Name_____ AP Physics HW # 5 Date_____

Chapter 3 Problems

Section 3.3 Displacement, Velocity, and Acceleration in Two Dimensions
Section 3.4 Motion in Two Dimensions

18. Tom the cat is chasing Jerry the mouse across the surface of a table 1.5 m above the floor. Jerry steps out of the way at the last second, and Tom slides off the edge of the table at a speed of 5.0 m/s. Where will Tom strike the floor, and what velocity components will he have just before he hits?

20. An artillery shell is fired with an initial velocity of 300 m/s at 55.0° above the horizontal. To clear an avalanche, 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?

22. A placekicker must kick a football from a point 36.0 m (about 39 yd) from the goal, and the ball must clear the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a velocity of 20.0 m/s at an angle of 53° 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?

37. Towns A and B in Figure P3.37 are 80.0 km apart. A couple arranges to drive from town A and meet a couple driving from town B at the lake, L. The two couples leave simultaneously and drive for 2.50 h in the directions shown. Car 1 has a speed of 90.0 km/h. If the cars arrive simultaneously at the lake, what is the speed of car 2?

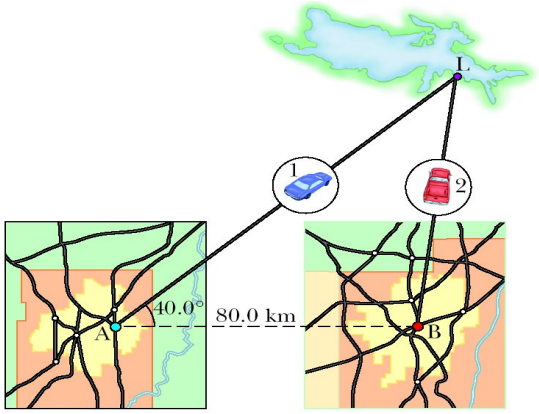

Figure P3.37

38. A Chinook salmon has a maximum underwater speed of 3.58 m/s, but it can jump out of water with a speed of 6.26 m/s. To move upstream past a waterfall, the salmon does not need to jump to the top of the fall, but only to a point in the fall where the water speed is less than 3.58 m/s; it can then swim up the fall for the remaining distance. Because the salmon must make forward progress in the water, let's assume that it can swim to the top if the water speed is 3.00 m/s. If water has a speed of 1.50 m/s as it passes over a ledge, how far below the ledge will the water be moving with a speed of 3.00 m/s? (Note that water undergoes projectile motion once it leaves the ledge.) If the salmon is able to jump vertically upward from the base of the fall, what is the maximum height of waterfall that the salmon can clear?

44. A 2.00-m-tall basketball player is standing on the floor 10.0 m from the basket, as in Figure P3.44. If he shoots the ball at a 40.0° angle with the horizontal, at what initial speed must he throw the basketball so that it goes through the hoop without striking the backboard? The height of the basket is 3.05 m.

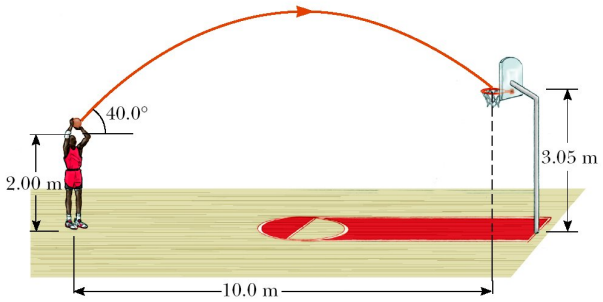

Figure P3.44

45. In a very popular lecture demonstration, a projectile is fired at a falling target as in Figure P3.45. The projectile leaves the gun at the same instant that the target is dropped from rest. Assuming that the gun is initially aimed at the target, show that the projectile will hit the target. (One restriction of this experiment is that the projectile must reach the target before the target strikes the floor.)

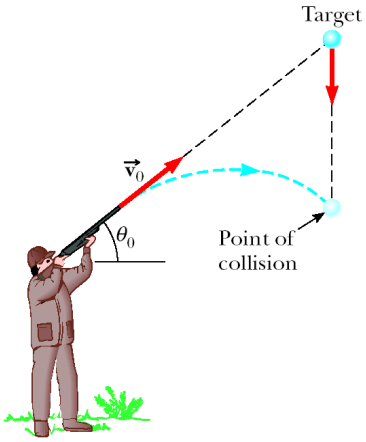

Figure P3.45

46. Figure P3.46 illustrates the difference in proportions between the male (m) and female (f) anatomies. The displacements $\vec{\mathbf{d}}_{1m}$ and $\vec{\mathbf{d}}_{1f}$ from the bottom of the feet to the navel have magnitudes of 104 cm and 84.0 cm, respectively. The displacements $\vec{\mathbf{d}}_{2m}$ and $\vec{\mathbf{d}}_{2f}$ have magnitudes of 50.0 cm and 43.0 cm, respectively. (a) Find the vector sum of the displacements $\vec{\mathbf{d}}_1$ and $\vec{\mathbf{d}}_2$ in each case. (b) The male figure is 180 cm tall, the female 168 cm. Normalize the displacements of each figure to a common height of 200 cm, and re-form the vector sums as in part (a). Then find the vector difference between the two sums.

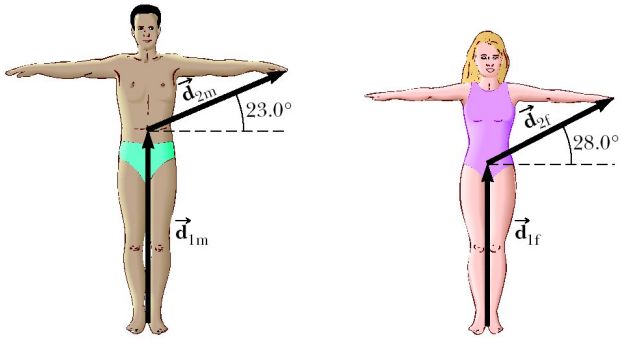

Figure P3.46

47. By throwing a ball at an angle of 45°, a girl can throw the ball a maximum horizontal distance *R* on a level field. How far can she throw the same ball vertically upward? Assume that her muscles give the ball the same speed in each case. (Is this assumption valid?)

48. A projectile is fired with an initial speed v_0 at an angle θ_0 to the horizontal, as in Figure 3.13. When it reaches its peak, the projectile has (x, y) coordinates given by $(R/2, h)$, and when it strikes the ground, its coordinates are $(R, 0)$, where R is called the *horizontal range*. (a) Show that the projectile reaches a maximum height given by

$$h = \frac{v_0^{\,2} \sin^2 \theta_0}{2g}$$

(b) Show that the horizontal range of the projectile is given by

$$R = \frac{v_0^{\,2} \sin 2\theta_0}{g}$$