

The Atwood Machine (With Rotary Motion Sensor)

Newton's Second Law states that the acceleration (\mathbf{a}) of an object is directly proportional to the net (or unbalanced) force (\mathbf{F}_{net}) acting on the object and inversely proportional to the total mass (m_T).

$$\mathbf{a} = \mathbf{F}_{net} / m_T \quad (1)$$

The Atwood Machine is a standard device for the investigation of this relationship. This Machine consists of two masses connected by a string looped over a sensor. (See Figure.) When applied specifically to the Atwood Machine, the acceleration of the descending mass is given by

$$a = (\Delta m / m_T) \cdot g \quad (2)$$

where $\Delta m = M - m$

M = mass of the ascending weights,

m = mass of the descending weights, $m_T = M + m$, and

g = acceleration of gravity.

The acceleration is determined experimentally by using the PASCO 700 Interface and the PASCO Rotary Motion Sensor. This method provides a direct readout of the acceleration of the system by using a photodiode to measure the angular rotational speed of the sensor.

Objective: The objective of this experiment is to study Newton's Second Law of Motion utilizing the Atwood Machine and to show that the acceleration is proportional to the force causing the motion.

Apparatus: Rotary motion sensor, thin string, weight hanger and weights, computer, PASCO Model 700 Interface, printer

Procedure:

1. Verify that the rotary motion sensor is mounted securely and stable.
2. The PASCO Model 700 Interface Must be turned on prior to turning on the computer.
3. Make sure that the support rod is mounted so that the masses can move freely vertically without swinging.
4. Mount the rotary motion sensor and support rod on a table that have sufficient space for the masses to move up and down on either side of the rotary motion sensor. The axis of the sensor should be horizontal and higher than 1 meter

- above the floor.
5. Add weights until the load including the mass of the hanger on each side is 200 g.
 6. Make sure the system machine doesn't move.
 7. In order to avoid negative values of the position x and the velocity v , choose the descending side to be the left side on which you are going to add extra masses.
 8. Add an extra mass of 12 g on the left side and release the system.
 9. From the graph that give the velocity vs. time, t , calculate the acceleration, a , of the motion using the slopes of the lines. Infer the value of the acceleration due to gravity, g , for each extra mass Δm .
 10. Calculate the average of the gravity acceleration, g , and the experimental error.

