Module 4: Energy

Topic 1 Application: Power Output Scientific Investigation

Before you begin this scientific investigation, make sure to download the Power Output Scientific Investigation Report. As you complete this scientific investigation, fill in any needed information on the report template. If you need more information about each section of the report, please visit the Developmental Module.

Introduction

In physics, work is the product of the force exerted on an object and the distance the object moves in the direction of the force. When the force is in the same direction that the object moves, work is done. When the force and the displacement are in the same direction, this means that work equals force times distance. While there are many times that you may feel you are doing "work," one solid example is climbing a set of stairs. Using several different measurements and conversions, you can determine your power input as you climb a set of stairs.

Objectives

In this scientific investigation, you will:

- determine your power input as you climb a set of stairs.
- convert units of mass, weight, and height to different units of measurement.
- examine the equation for work.

Hypothesis

Using the Procedure and Data Collection section, read through the procedural information for this scientific investigation. Based on your understanding of the procedure, develop your own hypotheses which describe your expected results. You should consider the following question: What is your power output when you climb the stairs? Record your hypotheses in the Hypothesis section of your Power Output Scientific Investigation Report.

Equipment and Materials

- Flight of stairs
- Bathroom scale
- Stopwatch or watch with second hand
- Meter stick or centimeter ruler

Procedure and Data Collection

1. Make sure that the scale is set to zero. Weigh yourself to determine your mass in pounds and record that number in the Data table in the Data section of your Power Output Scientific Investigation Report.
2. Using your mass in pounds, divide that number by 2.2 to get your mass in kilograms. Record that number in the Data table in the Data section of your Power Output Scientific Investigation Report.
3. Once you have calculated your mass in kilograms, multiply that number by 9.8 to get your weight in Newtons. This is the force that gravity pulls you down. Record that number in the Data table in the Data section of your Power Output Scientific Investigation Report.
4. Starting at the bottom of the stairs, walk quickly to the top of the stairs, measuring how many seconds it takes you to reach the top. Record that number in the Data table in the Data section of your Power Output Scientific Investigation Report.

5. Measure the height of one step in meters. Record that number in the Data table in the Data section of your Power Output Scientific Investigation Report.
6. Count the number of steps. Record that number in the Data table in the Data section of your Power Output Scientific Investigation Report.
7. Multiply the number of steps by the height of one step to get the total height of the stairway in meters. Record that number in the Data table in the Data section of your Power Output Scientific Investigation Report.
8. Multiply your weight in Newtons by the height of the stairs in meters to get the work you did in Joules. Record that number in the Data table in the Data section of your Power Output Scientific Investigation Report. Recall that the work equation is: work = force x distance or W = F x d.
9. To get your power in Watts, divide the work done in Joules by the time in seconds that it took you to climb the stairs. Record that number in the Data table in the Data section of your Power Output Scientific Investigation Report.

Data

Use the data table in the Data section of your Power Output Scientific Investigation Report to record your data from this scientific investigation. The data table is also shown below:

Measurement or Calculation	Data Type	Quantity
Your mass in pounds	Mass	
Your mass in kilograms	Mass	
Your weight in Newtons	Weight	
Time it takes you to walk quickly up the stairs in seconds	Time	
The height of one step in meters	Height	
The number of steps	Number	
The total height of the stairway in meters	Height	
The work you did in Joules	Work	
Your power in Watts	Power	

Data Analysis

In the Data Analysis section of your Power Output Scientific Investigation Report, provide responses to the following questions. Make sure to completely answer each question and to show all of your work.

1. What would your power be if you ran up the stairs twice as fast (i.e. your time up the stairs was cut in half)?
    a. Did your power increase or decrease?
    b. By what factor?
2. Why did you use your weight as the force in the work equation? (complete sentence)
3. Calculate what your power output would be if you climbed the same stairs in the same amount of time as you did in the lab, while also carrying a stack of books weighing 125 N?
4. If you were to walk up three flights of stairs, then walk back to your starting point, how much work have you done (in joules)?

Conclusion

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Using the Conclusion section of your Power Output Scientific Investigation Report, compose three to four sentences describing an overall conclusion based on your data. Were your hypotheses true or false, and how do you know? Use the data and notes that you collected from your experience to form your conclusion. Make sure that you include information that you gained from data analysis to support your conclusion.

Experimental Sources of Error

On your Power Output Scientific Investigation Report, provide responses to the following questions: Are there any sources of error? If so, what are they, and what could be done to minimize error?

Once you have completed the Power Output Scientific Investigation Report, please submit your work to the dropbox.