

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 will be used in the lab experiment, as shown above. A small mass of 51.5 *g* 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.

|  |  |
| --- | --- |
| D (m) | t (s) |
|  |  |
|  |  |
|  |  |
|  |  |

Data Analysis:

1. What quantities should be graphed in order to best determine the acceleration of the block? Explain your reasoning.

Distance v Time because when you take he 2nd derivative of the best fit you can find the acceleration of the block.

1. 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.

S(t) = -3.866x2 + 0.9534x + .4192

A(t)= -7.932 m/s2

T-mg=-ma

T= mg-ma

T= .0515kg\*9.81m/s2-.0515kg\*7.932m/s2

T= .0967 N

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.

T=mg-ma

T=mg-ma

∑Torque= I

Tr= I

(mg-ma)r= I

a=

(mg-ma)r= Ia/r

I= (mg-ma)r2/a

1. Calculate the rotational inertia of the pulley.



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

Yes the answer is reasonable because the gravity is the only force and the pulley has a really tiny radius, therefore the moment of inertia should be small.