Watt's your Power! Pre-Lab Sheet Name_____

When you climb a flight of stairs, you lift yourself and do work, by giving yourself gravitational potential energy. The force required to lift something (or someone) is equal to the **weight** of the object or person. Since weight is a force, it is measured in Newtons. ***Weight = Mass · Accel of Gravity***

During this lab you will get familiar with units and calculations of work and power.
Some basics: ***Work = Force · Distance*** ***Power = Work / Time***
Joules = Newtons · Meters ***Watts = Joules / Seconds***
1 pound → 0.454 kg (really 1 pound = 4.45 Newtons, which is the weight of .454 kg here on Earth.)

To convert from pounds to kg, multiply by 0.454.
To convert from pounds to Newtons, multiply by 4.45

Sample problem: Carla weighs 132 pounds.

a) What is her mass?

132 pounds x 0.454 = 59.9 kg

b) What is her weight in Newtons?

132 pounds x 4.45 = 587 N
or
59.9 kg x 9.8 m/s^2 = 587 N

c) How much work does she do climbing 2.8 meters?

Work = Force x distance
= Weight x height
= 587 N · 2.8 m
=1644 Joules

1 calorie = 4.184 Joules ***1 food Calorie =1000 calories = 4184 Joules***
Note the capital letter. To avoid confusion, I'll refer to food Calories as "kilocalories", or kcal.
(I swear I did not cause this stupid confusing system, so don't shoot the messenger.)

d) How many Calories ("kilocalories") does Carla burn climbing the 2.8 meters?
4184 J= 1 kcal (To convert from Joules to kcal, divide by 4184)
1644 J = .392 kcal.

That's it??! A lousy third of a Calorie to climb the stairs? Yes, the body can do a lot of work with a little energy from some sugar.

POWER!!! Power is not the amount of work you do; Power is how fast you do work.

Power = Work ÷ Time

If you do 8000 Joules of Work in 1 minute, that equals
8000 Joules / 60 seconds (note that you must convert!)
=133 Joules/sec = 133 Watts

746 Watts = 1 horsepower **To convert from Watts to horsepower, divide by 746**
To convert from hp to W, multiply by 746

Sample problem: If you lift a 75 kg mass a height of 3.2 meters in 15 seconds, how much power did you use?

Work = Force · Distance
= Weight · Height
= 75 kg · 9.8 m/s^2 · 3.2 m
= 2352 Joules

Power = Work ÷ Time
= 2352 Joules / 15 sec
= 157 Watts
157 Watts ÷ 746 = 0.21 horsepower

Show your formulas and substitution of numbers for these problems:

1) What is the weight, in Newtons, of a 50-kg woman?

2) What is the weight, in Newtons, of a 170 pound man?

3) How much work does it take to lift a person who weighs 800 N to a height of 2.5 meters?

4) How much work does it take to lift a person who weighs 800 N to a height of 7.5 meters?

5) How much power does an engine put out if it generates 5000 J of energy in 6 seconds?

6) How much power does a person use if she does 3812 J of work in 8.2 seconds?

7) A girl measures her weight as 147 lb. She takes 13.4 seconds to run up a flight of stairs that is 6.7 m high.

   a) What is the girl's weight in N?

   b) How much work does she do lifting herself?

   c) How many Calories of work did she do?

   d) How much power did she generate?

8) Tom, who weighs 630 N, climbs a rope and moves his feet 5.8 meters off the ground. If Tom needed 230 Watts to climb the rope, how many seconds did it take him to climb?

Bonus: A 128 pound student in a step aerobics class uses a platform that is 20cm high. If she steps up onto the platform 40 times per minute, figure out the power she uses.

Watt's your Power Lab

Purpose: to determine how much work you do while climbing stairs and to calculate your power. We will also calculate how many kcals of energy you burned while doing work.

Materials: Stairs, timer, calculator, data sheet

Procedure:

1. Locate a straight staircase at least 3.5 meters in vertical height and preferably with a hand railing. There should also be a clear area of at least two meters at both the top and bottom of the stairs. Measure the height of one single riser (step face) and multiply this by the total number of steps and record. This is your total displacement over which work will be done.

2. Use the bathroom scale to measure the weight of each person in your group. Since the bathroom scale is calibrated in English units you must convert the bathroom scale reading reading to metric units (N). Note that 1 pound equals 4.45 N.

3. Set the stopwatch to zero. Ask the first member to then run up the stairs between adjacent floors (first floor to second floor) as fast as possible. Remind all your fellow students before beginning their run to grasp the hand railing for safety as well as for added power during their ascent. Commence timing when both of each runner's feet have left the floor upon which they began their trip and stop the timing when both feet are on the top floor of the landing at the end of their trip. Record the time in seconds.

4. Repeat the procedure for each group member. Record all data. Some team members may wish to repeat their trials to improve their travel times.

5. Perform all calculations and conversions.

Data and calculations

1. Fill in data table
2. Make a graph (scatterplot) showing weight vs. work. Plot the weights in Newton's of all team members on the x-axis and the work done by each on the y-axis.

Lab Questions:

1. Which person did the most work (J) in this experiment? Who did the least? Give the data values.
2. Who generated the most horsepower? Explain why this is the case.
3. Who burned the most kcals going up the stairs? If one Oreo cookie is 50 calories, how far up the stairs would this person be able to go on 3 cookies?
4. Describe some possible sources of error in this experiment
5. Since everyone ran up the same stairs, what variable is responsible for the varying amount of work done by each person? Explain.

6. Look at your graph – do you notice any relationships between the variables? Explain. What type of relationship is shown?

7. What is the slope of the line on your graph? (Give number and unit of slope)

Conclusions- Write one to two paragraphs about the concepts, use scientific vocabulary. Make conclusions about your data etc. Do not just repeat the procedure to me.

Use this sheet to record your data for the power-climbing lab. The gray columns indicate results which are to be calculated later from the data which are recorded in the white columns.

Team members	Name of Person	Place Climbed	Weight (pounds)	Weight (Newtons)	Mass (kg)	Height Climbed (m)	Work (J)	Work (Cal)	Time (sec)	Power(W)	Power (hp)
1		Gym stairs									
2											
3											
4											
5											
6											
7											
8											
9											
10											