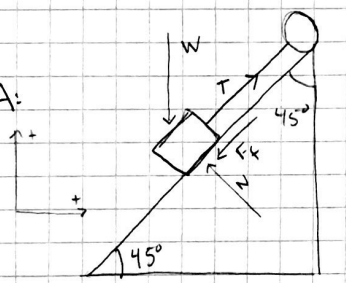
20-P-FA-AF-009

Multidimensional Motion

Q: A pulley outputs a force as a fcn of time, $F = At$. on a block of a mass of M kg. After a change in time of T s, what is the displacement (on the slope)?

A:



$\uparrow + \sum F = ma_y = T\sin\theta - W + N\sin\theta - F_f \sin\theta$

$\rightarrow + \sum F = ma_x = T\cos\theta - N\cos\theta - F_f\cos\theta$

$W = Mg = N$, $F_f = \mu N$, $T = A \cdot t$

$\theta = 45°$

$$a_y = \frac{T\sin\theta - W + N\sin\theta - F_f\sin\theta}{M} \quad , \quad a_x = \frac{T\cos\theta - N\cos\theta - F_f\cos\theta}{M}$$

use $t = T$

$$a_y = \frac{1}{M}\left[At\sin\theta + Mg\left[\sin\theta - \mu\sin\theta - 1\right]\right]$$

$$v_y = \frac{1}{M}\left[A\frac{t^2}{2}\sin\theta + Mg\left[\sin\theta\, t - \mu\sin\theta\, t - t\right]\right]$$

$$s_y = \frac{1}{M}\left[A\frac{t^3}{6}\sin\theta + Mg\left[\sin\theta\frac{t^2}{2} - \mu\sin\theta\frac{t^2}{2} - \frac{t^2}{2}\right]\right]$$

$$a_x = \frac{1}{M}\left[At\cos\theta - Mg\left[\cos\theta - \mu\cos\theta\right]\right]$$

$$v_x = \frac{1}{M}\left[A\frac{t^2}{2}\cos\theta - Mg\cos\theta\left[t - \mu t\right]\right]$$

$$s_x = \frac{1}{M}\left[A\frac{t^3}{6}\cos\theta - Mg\cos\theta\left[\frac{t^2}{2} - \mu\frac{t^2}{2}\right]\right]$$

$$s = \sqrt{s_y^2 + s_x^2}$$

$$s_y = \frac{1}{M}\cdot\frac{T^2}{2}\left[A\frac{t}{3}\sin\theta - Mg\left[\sin\theta\,\mu - 1\right]\right]$$

$$s_x = \frac{1}{M}\frac{t^2}{2}\cos\theta\left[A\frac{t}{3} - Mg\left[1 - \mu\right]\right]$$

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