PHY 105 Lab Test 1 October 11, 2005 Solutions

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1. a) The theoretical acceleration is found by substituting the given values for the masses into the acceleration formula

$$a_{Th} = \frac{M}{M_{cart} + M} g = \frac{150}{499.1 + 150} g = 2.26467 \,\text{m/s}^2$$

The measured acceleration is deviates from this value by -2.9%. Therefore,

$$a_{meas} = (1 - .029) a_{Th} = 2.199 \,\text{m/s}^2$$

b) This question assumes that the measured acceleration is very precise, and therefore the discrepancy between measured and theoretical acceleration is strictly due to an error in the mass-measurement of the cart. With this assumption:

$$\frac{150}{M_{cart} + 150} g = a_{meas}$$

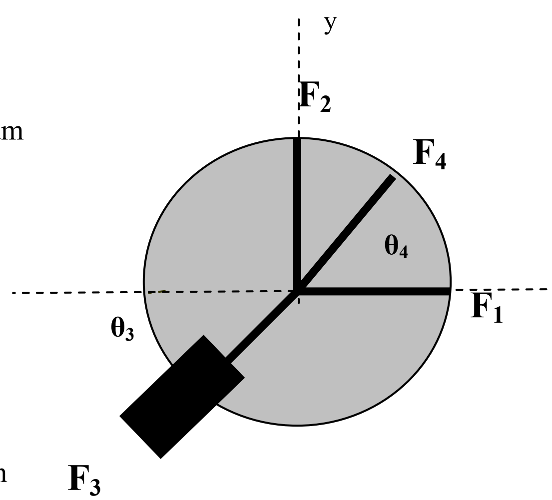
and M_{cart} = 518.46 grams. Considering this to be the true value of the cart's mass, the percent error in the cart-mass measurement is:

$$\frac{499.1 - 518.486}{518.486} \times 100 = -3.7\%$$

2. In addition to describing the basic measurements, set-up, data tables, etc., the lab-write-up of the Atwood machine needed to include

   a) a consideration how to measure the position and velocity of the masses: because they are close together, the motion sensor might "see" both objects at the same time.

   b) A description of how to determine the measured acceleration



3. a) The system is in equilibrium, therefore the vector sum of the forces is 0:

$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 = 0$$

If the y-axis is along the F_2 direction, then the y-components must balance, i.e.

$$F_2 + F_4 \sin\theta_4 = F_3 \sin\theta_3 \ .$$

In this problem, the magnitudes of all forces are known except for F_2. The angles are also given (θ_4= 55°, θ_3= 553°), and therefore F_2 = 3.0126 N, and the mass hanging on string 2 has mass

$$m_2 = \frac{F_2}{g} = 0.307 \,\text{kg}$$

b) Strings 1 and 4 can be replaced with an effective force by writing the forces along these strings in vector-component form:

$$\vec{F}_{eff} = \vec{F}_1 + \vec{F}_4 = m_1 g\hat{i} + \left(m_4 g \cos 55\hat{i} + m_4 g \sin 55\hat{j}\right)$$

And $\vec{F}_{eff} = 3.783\hat{i} + 1.204\hat{j}$ N. The magnitude and angle of this vector with respect to the positive x-axis are then F_{eff}=3.97 N, θ =17.7° . This force requires a mass of 3.97/*g* = 0.405 kg