Physics I; Mr. Flint Name _____ Period ____

Power Lab

Purpose: To measure the power output of a person running up a flight of stairs and to learn the meaning of the unit of horsepower.

Materials: Flight of stairs, meter stick, stopwatch, bathroom scale

Introduction: Power is the time rate of doing work, or $$P = \frac{W}{\Delta t} = \frac{Fd}{\Delta t}$$

where P is the power in watts (W), F is the force in Newtons (N), d is the height of the flight of stairs in meters (m), and Δt is the elapsed time in seconds (s).

A simple way to measure the power output of a person is to measure the time it takes the person to run up a flight of stairs of known height. In this experiment, you will compare your power output with that of your classmates. You will then convert these values into horsepower units.

When James Watt invented his steam engine, he was asked how many horses the engine could replace. To find out, Watt built a rope and pulley device with which he could measure the time it took a horse to lift various weights. After many experiments Watt concluded that a horse typically produces 746 watts of power for a sustained amount of time. (Watt used English units of measurement for his experiments. The metric unit of the Watt was later named in his honor.) Watt's definition of horsepower is still used today, even though the power output of an average horse during the course of a day is only about two-thirds of a standard horsepower.

An interesting application of human power is the Gossamer Condor airplane. This human powered airplane made its first successful flight in 1977. The plane now hangs next to the first Wright Brothers airplane in the National Air and Space Museum in Washington, D.C. The builders of the Condor calculated that, even by using very light materials and very long wings, the plane's human engine had to put out between one-fourth and one-third of a horsepower during flight. This is more than twice the power that a person can sustain for long periods of time.

Procedure

Caution: *Students who have medical conditions that exclude them from participating in sports or physical education classes are not required to participate in the first part of this experiment.*

Measure the height of the stairwell designated for this experiment in meters. Record the total height between landings in the data table.

Use a bathroom scale to measure the weight of each participant. Record the weight in Newtons (1 pound = 4.45 Newtons)

Each participating group member should run up the stairs as fast as possible. When doing so, grasp the handrail for added power and safety. Start with *both* feet on the lower landing and stop timing when *both* feet are on the top landing. Each person should do three trials.

Data

Height of flight of stairs = _____ m

Name	*Weight (N)*	*Time (trial 1)*	*Time (trial 2)*	*Time (trial 3)*	*Avg. Time*
1.					
2.					
3.					
4.					

Calculations *Show all work!*

1.) Determine the power output of each person in watts.

1. 3.

2. 4.

2.) Convert the wattage of each person into horsepower equivalents. (1 hp = 746 W)

1. 3.

2. 4.

Think about these:

1.) Even though a person may be able to climb the stairs in a very short amount of time, they may not produce the greatest amount of power. Explain why this is so.

2.) Why would anyone want to know what his or her power output is? ("Getting a grade for Physics class" does not count as a possible answer.)