Work, Power, and Energy

Objective:

To explore the relationship between work and power. In Part 1 of this lab, students will learn how to differentiate between the two. In Part 2, students will calculate how much work is required to use up the energy in a food.

Time:

This lab will take approximately 60 minutes to complete. Part 1 will take 30 minutes; Part 2 will take 15 minutes. Then the students will need approximately 15 minutes to do the calculations.

Part 1

Materials:

- Meter stick
- Stop watch
- Stairs
- Calculator

Procedure:

1. Divide into groups of three students each. Fill in the data table as you do the calculations. Show your work throughout.
2. Find the vertical height in meters of the stairs that you will climb as part of this lab. You will be going up and down the stairs to determine the amount of force, work, and power you use in climbing the stairs.
3. Determine the mass in kilograms of each student in your group.

Student 1:
Student 2:
Student 3:

4. Determine the force (in Newtons) each student exerts on the floor.

Student 1:
Student 2:
Student 3:

5. Determine the work (in Joules) that each student will do as he or she climbs the stairs.

6. Time each student as he/she walks up the stairs. Repeat for a total of three walking trials per student.
7. Time each student as he/she runs up the stairs. Repeat for a total of three running trials per student.
8. Calculate the power output (in Watts) of each student.

Formulas:

1 kg = 2.2 pounds
Force (N) = mass (kg) x acceleration (m/s^2)
Acceleration due to gravity = $9.8 m/s^2$
Work (J) = Force (N) x distance (m)
Power (W) = Work (J)/time (s)

Data and calculations:

Student 1 Name: _____

Walking	**Distance (m)**	**Mass (kg)**	**Force (N)**	**Work (J)**	**Time (s)**	**Power (W)**
Trial 1						
Trial 2						
Trial 3						
Average						

Running	**Distance (m)**	**Mass (kg)**	**Force (N)**	**Work (J)**	**Time (s)**	**Power (W)**
Trial 1						
Trial 2						
Trial 3						
Average						

Student 2 Name: _____

Walking	Distance (m)	Mass (kg)	Force (N)	Work (J)	Time (s)	Power (W)
Trial 1						
Trial 2						
Trial 3						
Average						

Running	Distance (m)	Mass (kg)	Force (N)	Work (J)	Time (s)	Power (W)
Trial 1						
Trial 2						
Trial 3						
Average						

Student 3 Name: _____

Walking	Distance (m)	Mass (kg)	Force (N)	Work (J)	Time (s)	Power (W)
Trial 1						
Trial 2						
Trial 3						
Average						

Running	Distance (m)	Mass (kg)	Force (N)	Work (J)	Time (s)	Power (W)
Trial 1						
Trial 2						
Trial 3						
Average						

Analysis:

1. What is the relationship between the mass of a student and the amount of work he or she does?

2. What is the relationship between the speed at which a student climbs the stairs and the amount of work he or she does?

3. What is the relationship between the mass of a student and his/her power output?

4. What is the relationship between the speed at which a student climbs the stairs and his/her power output?

5. Which student did the most work? Why did he/she do more work than the others?

6. Which student generated the most power? Why was he/she able to generate more power than the others?

7. One horsepower is equal to 760 Watts. Convert the power output of each student from W to hp. Show your work.

Student 1:

Student 2:

Student 3:

Which student has the greatest horsepower? Why?

8. Explain the difference between work and power.

Part 2

Background Information:

One calorie is the amount of energy required to raise the temperature of 1 milliliter of water 1 degree Celsius. When you eat, you are actually eating chemical potential energy. In your body, the potential energy in the food you consume is converted into the kinetic energy of your moving muscles. Food products list the calories in one serving, but these are actually Calories rather than calories. What's the difference? A Calorie is equal to 1000 calories (1 kilocalorie).

Materials:

- Snack foods

Procedure:

1. Choose a drink and a snack from the list that follows.
2. Determine the number of Calories in each and find total Calories consumed.
3. Convert Calories to calories.
4. Convert calories to Joules.
5. Determine your weight in Newtons.
6. Determine how high you would need to climb (in meters) to use up the energy you consumed.

Data and calculations:

Snack Calories	Drink Calories	Total Calories	calories	Joules	Weight	Meters you need to climb

Analysis:

1. How high can you climb using these calories? (Show your work.)

2. The energy in the food your body absorbs is eventually converted to heat. What happens to the matter in your food?

Snack Food	**Calories**
Granola bar	130
Donut, glazed	242
Donut, filled	307
French fries (large)	540
Crackers, cheese (18)	210
Crackers, Ritz (10)	175
Tortilla chips, 2 oz.	285
Potato chips, 2 oz.	302
Apple	65
Drink	
Soda (Coke, etc.)	120
Orange juice	180