would land if dropped from a moving airplane. The plane would be moving horizontally at a constant speed of 60.0 m/s at an altitude of 300 m.

a) If one of the physics teachers neglected drag while making his calculation, how far horizontally from the dropping point would he predict the landing?

b) Draw a sketch that shows the path the flour sack would take as it falls to the ground (from the perspective of an observer on the ground and off to the side.)

Relative Velocity.

1. Agent Man, flying at a constant 185 km/hr horizontally in a low flying helicopter, wants to drop a small radio transmitter (bug) onto a master criminal's automobile traveling 145 km/hr on a level highway 88.0 m below. **At what angle** should the car be in his sights when the bug is released?

4. A pronghorn antelope has been observed to run with a top speed of 97 km/h. Suppose an antelope runs 1.5 km with an average speed of 85 km/h, and then runs 0.80 km with an average speed of 67 km/h.

a. How long will it take the antelope to run the entire 2.3 km?

b. What is the antelope's average speed during this time?

6. The peregrine falcon is the fastest of flying birds (and, as a matter of fact, is the fastest living creature). A falcon can fly 1.73 km downward in 25 s.

What is the average velocity of a peregrine falcon?

7.

CONCEPTUAL CHECKPOINT 2–1

You drive 4.00 mi at 30.0 mi/h and then another 4.00 mi at 50.0 mi/h. Is your average speed for the 8.00-mi trip **(a)** greater than 40.0 mi/h, **(b)** equal to 40.0 mi/h, or **(c)** less than 40.0 mi/h?

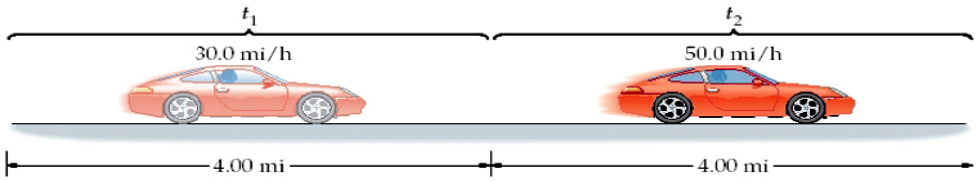
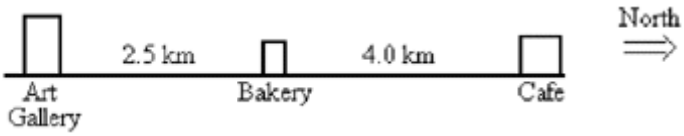


Figure 2-1



1) Refer to Figure 2-1. If you start from the Bakery, travel to the Cafe, and then to the Art Gallery, what is the distance you have traveled?
A) 6.5 km
B) 2.5 km
C) 10.5 km
D) 0 km

2) Refer to Figure 2-1. If you start from the Bakery, travel to the Cafe, and then to the Art Gallery, what is the magnitude (Size, no direction) of your displacement?
A) 6.5 km
B) 2.5 km
C) 10.5 km
D) 9.0 km

3) Refer to Figure 2-1. If you start from the Bakery, travel to the Cafe, and then to the Art Gallery, what is your displacement?
A) 6.5 km South
B) 2.5 km South
C) 10.5 km North
D) 9.0 km North

4) Refer to Figure 2-1. If you start from the Bakery, travel to the Art Gallery, and then to the Cafe, in 1.0 hour, what is your average speed?
A) 6.5 km/hr

B) 2.5 km/hr
C) 9.0 km/hr
D) 10.5 km/hr

5) A runner runs around a track consisting of two parallel lines 96 m long connected at the ends by two semicircles with a radius of 49 m. He completes one lap in 2.0 minutes. What is his average speed?
A) 1.6 m/s
B) 4.2 m/s
C) 2.9 m/s
D) 0 m/s

6) A runner runs around a track consisting of two parallel lines 96 m long connected at the ends by two semicircles with a radius of 49 m. She completes one lap in 100 seconds. What is her average velocity?
A) 2.5 m/s
B) 5.0 m/s
C) 10 m/s
D) 0 m/s

2. (a) Sand dunes in a desert move over time as sand is swept up the windward side to settle in the lee side. Such "walking" dunes have been known to walk 20 feet in a year and can travel as much as 100 feet per year in particularly windy times. Calculate the average speed in each case in m/s. (b) Fingernails grow at the rate of drifting continents, about 10 mm/yr. Approximately how long did it take for North America to separate from Europe, a distance of about 3 000 mi?

4. (a) A bristlecone pine tree has been known to take 4 000 years to grow to a height of 20 ft. Find the average speed of growth in m/s. (b) In contrast, the fastest growing plant is the giant kelp, which can grow at a rate of 2 feet in one day. Find the average speed of growth of this plant in m/s.

8. Two cars travel in the same direction along a straight highway, one at a constant speed of 55 mi/h and the other at 70 mi/h. (a) Assuming that they start at the same point, how much sooner does the faster car arrive at a destination 10 mi away? (b) How far must the faster car travel before it has a 15-min lead on the slower car?

Academic Physics **1 Dimensional Kinematics Supplemental Problems**
Mr. Alaimo

SHOW ALL WORK when answering these problems. Use **PPSP**!
Answer all problems on separate loose leaf or graphing paper. Don't forget... **QUIZ: ITNF!!**

Single Interval Problems:

1. A golf ball rolls *up* a hill toward a miniature-golf hole. The ball starts with a speed of 2.0 m/s and slows down at a constant rate of 0.50 m/s^2. (If it slows down, its acceleration should be what kind of number?)

a) What is its **velocity** after 2.0 sec?
b) If the constant acceleration continues for 6.0 sec, what will its **velocity** be then?

2. A bus, traveling at 30 km/hr, speeds up at a constant rate of 3.5 m/s^2.

a) What **velocity** does it reach 6.8 sec later?
b) What **displacement** does it undergo in that time interval?

3. A bike rider accelerates uniformly from some unknown initial velocity up to a velocity of 7.5 m/s in 4.5 sec. The bike's displacement during the acceleration interval was 19 m. What was the **initial velocity** of the bike?

4. A spaceship far from any star or planet accelerates uniformly from 65.0 m/s to 162.0 m/s in 10.0 sec.

a) **How far** does it move?
b) Convert both of these speeds into miles per hour (**remember**: 1 mile per hour = 0.447 m/s).

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a) Assuming the acceleration was about – 10 m/s^2 (about the maximum for dry pavement), **how fast** was the car going?
b) Was the car exceeding the 80 km/hr speed limit? Explain briefly.

6. Highway safety engineers build soft barriers so that cars hitting them will slow down at a safe rate. A person wearing a seat belt can withstand an acceleration of – 300 m/s^2. **How thick** should barriers be to safely stop a car that hits a barrier at 110 km/hr
(≈ 68 miles/hr)? (**HINT:** If we're looking for thickness here, what variable should we try to solve for?)

Multiple Interval Problems:

7. The driver of a car going 90.0 km/hr suddenly sees the lights of a barrier 40.0 m ahead. It takes the driver 0.75 sec to apply the brakes, and the average acceleration during braking is – 10.0 m/s^2.

a) Determine whether the car hits the barrier.
b) What is the **maximum speed** at which the car could be moving and not hit the barrier 40.0 m ahead. Assume the same acceleration.

8. An unmarked police car, traveling at a constant speed of 90 km/hr, is passed by a West HS senior with ***leadfoot disorder***, traveling at 140 km/hr. Precisely 1.00 sec after the speeding senior passes, the policeman steps on the accelerator. If the police car's acceleration is 2.00 m/s^2, **how much time** elapses from when the police car was passed until it overtakes the speeding senior (assuming the speeder is moving at constant speed)?

9. An express train, traveling at 36.0 m/s, is accidentally sidetracked onto a local train track. The express engineer spots a local train exactly 100 m ahead on the same track and traveling in the same direction. The local engineer is unaware of the situation.

The express engineer jams on the brakes and slows the express train at a constant rate of 3.00 m/s^2. If the speed of the local train is 11.0 m/s, will the express train be able to stop in time to avoid a collision?

(**<u>HINT 1</u>:** Take the position of the express train when it first sights the local train as your origin. **<u>HINT 2</u>:** keeping in mind that the local train has exactly a 100 m lead, calculate how far each train is from the origin at the end of the 12.0 sec it would take the express train to stop.)

10. As a traffic light turns green, a waiting car starts moving with a constant acceleration of 6.0 m/s^2. At the instant the car begins to accelerate, a truck with a constant velocity of 21 m/s passes in the next lane.

a) **<u>How far</u>** will the car travel before it overtakes the truck?

b) **<u>How fast</u>** will the car be traveling when it overtakes the truck?

1. An airplane travels 1400 ft at a constant acceleration while taking off. If it starts from rest, and takes off in 25 seconds, what is its takeoff velocity?
2. The same airplane lands later with a touchdown velocity of 400 m/s and comes to rest in 1.3 kilometers.
    a. What is the airplane's average deceleration?
    b. How long does it take for the plane to stop?
3. How long does it take for a stone to fall from a bridge to the water 70 m below? With what velocity does the stone hit the water?
4. An astronaut drops a baseball on the moon from a height of 1.2 m. If g_{moon}= 1.62 m/s^2, how long does it take to hit the ground?
5. A rock is thrown vertically downward from a building 40 m high with an initial velocity of –15 m/s.
    a. How long does it take for the rock to hit the ground?
    b. What is the rock's velocity as it strikes the ground?
6. A ball is thrown with an initial velocity of 80 m/s at an angle of 50° above the horizontal. Find:
    a. The maximum height of the ball.
    b. The time to rise to the top of the trajectory
    c. The total time the ball is in the air
    d. The range of the ball
    e. The velocity of the ball as it strikes the ground
    f. The position and velocity of the ball at t = 4s.

7. A projectile is fired horizontally from the roof of a building 15 meters high at an initial velocity if 30 m/s. Find:
    a. The total time the projectile is in the air.
    b. Where the projectile will hit the ground
    c. The velocity of the projectile as it hits the ground.

8. A javelin is released with a velocity of 22 m/s and stays in the air for 2.4 seconds.
    a. If it lands 400 meters away, at what angle was it released?
    b. What was its velocity when it hit the ground?

9. Blackbeard the Pirate, attempting to sink an English merchant vessel, fires a cannonball at an angle of 20° above the horizontal. The initial velocity (v_i) of the ball is 136 m/s.
    a. Determine the maximum height that the ball attains.
    b. Determine the total time of flight of the cannonball.
    c. The English ship is 1200 meters away. Does Blackbeard hit it?
    d. How far vertically up does he hit the ship? (find y at time t when x = 1200 m!)

10. A train is going down a track at a speed of 50 m/s. A cannon is attached to its back, and a cannonball is fired with a vertical velocity of 70 m/s.
    a. What is its total initial velocity? (find vi)
    b. Find the ball's maximum height
    c. Find the total time it is in the air.
    d. Find the horizontal distance the ball travels.