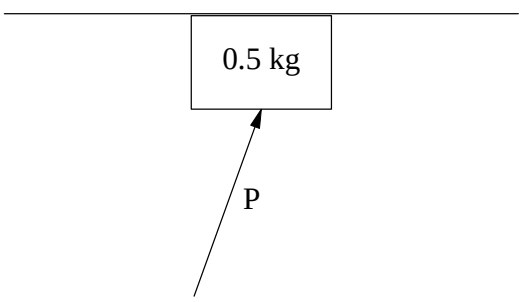
4. (40 pts.) A student slides a 0.5 kg box along the *ceiling* by pushing upwards at an angle of 70° from the ceiling, as shown in the figure. The coefficient of kinetic friction is 0.4, and the box accelerates along the ceiling with an acceleration of 2 m/s^2.



a. (5 pts.) Draw a carefully-labeled free body diagram for the box. Label each force with a symbol.

b. (25 pts.) What is the magnitude of the force the student exerts on the box?

c. (10 pts.) In unit vector notation, what is the total force exerted by the ceiling on the box? Be sure to indicate your axes clearly on a diagram.

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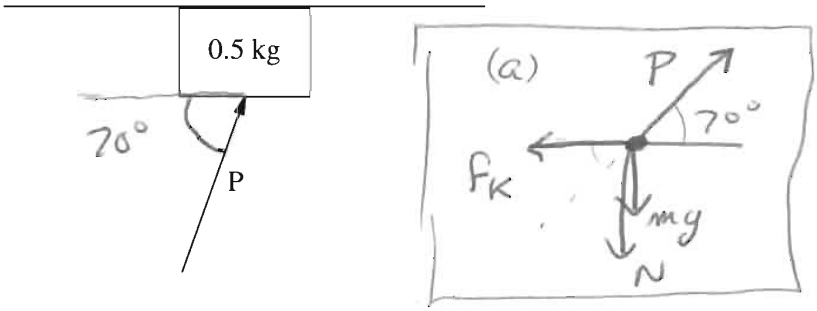

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$\Sigma F_x = m a_x$

$P\cos 70° - f_K = m a_x$

$P\cos 70° - \mu_K N = m a_x$

$\Sigma F_y = m a_y$

$P\sin 70° - N - mg = 0$

$N = P\sin 70° - mg$

← plug back in

$P\cos 70° - \mu_K (P\sin 70° - mg) = m a_x$

$P[\cos 70° - \mu_K \sin 70°] + \mu_K mg = m a_x$

$P[\cos 70° - \mu_K \sin 70°] = m(a_x - \mu_K g)$

$P[-0.0339] = 0.5(2 - 3.92)$

(b) $\boxed{P = 28.4\ N}$

(c) $\vec{F}_c = -f_K \hat{i} - N\hat{j}$ $\quad N = P\sin 70° - mg = 21.7\ N$

$\boxed{\vec{F}_c = -8.70\hat{i} - 21.7\hat{j}}$