Ch 7 (5th ed)

3. You have been asked to analyze a collision at a traffic intersection. Will you be better off to begin your analysis using conservation of momentum or conservation of kinetic energy? Why?

4. A sports car with a mass of 1200 kilograms travels down the road with a speed of 20 meters per second. Why can't we say that its momentum is smaller than its kinetic energy?

5. If a system has zero kinetic energy, does it necessarily have zero momentum? Give an example to illustrate your answer.

6. If a system has zero momentum, does it necessarily have zero kinetic energy? Give an example to illustrate your answer.

7. Which has the greater kinetic energy, a supertanker berthed at a pier or a motorboat pulling a water skier? Why?

8. Two cars have the same mass, but the red car has twice the speed of the blue car. We now know that the red car has _______ times the kinetic energy of the blue car.

9. Assume that a minivan has a mass of 2000 kilograms and a sports car has a mass of 1000 kilograms. If both vehicles are traveling at the same speed, which vehicle has the higher kinetic energy? Why?

10. If the sports car in the Question 9 has twice the speed of the minivan, which vehicle has the higher kinetic energy? Why?

11. A silver Camry is driving on the freeway at a constant 70 mph. An identical Camry, but white in color, is on the on-ramp and is speeding up at a rate of 5 mph per second. Compare their kinetic energies at the instant the white Camry reaches 70 mph.

12. A jet is circling above the Salt Lake City airport at constant speed and elevation. How does the jet's kinetic energy change, if at all, as it circles? How does the jet's momentum change, if at all, as it circles?

13. What will happen if you pull two balls from the same side of the collision-ball apparatus in Figure 7-1 and let them go?

14. What will happen if the end balls of the collision-ball apparatus in Figure 7-1 are pulled out the same distances and let go?

15. A bowler lifts a bowling ball from the floor and places it on a rack. If you know the weight of the ball, what else must you know in order to calculate the work he does on the ball?

Larry D. Kirkpatrick

16. Bill's job is to lift bags of flour and place them in the back of a truck, which is parked right next to him. Sally is loading the same bags of flour into a similar truck that is located 10 meters away. Sally wants a raise because she says that she is doing more work than Bill. Does the physics definition of work support her claim?

17. An object has a velocity toward the south. If a force is directed toward the north, will the kinetic energy of the object initially increase, decrease, or stay the same? Explain.

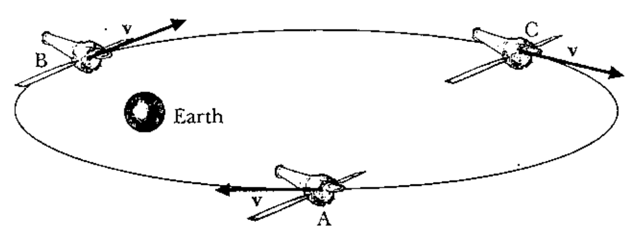
18. A bowling ball is rolling directly north along a smooth floor. Using a hammer, you tap the ball such that the force is directed east. How does the tap affect the ball's kinetic energy or its momentum?

*19. In tryouts for the national bobsled team, each competing team pushes a sled along a level, smooth surface for 5 meters. One team brings a sled that is much lighter than all the others. Assuming that this team pushes with the same force as the others, compare the kinetic energy of the light sled to that of the others after 5 meters. Compare the momentum of the light sled to that of the others after 5 meters. (*Hint:* Think about the times involved.)

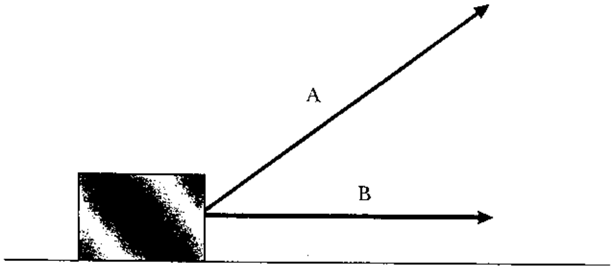
*20. Suppose the rules were changed in Question 19 so that the teams pushed for a fixed time of 5 seconds rather than a fixed distance of 5 meters. Compare the momentum of the light sled to that of the others after 5 seconds. Compare the kinetic energy of the light sled to that of the others after 5 seconds. (*Hint:* Think about the distances involved.)

21. The tractor of an 18-wheeler performs work on its trailer when the truck is traveling along a level highway with a constant velocity. Why doesn't the trailer continually gain kinetic energy—that is, continually speed up?

✓ 22. The Chandra X-ray satellite orbits the Earth in a highly elliptical orbit, as shown in the figure. The force that Earth exerts on the satellite is always directed toward Earth. Is the satellite's kinetic energy increasing, decreasing, or staying the same at each of the points indicated? Explain your reasoning. (*Note:* The velocity vectors on the figure are *not* drawn to scale.)



23. Two forces are used to move a block 2 meters across a level surface as shown. Is the work done by force A greater than, equal to, or less than the work done by force B? (*Note:* The force vectors are drawn to scale.)



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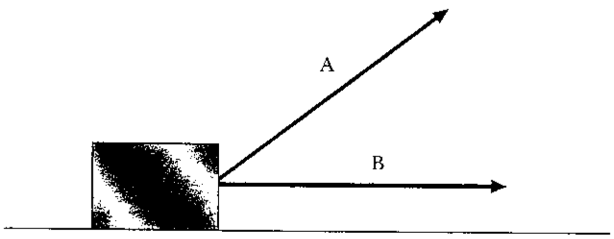


***25.** We can use Newton's third law to demonstrate that the momentum lost by one object is gained by another. Can you also do this for kinetic energy? Explain why or why not.

26. Is it possible to change an object's momentum without changing its kinetic energy? What about the reverse situation?

27. Which of the following, if either, does more work: a force of 5 newtons acting through a distance of 5 meters or a force of 4 newtons acting through a distance of 7 meters?

28. Which of the following, if either, produces the larger change in the kinetic energy: a force of 6 newtons acting through a distance of 3 meters or a force of 3 newtons acting through a distance of 6 meters?

29. On a test, the physics teacher asks, "What is the gravitational potential energy of a 10-newton ball resting on a shelf 2 meters above the floor?" Jamie got no points for responding that the answer was zero. What argument could Jamie use to convince the teacher that zero could be the right answer?

✓ **30.** As the firefighter in the picture slides down the pole, he initially speeds up to some terminal velocity, which he maintains until reaching the bottom. Gravitational potential energy is constantly decreasing during this process. Where does it go?

Richard Hutchings/PhotoEdit

31. The kinetic energy of a free-falling ball is not conserved. Why is this not a violation of the law of conservation of mechanical energy?

32. Which of the following is conserved as a ball falls freely in a vacuum: the ball's kinetic energy, gravitational potential energy, momentum, or mechanical energy?

✓ **33.** At which point in the swing of an ideal pendulum (ignoring friction) is the gravitational potential energy at its maximum? At which point is the kinetic energy at its maximum?

34. As an ideal pendulum (ignoring friction) swings from the bottom to the top of its arc, the string is always exerting a force on the ball. Why then is the gravitational potential energy at the top not greater than the kinetic energy at the bottom?

35. If we do not ignore frictional forces, what can you say about the height to which a pendulum bob swings on consecutive swings?

36. A block of wood, released from rest, loses 100 joules of gravitational potential energy as it slides down a ramp. If it has 90 joules of kinetic energy at the bottom of the ramp, what can you conclude?

37. Describe the energy transformations that occur as a satellite orbits Earth in a highly elliptical orbit.

EXERCISES

1. What is the kinetic energy of a 1400-kg sports car traveling down the road with a speed of 30 m/s?

2. What is the kinetic energy of an 87-kg sprinter running at 9 m/s?

3. In reviewing her lab book, a physics student finds the following description of a collision: "A 4-kg air-hockey puck with an initial speed of 6 m/s to the right collided head-on with a 1-kg puck moving to the left at the same speed. After the collision, both pucks traveled to the right, the 4-kg puck at 2 m/s and the 1-kg puck at 10 m/s." Is momentum conserved in this description? Is kinetic energy conserved in this description? Could this collision actually have taken place as described?

4. In reviewing his lab book, a physics student finds the following description of a collision: "A 4-kg air-hockey puck with an initial speed of 6 m/s to the right collided head-on with a 1-kg puck moving to the left at the same speed. After the collision, both pucks traveled to the right, the 4-kg puck at 3 m/s and the 1-kg puck at 12 m/s." Is momentum conserved in this description? Is kinetic energy conserved in this description? Could this collision actually have taken place as described?

5. A 3-kg toy car with a speed of 6 m/s collides head-on with a 2-kg car traveling in the opposite direction with a speed of 4 m/s. If the cars are locked together after the collision with a speed of 2 m/s, how much kinetic energy is lost?

6. A 4-kg toy car with a speed of 5 m/s collides head-on with a stationary 1-kg car. After the collision, the cars are locked together with a speed of 4 m/s. How much kinetic energy is lost in the collision?

7. A 0.5-kg air-hockey puck is initially at rest. What will its kinetic energy be after a net force of 0.8 N acts on it for a distance of 2 m?

8. A 20-N block lifted straight upward by a hand applying a force of 20 N has an initial kinetic energy of 16 J. If the block is lifted 1 m, how much work does the hand do? What is the block's final kinetic energy?

9. A radio-controlled car increases its kinetic energy from 4 J to 12 J over a distance of 2 m. What was the average net force on the car during this interval?

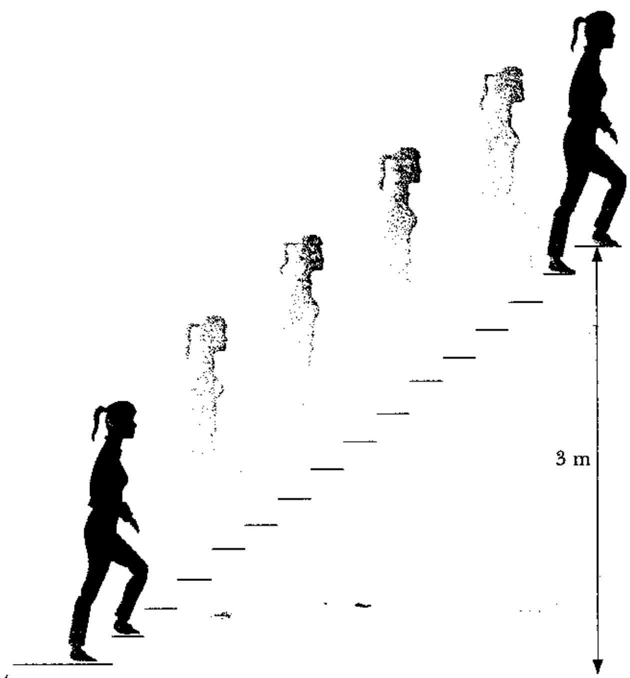
10. A toy car has a kinetic energy of 12 J. What is its kinetic energy after a frictional force of 0.6 N has acted on it for 5 m?

11. Earth, which orbits the Sun in an elliptical path, reaches its closest point to the Sun on about January 4 each year. Will the work done by the gravitational force of the Sun on Earth be positive, negative, or zero over the next six months? Over the next year?

12. How much work is performed by the gravitational force on a satellite in near-Earth orbit during one revolution?

13. How much work does a 55-kg person do against gravity in walking up a trail that gains 720 m in elevation?

14. A woman with a mass of 65 kg climbs a set of stairs that are 3 m high. How much gravitational potential energy does she gain?



15. A baseball (mass = 145 g) is thrown straight upward with kinetic energy 8.7 J. When the ball has risen 6 m, find (a) the work done by gravity, (b) the ball's kinetic energy, and (c) the ball's speed.

16. What is the gravitational potential energy of a ball with a weight of 50 N when it is sitting on a shelf 1.5 m above the floor? What assumption do you need to make to get your answer?

17. If a 0.5-kg ball is dropped from a height of 6 m, what is its kinetic energy when it hits the ground?

18. A 2-kg block is released from rest at the top of a 20-m-long frictionless ramp that is 4 m high. At the same time, an identical block is released next to the ramp so that it drops straight down the same 4 m. What are the values for each of the following for the blocks just before they reach ground level? Which quantities are the same for the two blocks?
    a. Gravitational potential energy
    b. Kinetic energy
    c. Speed
    d. Momentum?

19. A 1200-kg frictionless roller coaster starts from rest at a height of 24 m. What is its kinetic energy when it goes over a hill that is 12 m high?

20. You reach out the second-story window that is 5 m above the sidewalk and throw a 0.1-kg ball straight upward with 6 J of kinetic energy.
   a. What is the ball's gravitational potential energy when it is released?
   b. What is the ball's gravitational potential energy just before hitting the sidewalk?
   c. What is the ball's kinetic energy just before hitting the sidewalk?
   d. How would the answer to part (c) change if the ball had initially been thrown straight down with 6 J of kinetic energy?

21. What average power does a weightlifter need to lift 300 lb a distance of 4 ft in 0.8 s?

22. If an 80-kg sprinter can accelerate from a standing start to a speed of 10 m/s in 3 s, what average power is generated?

23. If a CD player uses electricity at a rate of 15 W, how much energy does it use during an 8-h day?

24. If a hair dryer is rated at 1500 W, how much energy does it require in 5 min?

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