Name: ____________________________________ Pd. ________ Date:_________________________

Strongman Competition

Overview: Power is often associated with mechanical engines, or electrical motors. Many other devices also produce power. Light bulbs dissipate power in order to provide light. The human body converts stored energy in food into heat, and in turn into mechanical energy through muscles. Anything that produces power including the human body is subject to the same laws of physics that govern mechanical processes.

Purpose: To investigate the power produced by different muscles in the human body as they do various athletic exercises.

Background:

1. Remember **POWER = WORK / TIME**.

   - The muscles in the human body are capable of applying a force through different distances. So the body is capable of doing work.

2. Remember, that an applied force can only do work if it is in the same direction as the resulting distance.

   - For example, if a person runs up the stairs, the WORK done is lifting the persons WEIGHT up.
   - So the DISTANCE the WEIGHT is lifted is just the vertical height the person climbs – not the distance along the stairs.
   - If the time it takes to get up the stairs is measured, the power output of the body can be determined.

3. This same type of analysis can be used for almost any physical activity.

Needed Equations:

Work = Force * distance (W = F*d)

Power = Work / time (P = W / t)

1 pound = 4.45 Newtons

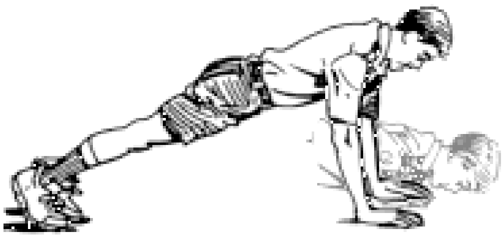
Materials:

- Stairs
- Stopwatch
- Meterstick or tape measure
- Weights
- Weight scale
- Rope

Procedure:

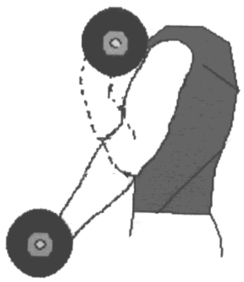
In this lab, the following activities will be tested and compared.

Doing push ups



Running up stairs

Curling a Mass



Dragging a weight

1. First the group must decide which member(s) will be performing each activity. All members should perform all the activities, but if all members are unable to, at least one member should perform all of them.

2. Before testing begins, use your lab data collection sheet(s) to write down your hypothesis concerning which activity will require the most power.

   * Rank the activities 1-4, 1 being the most powerful, 4 being the least.

3. Begin to test each activity for each person in the lab group.

4. You will measure the applied force, distance, and time for each activity and record this data in the data table.

   * You will always measure distance in meters
   * You will always measure time in seconds
   * You will always convert your weight (pounds) to Newtons when completing data table calculations

5. After the first activity is completed, move on to the second activity and record force, distance, and time data for each lab member.

6. Repeat the procedure again for the 3rd and 4th activities.

7. Use the force, distance and time data to calculate the power supplied by the human body to complete each activity.

Activity Procedures and Important Information

A) Push-Ups

Information you need to know:

- The muscles doing the applying in this case are your pectorals (chest) and your triceps.
- The force to do a pushup is due to gravity, but it is not the entire weight of the student. To figure out how much the arms and chest have to push up we can use a bathroom scale.

Finding the force you must apply:

- Get down in the push-up position, and place hands on top of a bathroom scale, rather than the floor.
- The reading on the scale is the size of the force that the arms must apply when doing a push-up (pushup weight).

How to measure distance traveled:

- To measure the distance traveled while doing a push-up, measure the shoulder height of the student in the "up" pushup position.
- Then measure the height in the "down position." This position is when your upper arms are parallel with the ground, or when the chest is on the ground depending on how the pushup is being done.
- Subtract the two numbers. This is the distance of your body during a push-up.

Calculating Distance and Time:

- Since we are doing 10 push-ups, the total distance will be 10 times the difference you found when measuring distance.
- To measure the time of doing the push-ups, just time how long it takes to do 10 push-ups.

B) Stair Climbing

Information you need to know:

- For the stair climbing part, we will be climbing 1 floor worth of stairs.

Finding the force you must apply:

- The force being applied in the direction of motion **is equal to the weight of the student**.
- Measure each group member's weight using a bathroom scale and record in the data table.

How to measure distance traveled:

- The distance traveled is a little tricky. Gravity acts straight down, so the distance that is parallel to motion is actually **just the height of the stairs climbed**.

Calculating Distance and Time:

- Find the distance by measuring the **height of one stair**, and then multiply it by the total number of stairs climbed.
- A stopwatch can measure the time it takes you to climb one flight of stairs.

C) **Curling a Mass (dumbbell)**

Information you need to know:
- Curling is lifting a weight using only your biceps. The dumbbell starts at your hip with your arm parallel to your body. It is then "curled" up until it is next to your shoulder, again parallel to your body.

Finding the force you must apply:
- The force that is being applied to produce motion has to be **equal to the weight of the mass.**

How to measure distance traveled:
- The distance is going to be the change in height of the dumbbell as you lift it.
- Hold the dumbbell in the start position and measure how high it is off the ground.
- Measure it again in the finish position.
- Subtract to find the difference between the two. This is the distance the dumbbell travels.

Calculating Distance and Time:
- We will do 10 curls, so the total distance is 10 times the difference you found when subtracting.
- The time can be measured using a stopwatch.

D) **Dragging a Mass**

Information you need to know:
- Do not use your legs. This should be done from a stationary, seated position on the floor
- You may want to use a blanket or towel to sit on depending on the state of your school floors.
- The muscles used to drag a mass are your shoulders back and upper arms.

To set up this experiment,
  - Tape off a 7-meter course.
  - Tie a rope to a backpack and place about 40 pounds of weights inside it.
  - Place the backpack at one end of the course, and lay the rope out until it reaches the other side of the course.
  - The participant should sit at the end where the rope is, about 1 meter behind the tape mark.
  - Pull in the rope hand over hand until the bag crosses the finish line.
  - A timer should measure the time from the beginning of the first pull until the front of the bag crosses the finish line.

Measurements
- The distance here is 7 meters.
- The force needed to move the mass is equal to the kinetic frictional force between the mass and the floor. Your value for this is _______________.
- To find this, attach a spring scale(s) to the bag and drag it. When it is dragged at a constant speed, a force should measure on the scale(s). This force is equal to the kinetic frictional force. **– This has been done for you!**
- Time is measured by a stopwatch in seconds.

Analysis: Answer the following questions in complete sentences.

1. In which activity was the most power produced? Which muscle group(s) was used primarily in this activity?

2. Which activity produced the least power? Which muscle group(s) were used in this activity?

3. How did your answers to 1 and 2 compare to your hypothesis? Do your results make sense?

4. Did the activity that used the largest force result in the largest power produced? Explain how a large force can result in a small power output.

5. We often use simple machines such as inclined planes, pulleys and levers to make work easier. Does this make us more powerful? Explain why or why not.

6. There is also something called electrical power, which we will learn later in the year. Just as a comparison, could any of the performances light a 60-Watt light-bulb? And if so, how many light-bulbs could it light?