NAME________________________________ PERIOD________

Human Horsepower

Introduction: When you pick up a textbook from a tabletop, you perform some work on the book and change its energy. You may have wondered if it matters whether you lifted slowly or quickly. From the energy point of view, the answer is no. If it did matter, and lifting the textbook quickly somehow gave it more energy, then you would expect it to fall back down to the table faster if you picked the book up faster.

However, quickly lifting the textbook to a fixed height does require more *power* than lifting it slowly. Power is defined as work done per unit time. By lifting the textbook quickly you have done the same amount of work, but in a shorter time.

Machines employ the concept of power everyday, from cars and busses to light bulbs and televisions. But some of the most powerful machines we know of are the human muscle groups. As a weightlifter exercises, muscle groups generate power and use energy. As the repetitions continue the muscle is depleted of energy and begins to break down (it actually tears a little). When the exercise is finished the muscle tissue begins to repair itself, getting bigger and stronger, to protect itself, in the process.

In this lab we will calculate how much power various physical activities generate.

In Chapter 8 you learned the definitions and equations for work, power, Potential energy (PE), and Kinetic energy (KE). Use your notes and write each equation below

Define work-

Define power-

Define potential energy-

Define kinetic energy-

Equations

work= *power=* *Potential energy=*

Kinetic energy= *2nd Kinetic energy equation=*

What is the unit for work?__________ What is the unit for power?____________

State the law of conservation of energy –

Materials: Meter stick (Tape measure), Stop watch, Pocketlab Go to https://www.thepocketlab.com/get-notebook and make a notebook account

Method: You and your group will be performing 4 physical activities: Walking a straight path, walking up stairs, and running up stairs.

Walking a Straight Path:

- Measure out a straight path of 10 m.
- Have each group member walk the path and record the time it takes him or her to complete the path.
- Use the pocketlab to record their velocity

Walking/Running Up Stairs

- Measure the height of one stair and record it in the table
- Have each group member (who are capable) walk up the stairs. Record the time it takes for them to climb the stairs.
- Use the pocketlab to record their velocity
- Repeat with running up the stairs. Be Careful!

Push-Ups

- Have all the group members (who are capable) do 5 push ups.
- Record the time to complete the 5 push-ups and the height of 1 push-up.

Data

*Note: 1 lb=4.5 N

Walking flat

Group Member	Weight (kg)	Weight (N)	Time (s)	Displacement (m)	Velocity	Work (J)	Power (W)	PE	KE

	Walking: Average Power of Group	

Stairs Walking

Group Member	Weight (kg)	Weight (N)	Time (s)	Displacement (m)	Velocity	Work (J)	Power (W)	PE	KE

	Walking: Average Power of Group	

Stairs running

Group Member	Weight (kg)	Weight (N)	Time (s)	Displacement (m)	Velocity	Work (J)	Power (W)	PE	KE

	Walking: Average Power of Group	

Push-Ups

Group Member	Weight (kg)	Weight (N)	Push-Up Height (m)	Time (s)	Reps	Total Displacement (m)	Work (J)	Power (W)
					5			
					5			
					5			
					5			

Push-Ups: Average Power of Group	

Analysis: *Graph:* Create a bar graph, plot Power (y-axis) vs. person (x-axis). Each data table will be a separate group on your graph, so label accordingly (use color). Don't forget to label your axis. You can turn the paper sideways if you need more room.

Title:

Question: What relationship do you see between the variables on the graph?

Conclusion:

1. Is there any trend in Power between group members? Did one person develop more power in all the exercises? If so, why do you think this is?

2. A typical human consumes 2500 Kcal of energy during a day. This is the equivalent to 10,450,000 J! Say you decided to run stairs all day. Given that there are:

24 hours / day • 60 minutes / hour • 60 seconds / minute = 86,400 seconds / day

How much energy, in Joules, would you burn in climbing stairs all day?

3. How many Kcal of food energy would you need to consume to do so? (Remember that there are 4180 J / Kcal.)

4. The concept of Horsepower was first defined by James Watt so he could compare steam engines to horses. Watt defined horsepower by determining that the average horse could do about 45,000 J of work in one minute. This is equivalent to a horse pulling 150 kg of coal a distance of 30 m in one minute. The unit HP stuck and today it is used to describe everything from chain saws to racecars. The average car produces about 150 HP, or 112,000 W. If 1 HP=745 W, determine how much horsepower you produced when doing pushups.

5. Explain the relationship between potential and kinetic energy. Give an example from the lab and explain how it explains the relationship between PE and KE.

6. Determine how fast you would have to do your 5 pushups to produce 150 HP.

7. Describe the work energy theorem

8. Fully explain the difference between work and power.

9. Look at the walking and running up stairs.

Which exercise did you do more work?

Which exercise did you exert more power?

Fully explain the difference.