5.1 Work Done by a Constant Force

1. **MC** The units of work are (a) $\mathrm{N \cdot m}$, (b) $\mathrm{kg \cdot m^2/s^2}$, (c) J, (d) all of the preceding. (d)

2. **MC** For a particular force and displacement, the most work is done when the angle between them is (a) 30°, (b) 60°, (c) 90°, (d) 180°. (d)

3. **MC** A pitcher throws a fastball. When the catcher catches it, (a) positive work is done, (b) negative work is done, (c) the net work is zero. (b)

4. **MC** Work done in free fall is (a) only positive, (b) only negative or (c) can be either positive or negative. (c)

8. ● If a person does 50 J of work in moving a 30-kg box over a 10-m distance on a horizontal surface, what is the minimum force required? 5.0 N

9. ● A 5.0-kg box slides a 10-m distance on ice. If the coefficient of kinetic friction is 0.20, what is the work done by the friction force? –98 J

14. ●● A father pulls his young daughter on a sled with a constant velocity on a level surface through a distance of 10 m, as illustrated in ▼Fig. 5.25a. If the total mass of the sled and the girl is 35 kg and the coefficient of kinetic friction between the sled runners and the snow is 0.20, how much work does the father do? 6.1×10^2 J

20. ●●● A man pushes horizontally on a desk that rests on a rough wooden floor. The coefficient of static friction between the desk and floor is 0.750 and the coefficient of kinetic friction is 0.600. The desk's mass is 100 kg. He pushes just hard enough to get the desk moving and continues pushing with that force for 5.00 s. How much work does he do on the desk? 1.35×10^4 J

5.2 Work Done by a Variable Force

22. **MC** The work done by a variable force of the form $F = kx$ is equal to (a) kx^2, (b) kx, (c) $\frac{1}{2}kx^2$, (d) none of the preceding. (c)

23. **CQ** Does it take twice the work to stretch a spring 2 cm from its equilibrium position as it does to stretch it 1 cm from its equilibrium position? no, it takes more than twice the work, force increases as spring stretches

24. **CQ** If a spring is compressed 2.0 cm from its equilibrium position and then compressed an additional 2.0 cm, how much more work is done in the second compression than in the first? Explain. three times as much

25. ● To measure the spring constant of a certain spring, a student applies a 4.0-N force, and the spring stretches by 5.0 cm. What is the spring constant? 80 N/m

26. ● A spring has a spring constant of 30 N/m. How much work is required to stretch the spring 2.0 cm from its equilibrium position? 6.0×10^{-3} J

27. ● If it takes 400 J of work to stretch a spring 8.00 cm, what is the spring constant? 1.25×10^5 N/m

33. ●● A particular spring has a force constant of 2.5×10^3 N/m. (a) How much work is done in stretching the relaxed spring by 6.0 cm? (b) How much more work is done in stretching the spring an additional 2.0 cm? (a) 4.5 J (b) 3.5 J

35. ●●● In stretching a spring in an experiment, a student inadvertently stretches it past its elastic limit; the force-versus-stretch graph is shown in ▼Fig. 5.27. Basically, after it reaches its limit, the spring begins to behave as if it were considerably stiffer. How much work was done on the spring? Assume that on the force axis, the tick marks are every 10 N, and on the *x*-axis, they are every 10 cm or 0.10 m. 6.0 J

5.3 The Work–Energy Theorem: Kinetic Energy

37. **MC** Which of the following is a scalar quantity: (a) work, (b) force, (c) kinetic energy, or (d) both a and c? (d)

38. **MC** If the angle between the net force and the displacement of an object is greater than 90°, (a) kinetic energy increases, (b) kinetic energy decreases, (c) kinetic energy remains the same, (d) the object stops. (b)

39. **MC** Two identical cars, A and B, traveling at 55 mi/h collide head-on. A third identical car, C, crashes into a brick wall going 55 mi/h. Which car has the least damage: (a) car A, (b) car B, (c) car C, or (d) all the same? (c)

40. **MC** Which of the following objects has the least kinetic energy: (a) an object of mass 4*m* and speed *v*; (b) an object of mass 3*m* and speed 2*v*; (c) an object of mass 2*m* and speed 3*v*; or (d) an object of mass *m* and speed 4*v*? (a)

41. **CQ** You want to decrease the kinetic energy of an object as much as you can. You can do so by either reducing the mass by half or reducing the speed by half. Which option should you pick, and why? reducing speed

46. ● A 1200-kg automobile travels at $90\ \text{km/h}$. (a) What is its kinetic energy? (b) What net work would be required to bring it to a stop? (a) 3.8×10^5 J (b) -3.8×10^5 J

51. ●●● An out-of-control truck with a mass of 5000 kg is traveling at $35.0\ \text{m/s}$ (about $80\ \text{mi/h}$) when it starts descending a steep (15°) incline. The incline is icy, so the coefficient of friction is only 0.30. Use the work–energy theorem to determine how far the truck will skid (assuming it locks its brakes and skids the whole way) before it comes to rest. 2.0×10^3 m

5.4 Potential Energy

53. **MC** A change in gravitational potential energy (a) is always positive, (b) depends on the reference point, (c) depends on the path, (d) depends only on the initial and final positions. (d)

54. **MC** The change in gravitational potential energy can be found by calculating $mg\Delta h$ and subtracting the reference point potential energy. (a) True, (b) false. (b)

55. **MC** The reference point for gravitational potential energy may be (a) zero, (b) negative, (c) positive, (d) all of the preceding. (d)

56. **CQ** If a spring changes its position from x_o to *x*, the change in potential energy is then proportional to what? (Express the answer in terms of x_o and *x*.) $x^2 - x_o^2$

57. **CQ** Two cars travel from the bottom to the top of a hill by different routes, one of which has more twists and turns. At the top, which has more potential energy? Same potential energy

58. ● How much more gravitational potential energy does a 1.0-kg hammer have when it is on a shelf 1.2 m high than when it is on a shelf 0.90 m high? 2.9 J

65. ●●● A 1.50-kg mass is placed on the end of a spring that has a spring constant of $175\ \text{N/m}$. The mass-spring system rests on a frictionless incline that is at an angle of 30° from the horizontal (▼Fig. 5.28). The system is eased into its equilibrium position, where it stays. (a) Determine the change in elastic potential energy of the system. (b) Determine the system's change in gravitational potential energy. (a) 0.154 J (b) –0.309 J

5.5 Conservation of Energy

66. **MC** Energy cannot be (a) transferred, (b) conserved, (c) created, (d) in different forms. (c)

67. **MC** If a nonconservative force acts on an object, and does work, then (a) the object's kinetic energy is conserved, (b) the object's potential is conserved, (c) the mechanical energy is conserved, (d) the mechanical energy is not conserved. (d)

68. **MC** The speed of a pendulum is greatest (a) when the pendulum's kinetic energy is a minimum, (b) when the pendulum's acceleration is a maximum, (c) when the pendulum's potential energy is a minimum, (d) none of the preceding. (c)

76. ●● A block *M* (1.00 kg) on a frictionless $5°$ incline is connected by a light string running over a frictionless pulley to a suspended block *m* (200 g). The blocks are released from rest and the suspended mass falls 1.00 m before hitting the floor. Determine the speed of the blocks just before *m* hits the floor. $1.36\ \text{m/s}$

79. ●● When a certain rubber ball is dropped from a height of 1.25 m onto a hard surface, it loses 18.0% of its mechanical energy on each bounce. (a) How high will the ball bounce on the first bounce? (b) How high will it bounce on the second bounce? (c) With what speed would the ball have to be thrown downward to make it reach its original height on the first bounce? (a) 1.03 m (b) 0.841 m (c) $2.32\ \text{m/s}$

88. ●●● A 1.00-kg block (*M*) is on a frictionless, $20°$ degree inclined plane. The block is attached to a spring $(k = 25\ \text{N/m})$ that is fixed to a wall at the bottom of the incline. A light string attached to the block runs over a frictionless pulley to a 40.0-g suspended mass. The suspended mass is given an initial downward speed of $1.50\ \text{m/s}$ How far does it drop before coming to rest? (Assume the spring is unlimited in how far it can stretch) 0.21 m

5.6 Power

89. **MC** Which of the following is not a unit of power: (a) J/s; (b) $\text{W}\cdot\text{s}$; (c) W; (d) hp? (b)

90. **MC** Consider a 2.0-hp motor and a 1.0-hp motor. Compared to the 2.0-hp motor, for a given amount of work, the 1.0-hp motor can (a) do twice as much work in half the time, (b) half the work in the same time, (c) one quarter of the work in three quarters of the time, (d) none of the preceding. (b)

91. **CQ** If you check your electricity bill, you will note that you are paying the power company for so many kilowatt-hours (kWh). Are you really paying for power? Explain. Also, convert 2.5 kWh to J. no, energy;

9.0×10^{6} J

101. ●● In a time of 10 s, a 70-kg student runs up two flights of stairs whose combined vertical height is 8.0 m. Compute the student's power output in doing work against gravity in (a) watts and (b) horsepower. (a) 5.6×10^{2} W (b) 0.74 hp

103. ●●● A 3250-kg aircraft takes 12.5 min to achieve its cruising altitude of 10.0 km and cruising speed of 850 km/h. If the plane's engines deliver, on average, 1500 hp during this time, what is the efficiency of the engines? 48.7%

109. George of the Jungle grabs a vine that is 15.0 m long and swings down to the jungle floor. He starts from rest with the vine at 60°, lets go at the bottom of the swing, and slides along level dirt ground to a stop. If George has a mass of 100 kg, and the coefficient of kinetic friction between him and the jungle floor is 0.75, determine how far he slides before coming to rest. 10 m