EXPERIMENT #4 - PHYSICS 230

Force and Motion

OBJECT: To study forces, including friction, and motion by using inclined planes and other simple accelerating systems.

EQUIPMENT:

pulleys	block	clamps
string	inclined plane	support rods
weights	stop watch	

GENERAL DIRECTIONS:

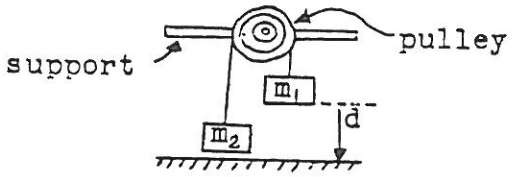
A. Inclined Plane:

1. By using a block on a plane inclined at an angle find the coefficient of static friction for the block and plane. The block should be placed on different parts of the plane and an average value of the coefficient found.

2. Using the same equipment, find the average value for the coefficient of kinetic friction.

B. Atwood's machine:

1. By using the proper combination of weights, the graduated pulley, and supporting system construct the following Atwood's machine:



m_1, m_2 = mass, where $m_1 > m_2$
m_1 and m_2 should be fairly large masses and $m_1 + m_2$ = constant

2. Place the string on the graduated pulley for the smallest pulley radius. From a static condition, release m_1 so that it falls a measured distance d in time t where t may be measured by a stop watch or other timing device. Do this several times to find the best or average value of t for a given d.

3. Repeat this experiment by placing the string on the graduated pulley for each larger pulley radius. In order to avoid small values of time t it may be necessary to read just m_1 and m_2 (but the sum of m_1 and m_2 is always the same).

4. Calculate an algebraic equation which gives the effective retarding force F of the pulley as a function of m_1, m_2, d, t, and the acceleration of gravity. Assume that the effective retarding force includes all friction and the moment of inertia of the pulley and is a constant for a given pulley radius.

5. In order to find the effective frictional force f of the pulley the moment of inertia I of the wheel must be considered as is shown in the following equation:

$$f = F - \frac{2Id}{R^2 t^2} \quad \text{..... where} \quad \begin{cases} I \cong 2700\ \text{g-cm}^2 \text{ (for the plastic graduated pulley)} \\ R = \text{pulley radius (at the string position)} \end{cases}$$

6. Calculate the effective friction force f for each pulley radius and make a graph of f versus R. From this data and from considering what physically is causing the friction determine what the approximate mathematical relation is (or should be) between the effective pulley friction and the pulley radius R where the string is placed. Discuss the physical situation and your conclusions in moderate detail.

7. If the sum of m_1 and m_2 were allowed to vary during this experiment, explain how your results would change.