On the Descent of Cotton Balls: A Theoretical Perspective

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Introduction

Below you will find an excerpt from a paper detailing a theory about free-falling cotton balls. Your job is to read the paper below and devise an experiment that will allow you to test the theory and determine its validity.

On the descent of cotton balls: a theoretical perspective

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Abstract. Cotton balls fall more slowly than rocks in most situations. We present an extension to the traditional Newtonian view of objects to include free-falling cotton balls.

Cotton balls (which are sometimes made of Rayon) are puffs of fluff, roughly spherical, with a diameter of about 3 cm and a mass between 0.5 g and 1.0 g. If you drop them, they fall.

It has been observed, however (Galileo and Snerd 1998), that if you drop a rock and a cotton ball simultaneously from the top of a tower, the rock lands first.

Evidently air resistance slows the cotton ball more than the rock. We suggest that its effect is greater because the cotton ball is lighter.

Our reasoning is this: Each air molecule, on impact, imparts a small force to a falling object. Using the traditional force formula $F = ma$ (Newton 1687), we see that each collision effectively reduces the gravitational acceleration of any object falling through air by an amount that is inversely proportional to that object's mass (i.e. $a = F/m$). Thus the light cotton ball is slowed more than a comparably sized (and heavier) rock. Therefore we should modify the formula for the distance s fallen in time t. Instead of the traditional

$$s = \tfrac{1}{2} g t^2 \qquad (1)$$

where g is the acceleration of gravity, we suggest that the correct model for falling cotton balls is

$$s = \tfrac{1}{2} k t^2 \qquad (2)$$

where k is an acceleration smaller than g. Though the truth of our theory seems self-evident, we await confirmation from experiment.

Experiment

1. Your job is to design an experiment to test the theory in the description above. The materials available to you are the following: cotton balls, a stop watch and a meter stick. If you would like to use anything else, please ask your instructor.

2. Make sure that you follow normal laboratory procedures
    a. Give an introduction
    b. Make a sketch of your experiment that defines your variables.
    c. Briefly describe your experiment and how you collect your data.
    d. Include a data table.
    e. Include your calculations and graphs.
    f. Restate and discuss your results, as well as any sources of error. Explain why you chose the fitting function used on your graph. Be sure to explain whether the theory is valid or not AND WHY using your data and graphs to justify your conclusion.