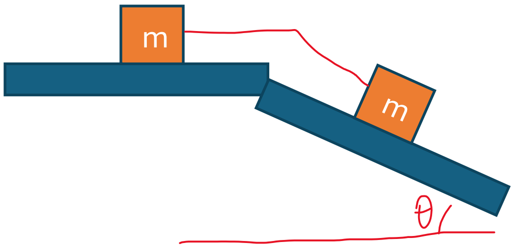
Question: How does having one of the masses of a modified Atwood's machine be on an inclined plane affect the acceleration of the carts?

Hypothesis: The relationship between g sin(theta) and acceleration will be linear. The slope of the graph of acceleration vs. G * sin(theta) will be m2 divided by total mass.



(fig. 1: Modified Atwood's Machine)

Strategy:

- As shown in fig. 1 above, we will have a rope between the two carts, with one cart staying on a horizontal plane, while the other is on an inclined plane.
- We can calculate theta using Trigonometry, and measure acceleration using the Vernier Graphical Analysis tool.
- Our IV, or Independent Variable, will be theta (or g * sin(theta)), since we can change theta ourselves.
- Our DV, or Dependent Variable, was acceleration, since that is what we are measuring.
- We wanted to run three different tests per each theta, and then plot the averages of the results.
- Once we had the averages, we could make a plot in Excel and find the line of best fit, which we then compared to m2/(m1 + m2).
- One can reach m2/(m1 + m2) with the equations presented below.

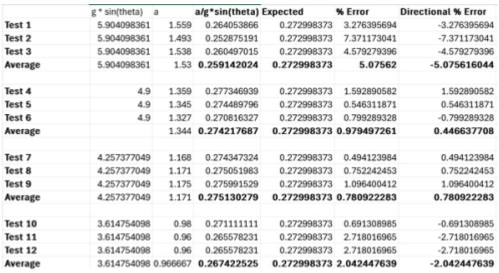
$$Fnet = m1 * a = T, Fnet = m2 * a = m2 * gsin(\theta) - T$$

$$m2 * a = m2 * gsin(\theta) - m1 * a$$

$$a * (m1 + m2) = m2 * gsin(\theta)$$

$$\frac{a}{gsin(\theta)} = \frac{m2}{m1 + m2}$$

Data:



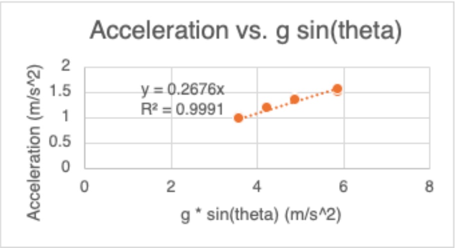
	g * sin(theta)	a	a/g*sin(theta)	Expected	% Error	Directional % Error
Test 1	5.904098361	1.559	0.264053866	0.272998373	3.276395694	-3.276395694
Test 2	5.904098361	1.493	0.252875191	0.272998373	7.371173041	-7.371173041
Test 3	5.904098361	1.538	0.260497015	0.272998373	4.579279396	-4.579279396
Average	5.904098361	1.53	**0.259142024**	**0.272998373**	**5.07562**	**-5.075616044**
Test 4	4.9	1.359	0.277346939	0.272998373	1.592890582	1.592890582
Test 5	4.9	1.345	0.274489796	0.272998373	0.546311871	0.546311871
Test 6	4.9	1.327	0.270816327	0.272998373	0.799289328	-0.799289328
Average		1.344	**0.274217687**	**0.272998373**	**0.979497261**	**0.446637708**
Test 7	4.257377049	1.168	0.274347324	0.272998373	0.494123984	0.494123984
Test 8	4.257377049	1.171	0.275051983	0.272998373	0.752242453	0.752242453
Test 9	4.257377049	1.175	0.275991529	0.272998373	1.096400412	1.096400412
Average	4.257377049	1.171	**0.275130279**	**0.272998373**	**0.780922283**	**0.780922283**
Test 10	3.614754098	0.98	0.271111111	0.272998373	0.691308985	-0.691308985
Test 11	3.614754098	0.96	0.265578231	0.272998373	2.718016965	-2.718016965
Test 12	3.614754098	0.96	0.265578231	0.272998373	2.718016965	-2.718016965
Average	3.614754098	0.966667	**0.267422525**	**0.272998373**	**2.042447639**	**-2.042447639**

(fig. 2: Observed and Calculated Data in Excel)

As seen in fig. 2, we measured acceleration and calculated g * sin(theta) at four different angles. We calculated a/g*sin(theta) to represent the average slope per theta, but we graphed a vs. g*sin(theta) on its own to find the experimental slope. Other than that, all other values that we measured/calculated can be seen on the Excel sheet above.

Analysis:

Now that we had tested multiple different values of theta and received multiple different values of acceleration, we graphed an acceleration vs. g * sin(theta) graph.



(fig. 3: Graph of acceleration vs. g * sin(theta))

As shown in the graph, we had an average slope of .2676, meaning our experimental value for m2/total mass was .2676. Compared with the theoretical value, which is roughly .273 and can be seen in fig. 2, we were quite close. In fact, our average percent error was calculated to be just under 2 percent, which is very good. This means that our original hypothesis was proven true. The reason for our 2% error may be due to air resistance, which would have reduced acceleration, thereby reducing a/g*sin(theta) and reducing our experimental slope (since .2676 is less than .273).

Overall, our experiment was highly accurate, and we were able to correctly find that, with an inclined plane, the graph of acceleration vs. g * sin(theta) is linear with a slope of m2/(m1 + m2).