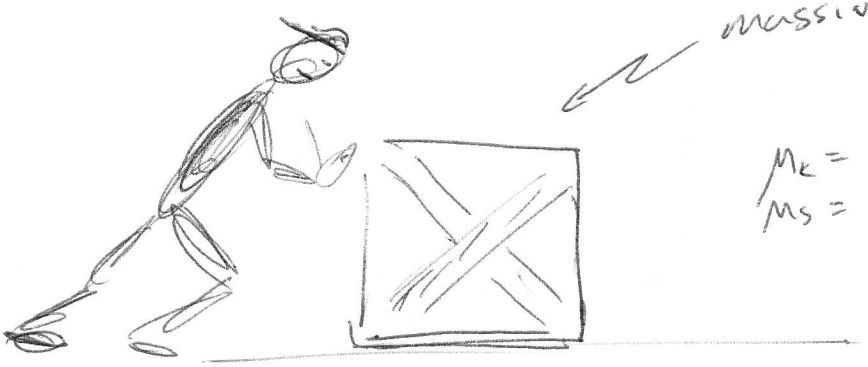
Problem Solving Guidelines

FOCUS the PROBLEM

Picture and Given Information



$\mu_k = 0.3$ $\quad m = 70\,kg$

$\mu_s = 0.5$ $\quad \theta = 50°$

Question(s)

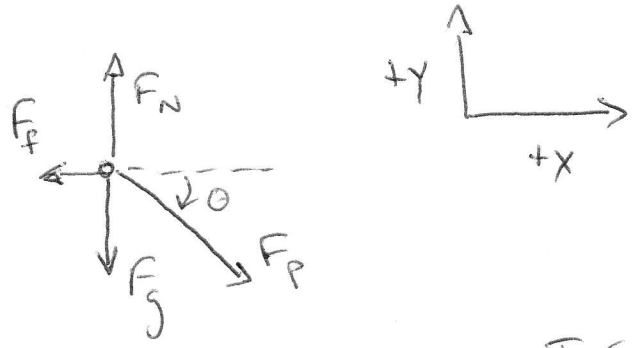
Find Force (min) needed to keep box moving.

Approach

$\sum F = ma$ constant velocity means $a = 0$

DESCRIBE the PHYSICS

Schematic Diagram(s) (Free Body Diagrams) and Define Variable Quantities



Target Quantity(ies)

F_p

Quantitative Relationships

Trig relationships

$F_{px} = F_p \cos\theta$

$F_{py} = F_p \sin\theta$

$\sum \vec{F} = m\vec{a}$

$F_f = \mu F_N$

$v = v_0 + at$

$F_g = mg$

X: $F_p \cos\theta - F_f = ma_x = 0$

Y: $F_N - F_g - F_p \sin\theta = ma_y = 0$

$F_f = \mu_k F_N$ use kinetic coef since box is moving

PLAN the SOLUTION

eq num unknown

$F_N = F_g + F_p \sin\theta$

$F_f = \mu_K F_N = \mu_K F_g + \mu_K F_p \sin\theta$

$F_p \cos\theta - \mu_K F_g - \mu_K F_p \sin\theta = 0$

$F_p (\cos\theta - \mu_K \sin\theta) = \mu_K F_g$

Sufficient equations?

Yup – 3 equation and 3 unknowns

Work to target

$$F_p = \frac{\mu_K mg}{(\cos\theta - \mu_K \sin\theta)}$$

Check Units

Yup!

$[N] = [\,][kg][m/s^2]$ ✓

[ ]

EXECUTE the PLAN

Calculate Target Quantity(ies)

For Pushing Box

$$F_p = \frac{\mu_K mg}{(\cos\theta - \mu_K \sin\theta)}$$

EVALUATE the ANSWER

Is Answer Properly Stated?

NOTE: There is an best angle to pull.. and it is not 0°

Is Answer Complete?

Why is Answer Reasonable?

$m \uparrow$ $F_p \uparrow$

$\mu_K \uparrow$ $F_p \uparrow$

$\theta \uparrow$ $F_p \uparrow$ (this is harder to see ... $\cos\theta \downarrow$ $\sin\theta \uparrow$ so denominator is getting smaller!

For $\theta = 0°$

$F_p = \mu_K mg = (0.3)(70kg)(9.8 m/s^2) =$ 206N

For $\theta = 50°$ (down or Push)

$F_p = 498N$

For $\theta = -50°$ (up or Pull)

$F_p = 236N$

Better to pull the box →