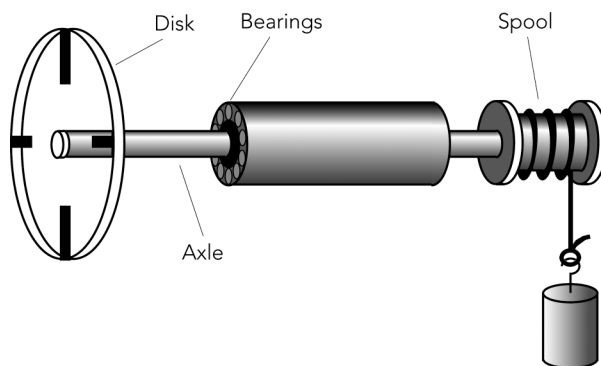


Physics 152 First Day Activity

In this activity, you will be analyzing the motion of a rotating aluminum disk and of a falling weight. This motion is shown in the digital video movie DSON014.mov. A small spool is connected to the aluminum disk by an axle that is free to rotate in an almost frictionless manner inside of a bearing, as shown in the diagram below.



A string is wrapped around the spool and a weight, which is attached to the string, is allowed to fall.

- 1) **Rotational Inertia, Angular Acceleration, and Torque:** The goal of this problem is to make some measurements and calculations of the motion of the *rotating disk*, and to ultimately use this information to determine the tension in the string that the weight is hanging from.
 - (a) Using information given in the first frame of the video, find the rotational inertia of the disk, the rotational inertia of the spool, and the total rotational inertia of the system. (**Note:** there is a typo for the disk diameter; however, the given disk radius is correct.)
 - (b) Use the VideoPoint Software to gather data for the angular position of some recognizable point on the disk as a function of time. Create a graph of angular position vs. time. Is the angular velocity constant or changing? Is the angular acceleration constant or changing? What about the angular position graph allows you to answer this question.

Note: When collecting data for angular position, it is not necessary to scale the video. However, question 2 will need the video to be scaled, so you may wish to do it at this time. Don't forget to move the origin to the center of the disk.
 - (c) Transfer your data to a spreadsheet and do either a model (MODWRK.xls) or a curve fit ("Add Trendline ...") on your data to show that within 5% or better that the magnitude of the angular acceleration of the disk is given by $\alpha = 3.01 \text{ rad/s}^2$.
 - (d) Using your answers to part (a) and part (c), find the magnitude of the torque that causes the angular acceleration of the disk-spool system.
 - (e) Using information from the first frame of the video and the definition of torque, show that within 5% or better that the magnitude of the tension force in the string is given by $F = 0.47 \text{ N}$.

- 2) **Linear Acceleration and Force:** The goal of this problem is to make some measurements and calculations of the motion of the *falling weight*, and to ultimately use this information to determine the tension in the string that the weight is hanging from.
- (a) Using information given in the first frame of the video, find the translational inertia of the falling weight.
 - (b) Use the VideoPoint Software to gather data for the vertical position of some recognizable point on the falling weight as a function of time. Create a graph of position vs. time. Is the velocity constant or changing? Is the acceleration constant or changing? What about the position graph allows you to answer this question.

Note: The falling weight is only visible in frames 8 – 15. If you haven't already scaled the video, you'll want to do it at this time.

- (c) Transfer your data to a spreadsheet and do either a model (MODWRK.xls) or a curve fit ("Add Trendline ...") on your data to show that within 5% or better that the vertical acceleration of the falling weight is given by $\vec{a} = -0.042 \text{ m/s}^2 \hat{y}$.
- (d) Using your answers to part (a) and part (c), find the *net force* acting on the falling weight.
- (e) Using your answers to part (c) and part (d), find the tension force in the string. How does it compare to the value that you found in question 1?

Note: To find the tension force, you'll most likely want to draw a free-body diagram of the falling weight and write out and solve Newton's second law using vector notation.

- (f) The movie ends before the string has become completely unwrapped from the spool. Use your knowledge of \vec{a} , \vec{v}_0 , and \vec{y}_0 , along with the kinematic equations, to determine the vertical position of the falling weight at $t = 3.0 \text{ s}$.