Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Climbing Stairs



**Purpose:** To gain an understanding of power, work and force by measuring your power output when climbing stairs.

**Introduction**: You will feel more tired if you run up a long set of stairs than if you walk up the same set of stairs. Whether you run or walk up the stairs, you do the same amount of work (because work = force x distance). The difference is that you do the work in a different amount of time. The rate at which work is done is called power. In this lab, you will measure how much power you and your lab partner create as you climb sets of stairs.

**Work = Force x Distance**

**Power = Work / Time**

**Procedure:**

1. Measure the height of one step in meters.
2. Count the number of steps you will climb and calculate the total height you will climb in meters. *(you should be using a staircase with a minimum of 10 stairs)*
3. Calculate your weight in Newtons. (Multiply your mass in pounds by 4.45)
4. Find the work you would do by walking and running up the flight of stairs using the correct formula. Remember that work is measured in Joules (J). *(for force, use the force of your weight in newtons)*
5. Walk up the stairs while your partner times you. Use the power formula to calculate your power when walking up the stairs.
6. Run up the stairs while your partner times you. Use the power formula to calculate your power when running.
7. Find horsepower you generated by dividing your power by 746. One horsepower is equal to 746 J/s or 746 watts.

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Formulas needed:**

**Work = F \* d**

 **Power = W ÷ t

Horsepower** = Power ÷ 746

 **Pounds to Newtons:** Your mass in pounds X 4.45

# Data Sheet

|  |  |
| --- | --- |
|  | **Your Data** |
| Height of one step | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Meters (m) |
| Number of stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Stairs |
| Total height climbed | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Meters (m) |
|  |  |  |
| Your mass (in pounds) | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Pounds (lbs) |
| Your weight (in Newtons) | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Newtons (N) |
|  |  |  |
| Work WALKING up stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Joules (J) |
| Work RUNNING up stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Joules (J) |
|  |  |  |
| Time WALKING up stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Seconds (s) |
| Power generated walking up stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Watts (W) |
| Horsepower generated walking up stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Horsepower (Hp) |
|  |  |  |
| Time RUNNING up stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Seconds (s) |
| Power generated running up stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Watts (W) |
| Horsepower generated running up stairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Horsepower (Hp) |

**Calculations:**

**End of Lab Questions.** Answer the following IN COMPLETE SENTENCES.

1. When James Watt was trying to sell his steam engine, he was repeatedly asked how the power of his engine compared to the power of a horse. To answer this question, Watt measured how fast horses worked. He determined how much work an average horse could do in one second and defined this as one horsepower. In this lab, you determined your work output as horsepower. Horses can maintain their work output for over half an hour. Do you think that you could maintain this power output for half an hour or more? ***Explain***.
2. How are force, work and power related? Describe how the formulas we have been using in class relate to one another.
3. Did you do more work when you were walking or running up the stairs?  ***Explain.***
4. Did you use more power, and more horsepower, when you were walking or running up the stairs? ***Explain***.
5. How did your power output compare to that of a 100 W light bulb? (*You should have an answer for walking, and for running)*
6. How did your maximum running power output compare to that of an average horse (746 Joules/second)?