43. (II) The roller-coaster car shown in Fig. 6–41 is dragged up to point 1 where it is released from rest. Assuming no friction, calculate the speed at points 2, 3, and 4.

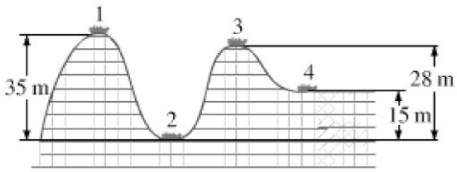

FIGURE 6–41 Problems 43 and 53.

44. (II) A 0.40-kg ball is thrown with a speed of 12 m/s at an angle of 33°. (*a*) What is its speed at its highest point, and (*b*) how high does it go? (Use conservation of energy, and ignore air resistance.)

45. (III) An engineer is designing a spring to be placed at the bottom of an elevator shaft. If the elevator cable should break when the elevator is at a height h above the top of the spring, calculate the value that the spring stiffness constant k should have so that passengers undergo an acceleration of no more than 5.0 g when brought to rest. Let M be the total mass of the elevator and passengers.

46. (III) A cyclist intends to cycle up a 7.8° hill whose vertical height is 150 m. Assuming the mass of bicycle plus cyclist is 75 kg, (*a*) calculate how much work must be done against gravity. (*b*) If each complete revolution of the pedals moves the bike 5.1 m along its path, calculate the average force that must be exerted on the pedals tangent to their circular path. Neglect work done by friction and other losses. The pedals turn in a circle of diameter 36 cm.

6–8 and 6–9 Law of Conservation of Energy

47. (I) Two railroad cars, each of mass 7650 kg and traveling 95 km/h in opposite directions, collide head-on and come to rest. How much thermal energy is produced in this collision?

48. (II) A 21.7-kg child descends a slide 3.5 m high and reaches the bottom with a speed of 2.2 m/s. How much thermal energy due to friction was generated in this process?

49. (II) A ski starts from rest and slides down a 22° incline 75 m long. (*a*) If the coefficient of friction is 0.090, what is the ski's speed at the base of the incline? (*b*) If the snow is level at the foot of the incline and has the same coefficient of friction, how far will the ski travel along the level? Use energy methods.

50. (II) A 145-g baseball is dropped from a tree 13.0 m above the ground. (*a*) With what speed would it hit the ground if air resistance could be ignored? (*b*) If it actually hits the ground with a speed of 8.00 m/s, what is the average force of air resistance exerted on it?

51. (II) You drop a ball from a height of 2.0 m, and it bounces back to a height of 1.5 m. (*a*) What fraction of its initial energy is lost during the bounce? (*b*) What is the ball's speed just as it leaves the ground after the bounce? (*c*) Where did the energy go?

52. (II) A 110-kg crate, starting from rest, is pulled across a floor with a constant horizontal force of 350 N. For the first 15 m the floor is frictionless, and for the next 15 m the coefficient of friction is 0.30. What is the final speed of the crate?

53. (II) Suppose the roller coaster in Fig. 6–41 passes point 1 with a speed of 1.70 m/s. If the average force of friction is equal to one-fifth of its weight, with what speed will it reach point 2? The distance traveled is 45.0 m.

54. (II) A skier traveling 12.0 m/s reaches the foot of a steady upward 18.0° incline and glides 12.2 m up along this slope before coming to rest. What was the average coefficient of friction?

55. (III) A 0.620-kg wood block is firmly attached to a very light horizontal spring ($k = 180$ N/m) as shown in Fig. 6–40. It is noted that the block–spring system, when compressed 5.0 cm and released, stretches out 2.3 cm beyond the equilibrium position before stopping and turning back. What is the coefficient of kinetic friction between the block and the table?

56. (III) A 280-g wood block is firmly attached to a very light horizontal spring, Fig. 6–40. The block can slide along a table where the coefficient of friction is 0.30. A force of 22 N compresses the spring 18 cm. If the spring is released from this position, how far beyond its equilibrium position will it stretch at its first maximum extension?

57. (III) Early test flights for the space shuttle used a "glider" (mass of 980 kg including pilot) that was launched horizontally at 500 km/h from a height of 3500 m. The glider eventually landed at a speed of 200 km/h. (*a*) What would its landing speed have been in the absence of air resistance? (*b*) What was the average force of air resistance exerted on it if it came in at a constant glide of 10° to the Earth?

6–10 Power

58. (I) How long will it take a 1750-W motor to lift a 315-kg piano to a sixth-story window 16.0 m above?

59. (I) If a car generates 18 hp when traveling at a steady 88 km/h, what must be the average force exerted on the car due to friction and air resistance?

60. (I) A 1400-kg sports car accelerates from rest to 95 km/h in 7.4 s. What is the average power delivered by the engine?

61. (I) (*a*) Show that one British horsepower (550 ft·lb/s) is equal to 746 W. (*b*) What is the horsepower rating of a 75-W lightbulb?

62. (II) Electric energy units are often expressed in the form of "kilowatt-hours." (*a*) Show that one kilowatt-hour (kWh) is equal to 3.6×10^6 J. (*b*) If a typical family of four uses electric energy at an average rate of 520 W, how many kWh would their electric bill be for one month, and (*c*) how many joules would this be? (*d*) At a cost of \$0.12 per kWh, what would their monthly bill be in dollars? Does the monthly bill depend on the *rate* at which they use the electric energy?

63. (II) A driver notices that her 1150-kg car slows down from 85 km/h to 65 km/h in about 6.0 s on the level when it is in neutral. Approximately what power (watts and hp) is needed to keep the car traveling at a constant 75 km/h?

64. (II) How much work can a 3.0-hp motor do in 1.0 h?

65. (II) A shot-putter accelerates a 7.3-kg shot from rest to 14 m/s. If this motion takes 1.5 s, what average power was developed?

66. (II) A pump is to lift 18.0 kg of water per minute through a height of 3.60 m. What output rating (watts) should the pump motor have?

67. (II) During a workout, the football players at State U. ran up the stadium stairs in 66 s. The stairs are 140 m long and inclined at an angle of 32°. If a typical player has a mass of 95 kg, estimate the average power output on the way up. Ignore friction and air resistance.