

Rotational Motion

Open-ended Lab

Purpose:

1. Determine the acceleration of a block when released from a pulley system.
2. Using the relationship between linear and rotational acceleration, determine the rotational inertia of the pulley.

Materials: Pulley with a block as illustrated to the left. Motion detector below the mass to measure linear acceleration by collecting distance vs. time data.

Procedure:

A pulley of unknown mass and radius of 0.0365 *meters* will be used in the lab experiment, as shown above. A small mass of 51.5 *grams* is attached to a string; the other end is attached to the pulley and wrapped around it several times. The block is released from rest, and distance vs. time data is collected with a motion detector CBL unit.

Data:

The time *t* is measured for various heights *D* and the data are recorded in the following table.

|  |  |  |
| --- | --- | --- |
| Time (s) | Time^2 (s^2) | Distance (m) |
| 0.28 | 0.0784 | 0.380947 |
| 0.288 | 0.082944 | 0.371507 |
| 0.296 | 0.087616 | 0.360956 |
| 0.304 | 0.092416 | 0.350127 |
| 0.312 | 0.097344 | 0.338466 |
| 0.32 | 0.1024 | 0.326804 |
| 0.328 | 0.107584 | 0.314032 |
| 0.336 | 0.112896 | 0.301259 |
| 0.344 | 0.118336 | 0.287932 |
| 0.352 | 0.123904 | 0.273494 |
| 0.36 | 0.1296 | 0.2585 |
| 0.368 | 0.135424 | 0.243506 |
| 0.376 | 0.141376 | 0.227958 |
| 0.384 | 0.147456 | 0.211576 |
| 0.392 | 0.153664 | 0.195194 |
| 0.4 | 0.16 | 0.178257 |
| 0.408 | 0.166464 | 0.163263 |
| 0.416 | 0.173056 | 0.142716 |
| 0.424 | 0.179776 | 0.125224 |

Data Analysis:

1. What quantities should be graphed in order to best determine the acceleration of the block? Explain your reasoning. The distance vs. time should be graphed in order to take the second derivative of the graph in order to find the acceleration.
2. Plot the quantities determined in (1), title the graph, label the axes, and calculate the linear acceleration of the block. Use this acceleration and Newton’s second law for linear motion to find the tension in the string.

The Acceleration of the graph is -7.772 m/(s^2)

1. Derive an expression for the relationship between the linear acceleration of the block and the angular acceleration of the pulley and the tension in the string.

Because the sum of the forces = ma

T=mg-ma

1. Calculate the rotational inertia of the pulley.

I= Tr/(alpha)=Tr^2/a=((mg-ma)r^2)/a

1.799E-5

1. Is your answer reasonable? Why or why not?

Yes, with very little mass and distance traveled, there is very little rotational inertia.