

Energy ▪ *Skills Lab*

Can You Feel the Power?

Problem

Can you change how much power you use while doing an exercise?

Skills Focus

calculating, interpreting data

Materials

stopwatch or clock with a second hand

calculator

board, about 2.5 cm × 30 cm × 120 cm

meter stick

18–20 books, each about 2 cm thick

Procedure 

1. Construct a step by making two identical stacks of books. Each stack should be about 20 cm high. Place a board securely on top of the stacks of books so that the ends of the board are even with the outside edges of the books. **CAUTION:** *Be sure to have your partners hold the board steady and level throughout the procedure.*
2. Record your data in the data table.
3. You gain gravitational potential energy every time you step up. Gaining energy requires work.
 $\text{Work} = \text{Weight} \times \text{Height} = \text{Gravitational potential energy}$
 - a. Assume your weight is 400 N and your partners' weights are 425 N and 450 N.
 - b. Measure the vertical distance in centimeters from the floor to the top of the board. Convert to meters by dividing by 100 and record this height in the data table.
4. Calculate the work you do in stepping up onto the board once. Then calculate the work you do in stepping up onto the board 20 times. Record both answers in your data table.
5. Step up onto the board with both feet and then step backwards off the board onto the floor. This up-and-down motion is one repetition. Make sure you are comfortable with the motion.
6. Have one partner time how long it takes you to do 20 repetitions performed at a constant speed. Count out loud to help the timer keep track of the number of repetitions. Record the time in your data table.

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7. Calculate the power you expended to do 20 repetitions. (Power = Energy transferred ÷ Time.) Predict how your results will change if you step up and down at different speeds.
8. Repeat Steps 6 and 7, but climb the step more slowly than you did the first time. Record the new data in the Trial 2 row of your data table.
9. Switch roles with your partners and repeat Steps 3 through 8 with a different weight from Step 3a.

Data Table

	Weight (N)	Height of Board (m)	Time for 20 Repetitions (s)	Work for 1 Repetition (J)	Work for 20 Repetitions (J)	Power (W)
Student 1 Trial 1						
Student 1 Trial 2						
Student 2 Trial 1						
Student 2 Trial 2						
Student 3 Trial 1						
Student 3 Trial 2						

Analyze and Conclude

Write your answers in the space provided.

1. **Calculating** What is the gravitational potential energy gained from stepping up onto the board? How does this compare to the amount of work required to step up onto the board?

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2. Interpreting Data Compare the amount of work you did during your first and second trials.

3. Interpreting Data Compare the amount of power you produced during your first and second trials.

4. Drawing Conclusions Did you and your partners all do the same amount of work? Did you all produce the same amount of power? Explain your answers.

5. Communicating Often, a physical therapist will want to increase the power output of a patient. Write a letter to a physical therapist suggesting how he or she could use music to change a patient's power output.

Design an Experiment

Design an experiment to test two other ways a physical therapist could change the power output of her patients. Obtain your teacher's permission before carrying out your investigation.

