First Last Name
Date
Period
Class

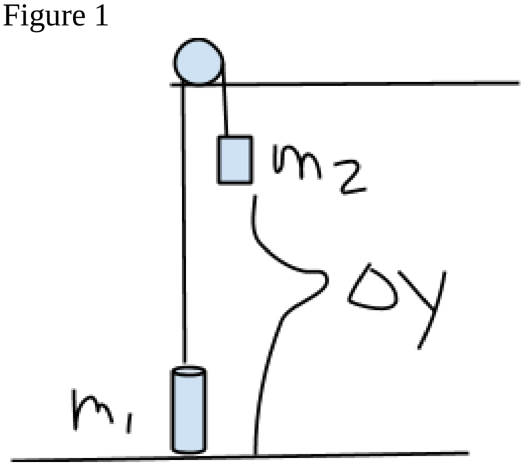
Frictionless Pulley/ Atwood Lab

Introduction: The purpose of the lab is to prove the acceleration of a pulley system between two objects with specific masses. Two objects are sent on a pulley and a theoretical acceleration can be calculated by applying it as a force problem. The lightest is placed on the ground and the heavier object is set upon the top. After the theoretical value is determined, a process of experimentation could be taken place to prove the acceleration with an experimental value.

Materials: Two objects of different: a cylindrical object and prism-based object, stopwatch, frictionless pulley placed on a metal structure, and string (to tie the two objects), meter stick

Procedure: The first step is to find a support that is elevated from the ground such as a table. Then, take frictionless pulley connected to its metal structure and place it on the table. The section of the frictionless pulley must be placed wear the bottom faces the ground and away from the table leaving the rest of the metal body at rest on the table. Then, pick two objects and weigh them on a scale and make sure this difference in mass is not greatly significant. Next, the two objects that have different masses must be tied to each other by a support such as a string. The objects tied to the string are placed onto the pulley in which it makes a system. The two objects have distinct masses: one being lighter than the other. The lighter object is held down to the bottom of the ground and then the heavier is object is pulled to the top. Consider Figure 1. During the experiment the materials should be placed like this and mass 1 object has to be held. The height of the mass 2 object needs to be measured using a meter stick and will be a constant value throughout the experiment. From there, it has to be released causing the mass 2 to fall to the ground. A time is then recorded and the acceleration could be calculated with the formula: $\Delta y = V_{oy}t + \frac{1}{2} at^2$. The acceleration could then be compared to the theoretical.

Figure 1



Observation and Data:

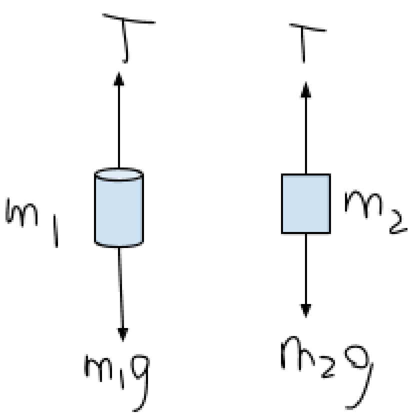
Acceleration Calculation Chart (Experiment Data)

Acceleration (m/s^2)	Time (s)	Height Displacement from position 0 (m)	Trials #
1.07 m/s^2	1.13 s	0.682 m	1
1.36 m/s^2	1.00 s	0.682 m	2
1.07 m/s^2	1.13 s	0.682 m	3
0.76 m/s^2	1.34 s	0.682 m	4
0.92 m/s^2	1.22 s	0.682 m	5

<u>Calculations:</u>

Theoretical Calculations:

Consider figure 1. This system could be set into two free body diagrams. From there, an equation could be derived to solve for the theoretical acceleration.



$m_1a = T - m_1g$ $\quad\quad$ $m_2a = m_2g - T$

$m_1a + m_2a = (T - m_1g) + (m_2g - T)$

$a(m_1 + m_2) = m_2g - m_1g \longrightarrow \quad a = g(m_2 - m_1)/ (m_1 + m_2)$

Given: $m_1 = 0.2002$ kg, $m_2 = 0.2548$ kg, $g = 9.8$ m/s^2

$a = 9.8\ m/s^2(0.2548\ kg - 0.2002\ kg)/ (0.2002\ kg + 0.2548\ kg) \approx 1.18\ m/s^2$

The theoretical value of the system's acceleration is 1.18 m/s^2 .

Experimental Calculations:

Find acceleration using formula: $\Delta y = v_{oy}t + ½ at^2$

Since the experiment depends on how long the heavier object takes to reach the ground when the lighter object is released, the height from the ground of the heavier object is always constant and its initial velocity will be at 0 m/s since it is at rest above the ground. Height: 0.682 meters

Trial # 1: t= 1.13 s
$\Delta y = v_{oy}t + ½ at^2 \rightarrow 0.682$ m= (0 m/s)(1.13 s) + ½ $a(1.13s)^2$ $\approx$1.07 m/s^2

Trial # 2: t=1.00 s
$\Delta y = v_{oy}t + ½ at^2 \rightarrow 0.682$ m= (0 m/s)(1.00 s) + ½ $a(1.00s)^2$ $\approx$1.36 m/s^2

Trial # 3: t=1.13 s
$\Delta y = v_{oy}t + ½ at^2 \rightarrow 0.682$ m= (0 m/s)(1.13 s) + ½ $a(1.13s)^2$ $\approx$1.07 m/s^2

Trial # 4: t=1.34 s
$\Delta y = v_{oy}t + ½ at^2 \rightarrow 0.682$ m= (0 m/s)(1.34 s) + ½ $a(1.34s)^2$ $\approx$0.76 m/s^2

Trial # 5: t=1.22 s
$\Delta y = v_{oy}t + ½ at^2 \rightarrow 0.682$ m= (0 m/s)(1.22 s) + ½ $a(1.22s)^2$ $\approx$0.92 m/s^2

Average Acceleration: All calculated acceleration/ number of values

Avg Acc = (1.07 m/s^2+1.36 m/s^2+ 1.07 m/s^2+ 0.76 m/s^2+ 0.92 m/s^2)/ 5 $\approx$1.04 m/s^2
The experimental value of the system's acceleration is 1.04 m/s^2

Percentage Error: $$\frac{\text{Acceleration}_{Exp} - \text{Acceleration}_{Theo}}{\text{Acceleration}_{Theo}} \times 100 = \frac{1.04\ m/s^2 - 1.18\ m/s^2}{1.18\ m/s^2} \times 100 = -12\%$$

<u>Conclusion:</u> After the experiment, the experimental acceleration of the pulley system was 1.04 m/s^2 and compared to the theoretical acceleration of 1.18 m/s^2, the yield percentage error was -12 %. According to the data, Trial # 1 and Trial # 3 were the closest to the theoretical acceleration with the time at 1.13 s. In trial # 4, the time was at 1.34s in it had an acceleration at 0. 76 m/s^2. The duration of the time was longer which made the experimental value of trial # 4 for acceleration to be smaller. In trial # 2 at t= 1 second, the acceleration was 1.36 m/s^2 which

deems to be high compared to the theoretical value for acceleration of the pulley system. In order to get a more accurate time, the time needs to be near 1.16 s because a theoretical time could be calculated using the formula: $\Delta y = v_{oy}t + \frac{1}{2} at^2$ where $a=1.18\ m/s^2$, and $\Delta y = 0.682$ m. The cause of errors could be from the misrecording of the time. There could have been an early or late delay in time calculation which distorted the true intentional value of the acceleration for the pulley system.