CH3 Exercises

1. (3.1) A squirrel has x- and y-coordinates (1.1 m, 3.4 m) at time $t_1 = 0$ and coordinates (5.3 m, -0.5 m) at time $t_2 = 3$ s. For this time interval, find (a) the components of the average velocity, and (b) the magnitude and direction of the average velocity.

2. (3.5) A jet plane is flying at constant altitude. At time $t_1 = 0$, it has components of velocity $v_x = 90$ m/s, $v_y = 110$ m/s. At time $t_2 = 30$ s, the components are $v_x = -170$ m/s, $v_y = 40$ m/s. (a) Sketch the velocity vectors at t_1 and t_2. For this time interval, calculate the average acceleration (b) components, and (c) magnitude and direction.

3. (3.12) A rookie quarterback throws a football with an initial upward velocity component of 12 m/s and a horizontal component of 20 m/s. Ignoring air resistance, (a) how much time is required for football to reach its highest point of trajectory? (b) How high is this point? (c) How much time (after thrown) is required for the football to return to its original level? How does this compare with time calculated in part (a)? (d) How far has the football travelled horizontally during this time?

4. (3.21) A man stands on the roof of a 15 m tall building and throws a rock with a speed 30 m/s at an angle 33^o above the horizon. Ignore air resistance. Calculate: (a) the maximum height above the roof the rock reaches. (b) The speed of the rock just before it reaches the ground. (c) The horizontal range from the base of the building to the point where the rock strikes the ground.

5. (3.23) The earth has a radius of 6380 km and turns once around on its axis every 24 hrs. (a) What is the radial acceleration of an object on earth's equator? (give answer in m/s^2, and as a fraction of g). (b) If a_{rad} at the equator is greater than g, objects will fly off the earth's surface and into space. What would the period (T) of earth's rotation have to be for this to occur?

6. (3.25) A jet plane comes in for a downward dive, for which the bottom part of the flight path is a quarter circle with a radius of curvature of 280 m. According to medical tests, pilots will lose consciousness when they pull out of a dive at an upward acceleration greater than 5.5 g. At what speed (in m/s and mph) will the pilot black out during this dive?

7. (3.27) A Ferris wheel with a radius of 14 m is turning about a horizontal axis. The linear speed of a passenger on the rim is constant and equal to 6 m/s. What are the magnitude and direction of the passenger's acceleration as she passes through (a) the lowest point in her circular motion, and (b) the highest point in her circular motion? (c) How much time does it take to the Ferris wheel to make one revolution?

8. A canoe has a velocity of 0.40 m/s southeast relative to the earth. The canoe is on a river that is flowing 0.5 m/s east relative to the earth. Find the velocity (magnitude and direction) of the canoe relative to the river.

9. (3.43) A test rocket starting from rest at point A is launched by accelerating it along a 200 m incline at 1.9 m/s^2. The incline rises at 35^o above the horizontal, and at the instant the rocket leaves, the engines turn off and the rocket is subject to only gravity (ignore air resistance). Find (a) the maximum height above the ground that rocket reaches, and (b) the rocket's greatest horizontal range from the bottom of the incline.

10. (3.45) A sly 1.5 kg monkey and a jungle veterinarian with a blow gun loaded with a tranquillizer dart are 25 m above the ground in the trees, 70 m apart. Just as the veterinarian short horizontally at the monkey, the monkey drops from the tree in attempt from being hit. What must the minimum muzzle velocity of the dart be for it to hit the monkey before he reaches ground?

11. (3.55) A baseball is thrown at an angle 60^o above the horizontal strikes a building 18.0 m away at a point 8.0 m above the point from which it was thrown. Ignoring air resistance, (a) find the magnitude of the ball's initial velocity (v_o). (b) Find the magnitude and direction of the velocity of ball just before it strikes the building.

12. (3.57) A grasshopper makes a 50^o leap into the air from the edge of cliff, and reaches a maximum height of 6.74 cm. He then lands at a horizontal distance of 1.06 m from the edge of the cliff of unknown height. Find the (a) initial speed of the grasshopper, and (b) the height of the cliff.

13. (3.67) A cart caring a vertical missile launcher moves horizontally at a constant velocity of 30 m/s to the right. It launches a rocket vertically upward. The missile has an initial vertical velocity of 40 m/s relative to the cart. (a) How high does the rocket go? (b) How far does the cart travel while the rocket is in the air? (c) Where does the rocket land relative to the cart?

14. (3.44 CALC) A bird flies in the xy-plane with a velocity vector given by $v = (\alpha - \beta t2)i + \gamma tj$, where α = 2.4 m/s, β = 1.6 m/s3, and γ = 4.0 m/s2. The positive y-direction is vertically upward. At t=0, the bird is at the origin. (a) Calculate the position and acceleration vectors of the bird as functions of time. (b) What is the bird's altitude (y-coordinate) as it flies over x = 0 for the first time after t = 0?

15. (3.51 CALC) A toy rocket is launched with an initial velocity of 12 m/s in the horizontal direction from the roof of a 30 m tall building. The rocket's engine produces a horizontal acceleration of ($1.6\ m/s^3$)t, in the same direction the acceleration is g, downward. Ignore air resistance. What horizontal distance does the rocket travel before it reaches the ground?