Names: Junyu Xu, Alexander Fernandez, Yuxiang Primary School in Beijing

Pulleys: Unknown Masses and Atwood's Machine

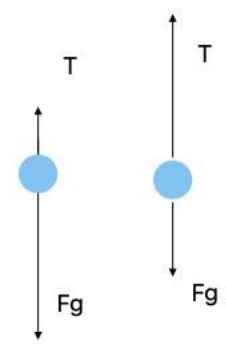
AP Physics C – Mechanics

Objective: I will calculate the acceleration of a system moving in one dimension when a net constant force acts on the system during a known interval of time by deriving a complete Newton's second law statement and testing the theoretical prediction with empirical data.

https://www.compadre.org/Physlets/mechanics/ex4_7.cfm

Procedure/Pre-lab questions

1. Draw free body diagrams for both masses and use Newton's 2nd Law to solve for the magnitude of acceleration of the masses in terms of masses and physical constants as needed.



a is the same because the rope must have tension

Ma=Mg-T

ma=T-mg

2. **2.** In the website, answer (c) at the bottom by using $\Delta y = \frac{1}{2}at^2 + v_0 t$ to solve for acceleration using experimental data for each case (M=m, M>>m, M<m). "M>>m" means make the ratio as big as allowed (much greater than). Identify which cases are true and write them below. Include a sample calculation for one of the three cases.

M=m: a=0

M>>m: y=1/2at^2+vt

12.3=1/2a(1.75)^2

24.6/1.75^2=a

A=8.033m/s/s

Names: Junyu Xu, Alexander Fernandez, Yuxiang Primary School in Beijing

A=g

M<m:

11.9=1/2a(6.8)^2

A=0.515m/s/s

A<0

Analysis Questions

1. If the limit of your expression for acceleration is evaluated when M goes to infinity, what is the magnitude of the acceleration? Justify why this is expected.

$$a = g\frac{(M-m)}{(M+m)}$$

$$\lim_{M\to\infty} g\frac{(M-m)}{(M+m)}$$

$$\lim_{M\to\infty} g\frac{(\infty-m)}{(\infty+m)}$$

$$\lim_{M\to\infty} g$$

This is expected because as M becomes huge, the force pulling it backwards is negligible compared to the total mass and it acts like M is in freefall.

2. In a science laboratory, you set up an Atwood machine and notice that the measured acceleration is lower in magnitude than predicted by Newton's Second Law. List three reasons why this could be and justify why these reasons could be present (format it as follows: "The measured acceleration may be lower than the theoretical value because ______. This is feasible because _______.") . How could we mitigate (reduce) these sources of error?

The measured acceleration may be lower than the theoretical value because of air resistance, virtual mass, the basset force, special relativity, and other factors. This is feasible because air resistance decreases the acceleration down, the virtual mass causes the particle to move air with it, the air is turbulent, and the object has a non-zero velocity which causes the observed mass to slightly increase.

3. Consider your theoretical expression for acceleration. You are provided with a table that details combinations of *m* and *M* (both quantities are listed separately), and measured values for acceleration for each combination. You wish to create a graph using these quantities to estimate the acceleration due to gravity *g*. Which quantities would you graph on each axis so that the straight line has a slope that approximates *g*? You do NOT need to create this graph.

I refuse.

gg

Names: Junyu Xu, Alexander Fernandez, Yuxiang Primary School in Beijing

$$a\frac{(M+m)}{(M-m)} = g$$

a(M+m) on the y, M-m on the x