NAME ______________________ DATE ____________ CLASS ______________

WORK AND POWER 9

Work is energy transferred through motion. When you kick a soccer ball, you transfer some kinetic energy from your foot to the soccer ball. While kicking the ball, you are doing work on it. As a result, both the motion and the kinetic energy of the ball change. When you wind up a toy car, you transfer some kinetic energy from your hand to the spring. While winding the spring, you are doing work on it. As a result the spring gains potential energy because it is now more tightly wound. Work is done on an object only if there is a change in the kinetic energy, the potential energy, or both the kinetic and potential energies of the object.

Work *(W)* is defined by the following equation.

$$W = F \times d$$

In this equation, *F* represents a force acting on the object and *d* represents the distance through which the object moves as that force acts on it. In the metric system, force is measured in newtons (N), and distance is measured in meters (m). If a force of one newton acts on an object and the object moves one meter while the force is acting on it, the value of $F \times d$ equals 1 newton-meter (N-m). That amount of work is equal to one joule of energy being transferred. Because work is energy transferred through motion, work is expressed in the same units as energy, namely, joules.

Power *(P)* is the rate at which work is done. It can be determined by the following equation.

$$P = \frac{W}{t}$$

In this equation, *W* represents the work done and *t* represents the amount of time required to do the work. In the metric system, the unit of power is the watt (W). If one joule of work is done in one second, W/t has a value of 1 J/s, which is equal to 1 watt.

Objectives

In this experiment, you will

- determine the amount of work required to lift an object, and
- determine the power developed while lifting the object.

Equipment

- wood dowel, about 50 cm long
- 1-kg mass
- masking tape
- meter stick
- metric spring scale
- plastic-coated wire tie
- scissors
- stop watch
- string

Procedure

1. Weigh the 1-kg mass using the metric spring scale. Record this value in the Data and Observations section.
2. Cut a 1.3-m length of string. Tightly tie one end of the string to the center of the wood dowel. Secure the knot with a piece of masking tape to prevent the string from slipping.
3. Make a small loop at the other end of the string and knot it. Attach the 1-kg mass to the loop with a plastic-coated wire tie.
4. Measure a 1.00-m distance along the string from the dowel using the meter stick. Mark this distance on the string with a small strip of masking tape.
5. Hold the dowel at both ends as shown in Figure 9-1.

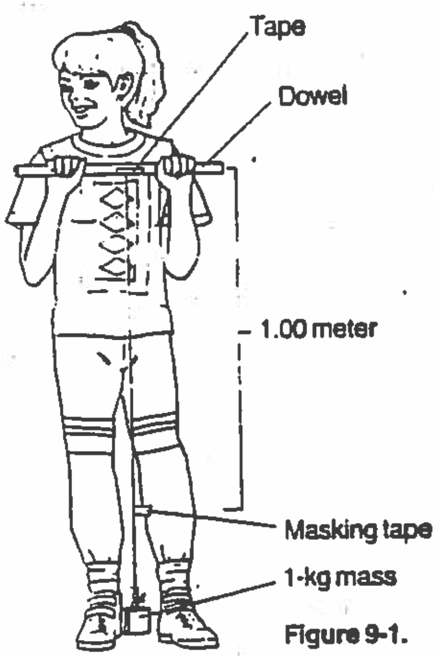

Figure 9-1.

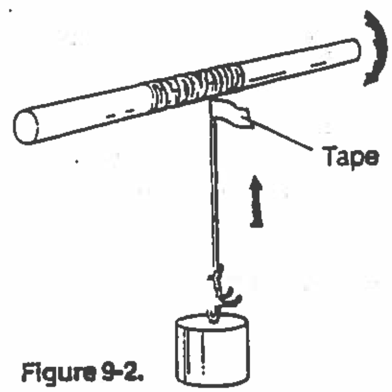

Figure 9-2.

6. Raise the 1-kg mass by winding up the string on the dowel as shown in Figure 9-2. Keep the winding motion steady so that the string winds up and the mass rises at a constant speed. Practice raising the mass in this manner several times.
7. You are now ready to have your lab partner measure the time it takes for you to raise the mass a distance of 1.00 m.
8. Suspend the 1-kg mass from the dowel as before. At a signal from you lab partner, begin to raise the mass at a constant speed by winding the string on the dowel. Have your lab partner use a stop watch to measure the time required for the piece of masking tape on the string to reach the dowel. Record this value under Student 1 in Table 9-1.
9. Reverse roles with your lab partner and allow him or her to repeat steps 6–8. Record the time value under Student 2 in Table 9-1.

Analysis

1. The size of the force that was needed to raise the 1-kg mass is equal to the weight of the 1-kg mass. The distance that the 1-kg mass was raised is the distance between the dowel and the piece of masking tape, which is 1.00 m. Record the values for the force and distance under Student 1 and Student 2 in Table 9-1.

2. Calculate the work you did to raise the 1-kg mass and record this value under Student 1 in Table 9-2.
3. Calculate the power you developed lifting the 1-kg mass. Record the value under Student in Table 9-2.
4. Complete Table 9-2 using your lab partner's data from Table 9-1.

Data and Observations

Weight of 1-kg mass: ______ N

Table 9-1

Measurement	Student 1	Student 2
Time (s)		
Force (N)		
Distance (m)		

Table 9-2

Calculation	Student 1	Student 2
Work (J)		
Power (W)		

Conclusions

1. Compare the amounts of work that you and your lab partner did. ______________

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2. Why would you expect both amounts of work to be the same? ______________

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3. Compare the amounts of power developed by you and your lab partner. ______________

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4. Why would you expect the amounts of power to differ? ______________

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5. How do the amounts of work and power depend on the speed at which the 1-kg mass is lifted?

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