Part (I)

A) The radius of Earth is 6.37×10^6 m. The average Earth-sun distance is 1.496×10^{11} m. How many Earths would fit between Earth and the sun if they are separated by their average distance? Determine an exact answer and express it in scientific notation with the correct number of significant digits (Extra Credit: Then, use an order-of-magnitude calculation to estimate this number.)

B) A biker travels at an average speed of 18 km/h along a 0.30 km straight segment of a bike path. How much time (in seconds) does the biker take to travel this segment?

C) A sports car traveling at 27.8 m/s slows at a constant rate to a stop in 8.00 s. What is the displacement of the sports car in this time interval?

D) Someone throws a rubber ball vertically upward from the roof of a building 8.00 m in height. The ball rises and then falls. It just misses the edge of the roof, and strikes the ground. If the ball is in the air for 3.00 s, what was its initial velocity? (Disregard air resistance. $a = -g = -9.81$ m/s^2.)

Part (II)

A) A hiker walks at a speed of 9 km/h for 2 hrs at an angle of 45.0° north of west. Then the hiker walks at a speed of 18 km/h for 4 hrs due south. What is the magnitude of the hiker's total displacement? (You must first find his displacement in each step.)

B) A squirrel on a limb near the top of a tree loses its grip on a nut, so that the nut slips away horizontally at a speed of 10.0 cm/s. The nut lands at a horizontal distance of 18.6 cm from the tree.

a) How high above the ground is the squirrel?

b) Suppose a second squirrel standing on the ground 50 cm away from the tree starts running toward the tree the moment the first squirrel looses grip on the nut and catches the nut the moment it hits the ground. What is the average speed of the second squirrel?

C) As shown below, a ball is thrown from the top of one building toward a tall building 50 m away. The initial velocity of the ball is 20 m/s and 40 degrees above the horizontal.

a) How far has the ball fallen when it hits the second building?

b) What is the horizontal velocity when it hits the second building?

c) What is the vertical velocity as it hits the second building?

d) At what angle does the ball strike the second building?

Part (III)

A) A 100 kg sled is being ***pushed*** at a ***constant velocity*** across a horizontal snow surface. A force of 8.0×10^{1} N is being applied to the sled rope at an angle of 53° to the ground.

a) What is the magnitude of the force of friction of the snow acting on the sled?

b) What is the coefficient of kinetic friction between the sled and the ground?

B) What is the magnitude of the largest net force that can be produced by combining a force of 6.0 N and a force of 8.0 N? What is the magnitude of the smallest such force?

C) An elevator weighing 2.00×10^{5} N is supported by a steel cable.
a) What is the tension in the cable when the elevator is accelerated upward at a rate of 3.00 m/s^2? (g = 9.81 m/s^2)

(***Extra Credit:*** What is the tension in the cable when the elevator decelerates downward (slows down as it descends) at 3.00 m/s^2?)

D) A rope attached to an engine pulls a 250 N crate up an 18.0° ramp with ***an acceleration of 2m/s^2***. The coefficient of kinetic friction for the surfaces of the crate and ramp is 0.26. What is the magnitude of the force that the rope exerts on the crate parallel to the ramp? (g = 9.81 m/s^2)

E) A couch with a mass of 1.00×10^2 kg is placed on an adjustable ramp connected to a truck. As one end of the ramp is raised, the couch begins to move downward. If the coefficient of kinetic friction between the ramp and the couch is 0.22, at what angle will the couch start to slides down the ramp with ***a constant velocity***? (g = 9.81 m/s^2)

F) In figure below, the tension in the horizontal cord (T_3) is 30N. First find the tension in the second cord (T_2); then find the weight of the object:

G) A 50 kg man lifts a 20 kg object with an acceleration of 2 m/s^2; what is the force on his feet from the ground?

H) A house is lifted from its foundations onto a truck for relocation. The house is pulled upward by a **net** force of 2850 N. This force causes the house to move from rest to an upward speed of 2.5 m/s in 5.0 seconds. What is the mass of the house?

I) In figure below, the acceleration of the system is 2 m/s^2; if the heavier box is 20 kg, what is the mass of the lighter box?

Part (IV)

Consider the following graph:

A) Suppose this is a velocity/time graph:
   a) What is the displacement from t = 2 to t = 4?

   b) What is the distance from t = 2 to t = 4?

   c) What is the acceleration from t = 2 to t = 4?

   d) At what interval in the acceleration greatest?

   e) At what interval is the acceleration negative?

B) If this is a displacement/time graph:
   a) At what interval is the velocity NOT constant?

   b) At what interval is the velocity negative?

C) If this is an acceleration/time graph:
   a) At what interval(s) is the velocity negative?

Part (V)

A) What velocity must a 1340 kg car have in order to have the same momentum as a 2680 kg truck traveling at a velocity of 15 m/s to the west?

B) A 6.0×10^{-2} kg tennis ball moves at a speed of 12 m/s. The ball is struck by a racket, causing it to rebound in the opposite direction at a speed of 18 m/s. What is the change in the ball's momentum?

C) A 2 kg baseball bat strikes a baseball with a force of 35 N. The bat is in contact with the ball for 0.12 s

a) What is the impulse?

b) What is the magnitude of the change in momentum of the ball?

D) A train with a mass of 1.8×10^{3} kg is moving at 15 m/s when the engineer applies the brakes. If the braking force is constant at 3.5×10^{4} N, how long does it take the train to stop? How far does the train travel during this time?

E) A bullet with a mass of 5.00×10^{-3} kg is loaded into a gun. The loaded gun has a mass of 0.52 kg. The bullet is fired, causing the empty gun to recoil at a speed of 2.1 m/s. What is the speed of the bullet?

F) Two ice-skaters, each with a mass of 50 kg, are stationary on a frictionless ice pond. One skater throws a 2 kg ball at 5 m/s to the other skater, who catches it. What are the velocities of the skaters when the ball is caught?

G) A bowling ball with a mass of 7.0 kg strikes a second ball that has a mass of 2.0 kg. The lighter ball moves forward with a velocity of 6.0 m/s, and the heavier ball continues forward at 4.0 m/s. What was the original velocity of the heavier (7.0 kg) ball?

EC:

1) A pair of glasses is dropped from the top of a 32.0 m high stadium. A pen is dropped from the same position 2.00 s later. How high above the ground is the pen when the glasses hit the ground? Disregard air resistance. $a = -g = -9.81$ m/s^2. (Hint: you first have to find out how long it takes the glasses to hit the ground.)
2) A baseball is thrown with an initial speed of 15.0 m/s with an unknown angle. Suppose the ball's horizontal displacement is 17.6 m (use the trigonometric identity $2(\sin\theta.\cos\theta) = \sin(2\theta)$ to solve for θ.)
   a) At what angle with respect to the ground is the ball pitched?
   b) What is the total speed after 1 second?
3) A model rocket flies off the edge of a cliff at a velocity of 32.0 m/s and an angle of 30 degrees with respect to horizontal. The canyon below is 88.0 m deep ($g = -10.0$ m/s^2).
   a) How far below is the rocket after 2 seconds?
   b) How far from the edge of the cliff does the model rocket land?
   c) What is the total speed when it hits the ground?
   d) At what angle will it hit the ground?
4) An Olympic skier moving at 20.0 m/s down a 30.0° slope encounters a region of wet snow and slides 145 m before coming to a halt. What is the coefficient of friction between the skis and the snow? ($g = 9.81$ m/s^2)
5) A 90 kg halfback runs north and is tackled by a 120 kg opponent running south at 4 m/s. The collision is perfectly inelastic. Just after the tackle, both players move at a velocity of 2 m/s north. Calculate the velocity of the 90 kg player just before the tackle.
6) A 0.10 kg object makes an elastic head-on collision with a 0.15 kg stationary object. The final velocity of the 0.10 kg object after the collision is 0.045 m/s in the direction opposite its initial movement. The final velocity of the 0.15 kg object after the collision is 0.16 m/s in the same direction as the object which strikes it. What was the initial velocity of the 0.10 kg object?
7) A 60.0 g egg dropped from a window is caught by a student. If the student exerts a net force of –1.5 N over a period of 0.25 s to bring the egg to a stop, what is the egg's initial speed?