CALCULATIONS

A. Acceleration vs. Total Mass (Constant Net Force)

1. Using the data in TABLE 1 and *Graphical Analysis*, create the graph **Acceleration *a* vs. Total Mass *m*.** The data should show an inverse relationship. Equation (6.4) is exactly of this form

$$y = \frac{A}{x} \tag{6.5}$$

where the constant $A = (m_2 - m_1)g$ is simply the net force F_{ext} given in Equation (6.2) and the independent variable x is now the total mass $m = m_1 + m_2$. Fit the data to the function shown in Equation (6.5). Record A and σ_A, i.e., F_{ext} and $\sigma_{F_{ext}}$, obtained from your best-fit.

$F_{ext} =$ 0.08981 ± 0.002 (N)

2. From F_{ext} and $\sigma_{F_{ext}}$, calculate and record g using Equation (6.2) and its uncertainty.

$g =$ ________ ± ________ (   )

B. Acceleration vs. Net Force (Constant Total Mass)

1. Using the data in TABLE 2 and *Graphical Analysis*, create the graph **Acceleration *a* vs. Net Force *F*.** The data should show a linear relationship. Again, referring to Equation (6.4) and rewriting it in the form

$$a = \frac{1}{m_1 + m_2} \cdot (m_2 - m_1)g \tag{6.6}$$

we see that it has the form of a straight line $y = Ax$ where the constant (slope) $A = \frac{1}{m_1 + m_2}$ is simply the reciprocal of the total mass and the independent variable x is now the net force $(m_2 - m_1)g$. Construct a best-fit line $y = Ax$ to the data. Record A and σ_A, i.e., $\frac{1}{m_1 + m_2}$ and $\sigma_{\frac{1}{m_1+m_2}}$, obtained from your best-fit.

$\frac{1}{m_1 + m_2} =$ 2.214 ± 0.03 (m/s²)

2. From $\frac{1}{m_1 + m_2}$ and $\sigma_{\frac{1}{m_1+m_2}}$, calculate and record $m = m_1 + m_2$ and its uncertainty.

$m =$ __________ $\pm$ __________ (   )

QUESTIONS

1. From your two graphs, explain in terms of Newton's Second Law of Motion the relationship between acceleration and total mass and between acceleration and net force.

2. Compare the:
   (a) net external force F_{ext} obtained in Part A of the **CALCULATIONS** section of this experiment to the theoretical value recorded above TABLE 1;

   (b) experimental value of g obtained in Part A of the **CALCULATIONS** section of this experiment to the accepted value;

   (c) total mass $m_1 + m_2$ obtained in Part B of the **CALCULATIONS** section of this experiment to the theoretical value recorded above TABLE 2.

3. Consider if friction in the pulleys and/or the mass of the pulleys was not negligible.
   (a) How would this affect your experimental value of g?

   (b) Do these effects appear in your experimental value?

4. In Part B of this experiment, what is the advantage of transferring mass from one side of the Atwood Machine to the other side instead of simply adding mass to one side?

5. (a) If $m_2 = 1.0$ kg and $m_1 = 0.0010$ kg (1.0 g), what, essentially, is the acceleration of the two masses? Explain. (You do not need to explicitly calculate the acceleration.)

   (b) Verify your answer to (a) by taking the limit of Equation (6.4) as $m_2 \to \infty$. NOTE: You must apply l'Hôpital's Rule to evaluate the limit.