

Name _____

Section _____

Date _____

LABORATORY 9 *Newton's Second Law on Atwood's Machine*

PRE-LABORATORY ASSIGNMENT

1. A net force of 3.50 N acts on a 2.75 kg object. What is the acceleration of the object? Show your work.

2. Describe the basic concept of the Atwood's machine. What is the net applied force? What is the mass to which this net force is applied? Show your work.

3. An Atwood's machine consists of a 1.060 kg mass and a 1.000 kg mass connected by a string over a massless and frictionless pulley. Use Equation 3 to find the acceleration of the system. Assume that g is 9.80 m/s^2 . Show your work.

4. Suppose that the system in Question 3 has a frictional force of 0.056 N. Use Equation 4 to determine the acceleration of the system. Show your work.

The following data were taken with an Atwood's machine for which the total mass $m_1 + m_2$ is kept constant. For each of the values of mass difference $(m_2 - m_1)$ shown in the table, the time for the system to move $x = 1.000$ m was determined.

$(m_2 - m_1)$ (kg)	0.010	0.020	0.030	0.040	0.050
t (s)	8.30	5.06	3.97	3.37	2.98
a (m/s^2)					
$(m_2 - m_1)g$ (N)					

- From the data above for x and time t , use Equation 6 to calculate the acceleration for each of the applied forces and record them in the table above. Show the calculation for the 0.010 kg mass difference as a sample calculation.
- From the mass differences $(m_2 - m_1)$ calculate the applied forces $(m_2 - m_1)g$ and record them in the table above. Use a value of 9.80 m/s^2 for g . Show the calculation for the 0.010 kg mass difference as a sample calculation.
- Perform a linear least squares fit with the applied force as the vertical axis and the acceleration as the horizontal axis. The slope of the fit is equal to the total mass $(m_1 + m_2)_{\text{exp}}$ and the intercept is the frictional force f . Record those and the value of the correlation coefficient r . (This is the calculation that will be performed for the data of the laboratory.)

$$(m_1 + m_2)_{\text{exp}} = \text{_____ kg} \quad f = \text{_____ N} \quad r = \text{_____}$$

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LABORATORY REPORT

Data Table

$(m_1 + m_2) = 0.4$ kg		$m_p = 0$ kg		$x = 0.315$ m	
$(m_2 - m_1)$ (kg)	t_1 (s)	t_2 (s)	t_3 (s)	t_4 (s)	t_5 (s)
0.012	0.34	0.25	0.29		
0.016	0.23	0.31	0.28		
0.020	0.21	0.23	0.26		
0.024					
0.028					
0.032					

Calculations Table

$(m_2 - m_1)g$ (N)	$\bar{t}$ (s)	α_t (s)	a (m/s ²)
$(m_1 + m_2)_{\text{exp}} =$ kg	$f =$	N	$r =$

SAMPLE CALCULATIONS

1. % Error = $(E - K)/K \times 100\% =$

QUESTIONS

1. According to statistical theory for six data points there is only 1% probability (1 chance in 100) that a value of $r \geq 0.917$ and a 0.1% probability (1 chance in 1000) that a value of $r \geq 0.974$ would be obtained for data that are uncorrelated. Based on this idea, what does your value of r indicate for the level of correlation of your data?
2. Divide the frictional force by the applied force, $(m_2 - m_1)g$, for each applied force and express it as a percentage in the space below. Friction would not be important if these percentages were a few percent, would be small if they were about 10%, and would be very important if they were 25% or greater. Make the best possible statement about the importance of friction for your data.
3. Your value of $(m_1 + m_2)_{\text{exp}}$ should be greater than your recorded value of $(m_1 + m_2)$ because of the effect of the pulley. Perform the calculations needed to determine what fraction of the pulley's mass appears to be included in your value of $(m_1 + m_2)_{\text{exp}}$. If you were to express that fraction as a whole number fraction, which of the following would best fit your data? ($\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$ $\frac{1}{5}$)

5. What concept is this laboratory designed to investigate? Describe the extent to which your data and analysis validate the concept.