19. Work

19.1 *A liter bottle of water is sitting on my desk. I exert a horizontal force to slide it across the table 50 cm to the right, where it comes to rest again (because friction slows it down). For the following questions, estimate the mass of the bottle of water, if needed.*
(a) Suppose I exerted an average force of 2 N on the bottle. How much work did I do on the bottle (from initial to final)?
(b) How much work did the force of gravity do on the bottle?
(c) How much work did the normal force exerted by the table do on the bottle?

(a) 1 J, (b) 0, (c) 0

19.2 *A liter bottle of water is sitting on my desk. I exert a horizontal force to slide it across the table 50 cm to the right, where it comes to rest again (because friction slows it down). For the following questions, estimate the mass of the bottle of water, if needed.*
(a) The bottle's initial velocity was zero. The bottle's final velocity was zero. What was the total change in the bottle's kinetic energy (from the initial "at rest" to final "at rest")?
(b) What was the total work done on the bottle (from initial to final)?
(c) Suppose I exerted an average force of 2 N on the bottle. How much work did the frictional force exerted by the table do on the bottle? Explain.
(d) Suppose there was no friction between the table and the bottle. If I exert an average force of 2 N on the bottle, how fast is it going after moving 50 cm? Assume the bottle started at rest.

(a) 0, (b) 0, (c) -1 J, (d) 1.4 m/s

19.3 *Suppose you throw a rock up in the air. As it goes up, the rock's kinetic energy decreases.*
(a) What is the work done by gravity during this time: positive, negative or zero? Explain without using equations.

(b) What is the change in gravitational energy during this time: positive, negative or zero? Explain without using equations.

(a) negative, (b) positive

19.4 *When a 200-g block is placed on spring, the equilibrium position is found to stretch 10 cm.*
(a) What is the force exerted on the block by the spring at the new equilibrium position? The net force on the block should be zero at the equilibrium position.
(b) What is the average force exerted on the block by the spring between the time it is first placed on the spring and the final equilibrium position?
(c) What was the work done by the spring on the block as it was displaced the 10 cm?
(d) What must the spring strength be of the spring?

(a) 1.96 N, (b) 0.98 N, (c) 0.098 J, (d) 19.6 N/m

19.5 *Suppose in figure 16.8 the table wasn't frictionless but instead had a coefficient of kinetic friction, μ_k, equal to 0.400. This introduces a third force that is doing work on the system.*
(a) What is the work done by the friction force on the system? Remember that it is negative since friction acts opposite the direction of the sliding.
(b) What is the total work done on the system? Remember that it was 29.4 J when the surface was frictionless.
(c) What is the system's change in kinetic energy?
(d) If the blocks start at rest, use your answer to part (c) to find the velocity of block 2 when block 3 hits the ground (after falling 0.750 m). Compare your answer to what was obtained in the previous checkpoint.

(a) -14.7 J, (b) 14.7 J, (c) 14.7 J, (d) 1.4 m/s (less than 1.98 m/s, obtained on page 358)

19.6 *A 5 kg box is on a frictionless inclined surface that is inclined 20° above the horizontal.*
(a) What is the change in kinetic energy of the box if it moves 4 meters down the ramp? The 4 meters is parallel to the surface of the ramp.

(b) If the box starts at with a speed of 3 m/s, what is its speed after traveling for 4 meters along the ramp?

(a) 67 J, (b) 6 m/s

19.7 *Suppose the smaller hill in 19.2 is 5 meters below the top of the first hill. Assuming the cart passes over the first hill with a speed of 5 m/s, how fast is the cart moving when it passes over the top of the second hill? Assume no friction between the cart and the track.*

11.1 m/s

19.8 *Suppose the cart is moving toward the left in 19.2 and the smaller hill (at point E) is 5 meters below the top of the higher hill (at point B).*
(a) If the cart passes over the hill at point E with a speed of 20 m/s, what is its speed as it passes over the hill at point B? Assume no friction between the cart and the track.
(b) Suppose the cart had a speed of only 5 m/s at point E. Does it make it over the hill at point B?

(a) 17.4 m/s, (b) no, its initial kinetic energy is only 12,500 J and it experiences a change of $-49,000$ J as it moves up to the next hill; it will stop before it gets there

19.9 *A pendulum is made up of a 1-kg ball and a massless string of length 50 cm. The pendulum is then displaced 25° from vertical.*
(a) What is the ball's speed when it reaches its lowest point (i.e., at the bottom of the pendulum motion)?
(b) What is the ball's speed when it reaches a point where it is 10° from vertical?
(c) What is the ball's speed when it reaches a point where it is 25° from vertical on the side opposite where it started?

(a) 0.96 m/s, (b) 0.88 m/s, (c) zero

19.10 *Suppose we replace the 5-kg center block (the block sliding on the table) with a more massive 10-kg block.*
(a) How does that change the amount by which the gravitational energy changes, if at all?

(b) How does that change the amount by which the system's kinetic energy changes, if at all?
(c) How does that change the amount by which the system speeds up, if at all?

(a) it doesn't change, (b) it doesn't change, (c) decreases (total mass is more than before)