

13 Work, Power, and Energy

Lab B: PERSONAL POWER

Name _____

AP Physics B

You have studied the concept of power. You know that it signifies the time rate of energy use, or the time rate at which work is done. Power is measured in the metric (SI) system in **watts**. In the English system of units, the **horsepower** is often used. Ironically, it was James Watt himself who devised the horsepower unit. One horsepower is defined as 550 foot-pounds per second, or approximately 746 watts. This power unit is supposed to approximate the power a single draft horse can generate.

Today we ask the question: "Are you as strong as a horse?" We will answer it by having you do work in a certain period of time and calculate your power output. Then we can convert your power output from watts to horsepower.

To determine your power output, we will use the following equation:

$$P = \frac{\text{Work}}{t} = \frac{F_{\perp}d}{t} = F_{\perp}v$$

We need an easy-to-find force and distance. The simplest force to find for you is your own weight. Thus we will have you move your weight through a distance. This is accomplished by having you run up a flight of stairs. The distance in the formula is then the change in height from the bottom to the top of the stairs. We find the time using a simple stopwatch.

Procedure

1. Each lab partner should measure their mass in kilograms on the scale. Convert the masses to weights in Newtons and then record them in the table.
2. Now find the distance you will be rising as you climb the flight of stairs. (Multiply the height of one step by the number of steps.) Record that distance in the table.
3. Finally, have each person climb the flight of stairs as quickly as possible, while another partner times them. You may skip steps if you wish. Record the time in the table.
4. After everyone has made their timed run, calculate their speed and then their power expenditure in Watts, which is converted to horsepower. Enter the results in the table.

Name	Weight (N)	Height (m)	Time (s)	Speed (m/s)	Power (W)	Power (hp)

When your lab group has completed the table, write the speeds and powers on the board and then work together to answer the questions on the back.

THE IDEA ANSWER ALL QUESTIONS IN COMPLETE SENTENCES

1. Is it true that the person in the class who climbed the stairs most quickly **must** have the greatest power output? Explain.

2. Once all of the speed and power data for the class is on the board, look it over.
 - a) Did the person who climbed the fastest have the most power?

 - b) Did the person who climbed the slowest have the least power?

3. Consider the time period over which you expended energy. Do you think you could produce your measured power output for an hour or more? Why or why not?

It has been found that an average person can put out about 0.1 horsepower continuously for several hours, while a well-trained athlete may produce 0.25 horsepower for up to four hours. Athletic conditioning can thus boost endurance and long-term power output as well as improve short-term power output.

There are other possible exercises where you can easily measure your power output. These include push ups, sit ups, lifting weights, jumping, etc. You would need to do several repetitions to produce a measurable time. Some of these activities produce more power output than others, because of the various muscle groups being used. We ran stairs because that activity uses your leg muscles, giving a large power output.