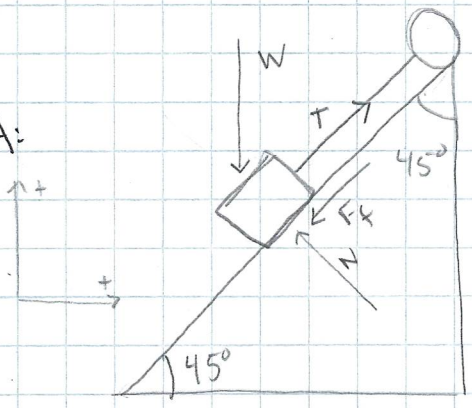
20-P-FA-AF-009

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 displacent (on the slope)?

A:



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

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

$$W = Mg = N \quad , \quad F_f = \mu N \quad , \quad T = A \cdot t$$
$$\theta = 45^\circ$$

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

use $t = T$

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

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

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

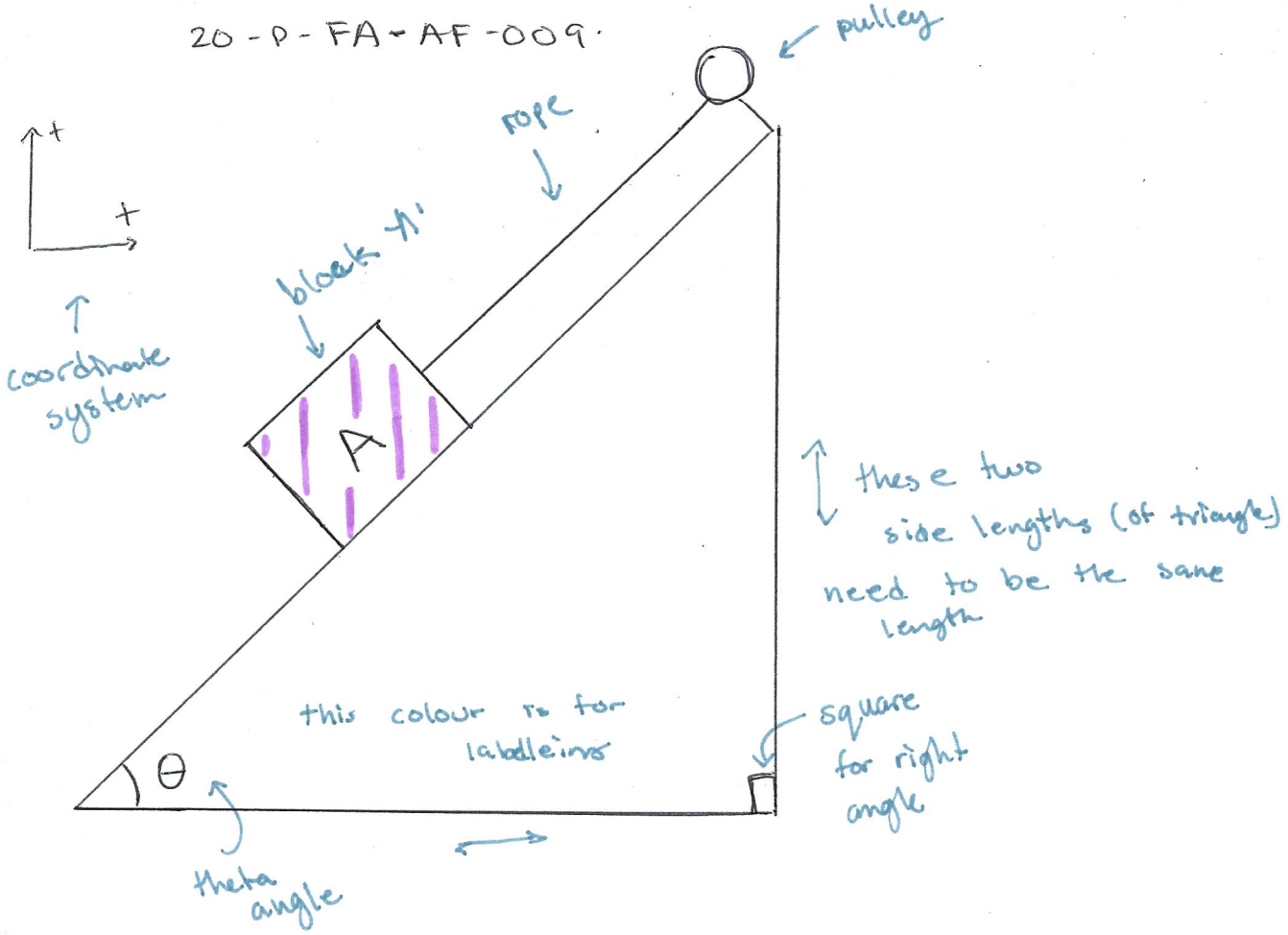
$$a_x = \frac{1}{M}\left[At\cos\theta - Mg\left[\cos\theta - \mu\cos\theta\right]\right]$$

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

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

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

20-P-FA-AF-009.


pulley
rope
block 'A'
+
+
coordinate system
A
these two side lengths (of triangle) need to be the same length
this colour is for labelling
square for right angle
θ
theta angle