DYNAMICS - Gravitational Forces

Two air tracks, one level and one at an angle of »6.50, form an elementary Atwood machine. Each track has an air cart linked together by a string. The string rides on a pulley between the air tracks. The horizontal cart has a 10-cm flag attached that interrupts one of three LEDs connected to a timing system. The horizontal cart is released at the beginning of the track and the velocity of the cart is measured at set intervals. Acceleration of the carts os determined and compared with theory.

THEORETICAL:

\[ 2ma = mg \sin \theta \]
\[ a = \frac{(g \sin \theta)}{2} \]
\[ a = \frac{98 \text{cm/s}^2}{2} \sin 7.5 \text{ deg} \]
\[ a = 63.9 \text{ cm/s}^2 \]

ACTUAL:

1. \[ a_1 = \frac{2S_2 - 2S_1}{t_2 - t_1} \]
2. \[ a_2 = \frac{2[S_3 - S_1] - 2[S_2 - S_1][2(t_2 - t_1)/(t_2 - t_3)]}{[t_2 - t_1][t_2 - t_3]} \]

\[ a_1 = 60 - 20\left[\frac{t_2}{t_1}\right] \]
\[ a_2 = 100 - 40\left[\frac{(t_3 - t_1)/(t_2 - t_3)}{[t_2 - t_1][t_3 - t_2]}\right] \]
Two airtracks, one level and one at an angle of ~65°, form an elementary Awwood machine.

Each track has an air cart linked together by a string. The string rides on a pulley between the airtracks. The horizontal cart has a 10 cm tag attached that interrupts one of three LEDs connected to a timing system. The horizontal cart is released at the beginning of the track and the velocity of the cart is measured at set intervals. Acceleration of the carts is determined and compared with theory.
Coupled Air Track

Air Track Demo

\[
\theta = \sin^{-1} \left( \frac{15.1}{140.0} \right) = 6.52^\circ \\
\sin \theta = 0.1136, \quad \theta = 6.52^\circ
\]

Tilted Air Track

\[
\begin{align*}
140.0 \text{ cm} & \quad 41.0 \text{ cm} \\
25.0 \text{ cm} & \quad 15.1 \text{ cm}
\end{align*}
\]

Straight Track

\[
\begin{align*}
S_1 &= 10 \text{ cm} \\
S_2 &= 30 \text{ cm} \\
S_3 &= 60 \text{ cm}
\end{align*}
\]

The Physics:

\[
zma = mg \sin \theta \quad \Rightarrow \quad a = g \sin \theta \quad \therefore \quad g = \frac{zma}{\sin \theta}
\]

\[
a = (980 \text{ cm/s}^2)(0.1136)(\frac{1}{2}) = 55.66 \text{ cm/s}^2
\]

\[
\begin{align*}
a_{\text{exp}} &= \frac{z_s}{t_s^2} \\
a = &\frac{55.66 \text{ cm/s}^2}{2} \\
a_{\text{avg}} &\text{ and } \sigma_{\text{exp}}
\end{align*}
\]

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