Unit 6: Work, Power and Energy

Name: ________________
Date: _______ Period: ____

Questions: Place answers on different paper!

1. In what ways is the word "work" as used in everyday language the same as that defined in physics? In what

2. Can the normal force on an object ever do work? Explain.

3. Is the work done by kinetic friction forces always negative? [*Hint*: Consider what happens to the dishes when you pull a tablecloth out from under them.]

4. You have two springs that are identical except that spring 1 is stiffer than spring $2\left(k_1 > k_2\right)$. On which spring is more work done (*a*) if they are stretched using the same force, (*b*) if they are stretched the same distance?

5. By approximately how much does your gravitational potential energy change when you jump as high as you can?

6. A pendulum is launched from a point that is a height *h* above its lowest point in two different ways (Fig. 6–32). During both launches, the pendulum is given an initial speed of $3.0\,\text{m/s}$. On the first launch, the initial velocity of the pendulum is directed upward along the trajectory, and on the second launch it is directed downward along the trajectory. Which launch will cause it to swing the largest angle from the equilibrium position? Explain.

7. A bowling ball is hung from the ceiling by a steel wire (Fig. 6–33). The instructor pulls the ball back and stands against the wall with the ball against his nose. To avoid injury the instructor is supposed to release the ball without pushing it. Why?

8. Describe the energy transformations when a child hops around on a pogo stick.

9. A child on a sled (total mass *m*) starts from rest at the top of a hill of height *h* and slides down. Does the velocity at the bottom depend on the angle of the hill if (*a*) it is icy and there is no friction, and (*b*) there is friction (deep snow)?

10. Two identical arrows, one with twice the speed of the other, are fired into a bale of hay. Assuming the hay exerts a constant frictional force on the arrows, the faster arrow will penetrate how much farther than the slower arrow? Explain.

11. When a "superball" is dropped, can it rebound to a height greater than its original height? Explain.

Problems

6–1 Work, Constant Force

1. (I) How much work did the movers do (horizontally) pushing a 160-kg crate 10.3 m across a rough floor without acceleration, if the effective coefficient of friction was 0.50?

2. (II) A box of mass 5.0 kg is accelerated by a force across a floor at a rate of $2.0\,\mathrm{m/s^2}$ for 7.0 s. Find the net work done on the box.

3. (II) Eight books, each 4.3 cm thick with mass 1.7 kg, lie flat on a table. How much work is required to stack them one on top of another?

4. (II) What is the minimum work needed to push a 950-kg car 810 m up along a 9.0º incline? (*a*) Ignore friction. (*b*) Assume the effective coefficient of friction retarding the car is 0.25.

6–2 Work, Varying Force

5. (II) The force on an object, acting along the *x* axis, varies as shown in Fig. 6–37. Determine the work done by this force to move the object (*a*) from $x = 0.0$ to $x = 10.0\,\mathrm{m}$, and (*b*) from $x = 0.0$ to $x = 15.0\,\mathrm{m}$.

6–3 Kinetic Energy; Work-Energy Principle

6. (I) At room temperature, an oxygen molecule, with mass of 5.31×10^{-26} typically has a KE of about 6.12×10^{-21} J. How fast is the molecule moving?

7. (II) An 88-g arrow is fired from a bow whose string exerts an average force of 110 N on the arrow over a distance of 78 cm. What is the speed of the arrow as it leaves the bow?

8. (II) At an accident scene on a level road, investigators measure a car's skid mark to be 88 m long. The accident occurred on a rainy day, and the coefficient of kinetic friction was estimated to be 0.42. Use these data to determine the speed of the car when the driver slammed on (and locked) the brakes. (Why does the car's mass not matter?)

9. (II) How high will a 1.85-kg rock go if thrown straight up by someone who does 80.0 J of work on it? Neglect air resistance.

6–4 and 6–5 Potential Energy

10. (II) A 1200-kg car rolling on a horizontal surface has speed $v = 65\ \mathrm{km/h}$ when it strikes a horizontal coiled spring and is brought to rest in a distance of 2.2 m. What is the spring stiffness constant of the spring?

11. (II) A 55-kg hiker starts at an elevation of 1600 m and climbs to the top of a 3300-m peak. (*a*) What is the hiker's change in potential energy? (*b*) What is the minimum work required of the hiker? (*c*) Can the actual work done be more than this? Explain why.

12. (II) A spring with $k = 53\ \mathrm{N/m}$ hangs vertically next to a ruler. The end of the spring is next to the 15-cm mark on the ruler. If a 2.5-kg mass is now attached to the end of the spring, where will the end of the spring line up with the ruler marks?

6–6 and 6–7 Conservation of Mechanical Energy

13. (I) A sled is initially given a shove up a frictionless 28.0º incline. It reaches a maximum vertical height 1.35 m higher than where it started. What was its initial speed?

14. (II) In the high jump, Fran's kinetic energy is transformed into gravitational potential energy without the aid of a pole. With what minimum speed must Fran leave the ground in order to lift her center of mass 2.10 m and cross the bar with a speed of $0.70\ \mathrm{m/s}$?

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

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

16. (II) A ski starts from rest and slides down a 22º 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.

6–10 Power

17. (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?

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

19. (II) How fast must a cyclist climb a 6.0° hill to maintain a power output of 0.25 hp? Neglect work done by friction, and assume the mass of cyclist plus bicycle is 68 kg.