

# More Power

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## 1 Purpose

The purpose of this lab was to calculate the power output of Matt Proctor. Both typical (walking up stairs) and peak (running at constant speed up stairs) powers were calculated.

## 2 Power Calculations

To calculate power, we used the equation

$$P = \frac{\Delta PE}{t} = \frac{mg\Delta h}{t}$$

where  $P$  is Power,  $PE$  is potential energy,  $m$  is the mass of Matt Proctor,  $g$  is the gravitational force exerted by the Earth,  $h$  is the change in Matt's height, and  $t$  is the time it takes him to reach the top of the stairs.  $PE = mgh$ ;  $m$  and  $g$  are constant, so  $\Delta PE = mg\Delta h$ . We took  $g$  to exactly equal  $9.80 \frac{m}{s^2} \pm 0.01$ . We measured  $m$  on the balance in Nurse Lancaster's

office, it turned out to be  $245 \pm 1$  pounds.  $t$  was measured for each run by Doug and Thomas with stopwatches.  $h$  was special.

## 2.1 $h$

### 2.1.1 Method 2.1.1: Two Stairways

While it was hard to directly measure the height of the stairs, which was the change in Matt's height unless something very odd happened, it was easy (because of the construction of the stairway) to measure the height of two consecutive stairways in the stairwell. Both stairways together measured  $3.91m \pm 0.04m$ . The error is an estimate of the inaccuracies introduced by the tape measure's odd construction and possible errors in reading the tape.

The other stairway had 12 steps while our stairway had 13. We therefore multiplied our 3.91 meters by the proportion of steps that belonged to our stairway.  $3.91m \times \frac{13}{12+13} = 2.03m$ . The maximum value, calculated by adding the error to the measured value of the height of both stairways and then using the above multiplication, was  $2.05m$ . The minimum, found by similarly subtracting the error, was  $2.01m$ . The error after this calculation was reduced to  $0.02m$ .

### 2.1.2 Method 2.1.2: The Wall

For this method we found that there was a row of concrete blocks in the wall that began level with the top floor. At the base of the stairs we measured from the floor to that row of blocks. Possible errors in this method included the inability to measure directly to the floor because of inconveniences of the construction of the stairwell and again misreading of the

tape measure. This method found the stairway to be  $2.08m \pm 0.03m$  high.

### **2.1.3 Method 2.1.3: The Ball**

This method will be turned in at a later date.

## **2.2 Power**

As stated before,  $P = \frac{mg\Delta h}{t}$ .