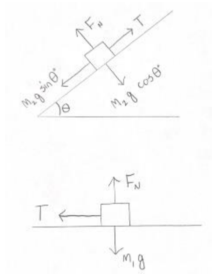
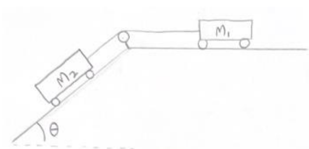
Lydia Metcalf – Dynamics Lab Report



Question: How does the velocity of a cart m_1 on a horizontal track vary with the angle of the incline that the other cart m_2 slides down in a modified Atwood's machine setup?

Hypothesis: The acceleration of the m_1 cart will vary linearly with $m_2 g \sin\theta°$. As θ decreases, $m_2 g \sin\theta°$ will increase, which also increases the acceleration. The slope will be $(m_1 + m_2)$. The y-intercept will be 0, because acceleration is 0 when there is an angle of 0 degrees.

Strategy:



- The horizontal track was laid along a table. Another track was positioned diagonally to the table so that the top of the track touched the edge of the table. Two carts were tied together and allowed to move along the two tracks, as shown in the diagram. The angle of the diagonal track was varied by placing different numbers of books under the bottom of the track, and the hypotenuse and height of the triangle formed were measured to determine θ by taking $\sin^{-1}\left(\frac{height}{hypotenuse}\right)$. The acceleration of the cart on the horizontal track was measured using Vernier sensors at each angle. Friction was ignored due to both sets of cart wheels having negligible friction with the tracks.
- The free body diagrams were used to determine the equation to be used. Using the FBD for m_1, it was found that $T = m_1 a$. Using the FBD for m_2, it was found that $m_2 g \sin\theta° - T = m_2 a$, or $m_2 g \sin\theta° - m_1 a = m_2 a$. This further simplifies to $m_2 g \sin\theta° = (m_1 + m_2)a$. So, a graph with the acceleration on the x-axis and $m_2 g \sin\theta°$ on the y-axis should have a slope equal to $(m_1 + m_2)$.

Analysis:

Change in height (m)	Hyp (m)	Angle (deg)	Acceleration (m/s^2)	m2gsin theta (N)
0.75	1.27	36.2	2.711	1.748
0.63	1.27	29.7	2.279	1.466
0.55	1.27	25.7	1.924	1.283
0.43	1.27	19.8	1.454	1.003
0.33	1.27	15.1	1.037	0.771
0.24	1.27	10.9	0.699	0.560
0	1.27	0	0	0.000

A linear regression was performed on the data noted above, which yielded a slope of 0.6253 kg, representing the total mass. The actual value of the total mass was found to be 0.597 kg when the two carts were massed. This yielded $\frac{0.6253-0.597}{0.597} \cdot 100 = 4.74\%$ error. The low percent error indicates that the hypothesis has been proved. A likely explanation for the error would be a lower value of acceleration than expected due to friction, which we assumed to be negligible.

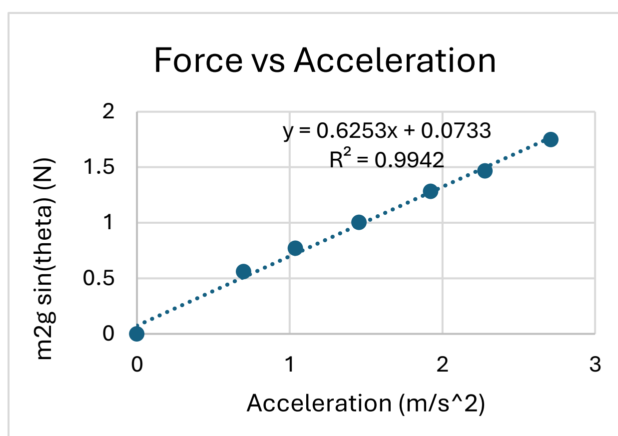


Figure 1: A graph of acceleration and $m_2 g\, sin(\theta)$. The slope represents $(m_1 + m_2)$.