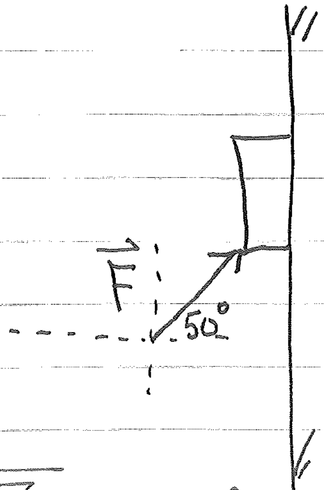
EX] A book worm (someone who reads) is pressing a book up against a vertical wall as shown.

Find the min.* and max. force @ which book worm can press w/o moving the book.

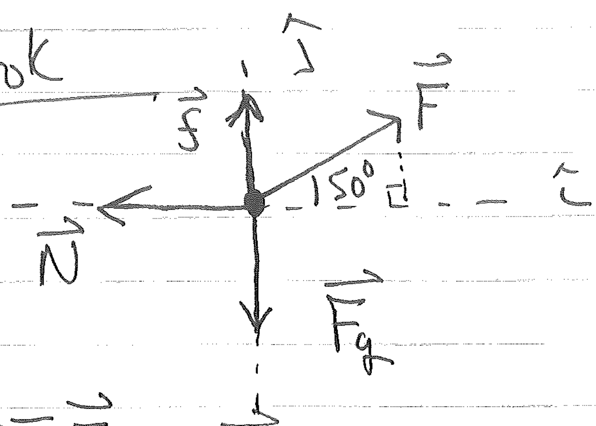


Coeff. of static friction between book and wall is $\mu_s = 0.01$

Mass of book is 0.5 kg

* Assume that we are barely holding the book up. *

for the book



$$\vec{F_g} = -mg\,\hat{j}$$
$$\vec{N} = -N\,\hat{i}$$
$$\vec{f} = +\mu_s N\,\hat{j}$$
$$\vec{F} = +F\cos(50)\,\hat{i} + F\sin(50)\,\hat{j}$$

2nd $\sum \vec{F} = m\vec{a}$

$[\hat{i}]$ $\sum F_x = m\cancel{a_x}^{\,0}$ "Static Equilibrium"

$-N + F\cos(50) = 0$

$[\text{I}]$ $\boxed{N = F\cos(50)}$

$[\hat{j}]$ $\sum F_y = m\cancel{a_y}^{\,0}$

$-mg + \mu_s N + F\sin(50) = 0$

$\uparrow$ $F\cos(50)$ from $[\text{I}]$

$$-mg + F(\mu_s\cos(50) + \sin(50)) = 0$$

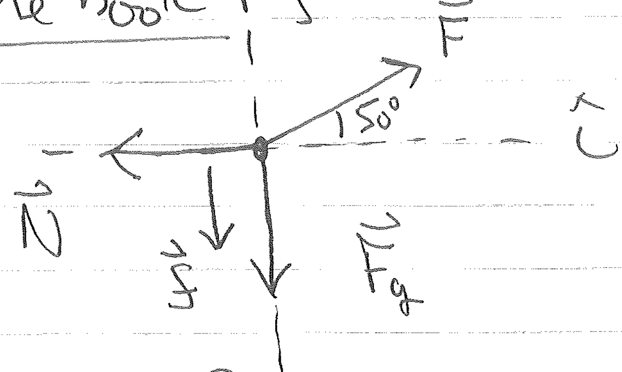
$$F = \frac{mg}{(\mu_s\cos(50) + \sin(50))} = 6.34\ N$$

newtons

$$\therefore N = F\cos(50) = 4.08 \text{ newtons}$$

To get maximum Force, assume that we are almost sliding book up the wall. friction is stopping us.

for the book :



$$\vec{F}_g = -mg\,\hat{j}$$
$$\vec{N} = -N\,\hat{i}$$
$$\vec{f} = -\mu_s N\,\hat{j}$$
$$\vec{F} = +F\cos(50)\,\hat{i} + F\sin(50)\,\hat{j}$$

2nd $\sum \vec{F} = m\vec{a}$

$\boxed{\hat{i}}$ $\sum F_x = \cancel{ma_x}^{\,0}$

$$-N + F\cos(50) = 0$$

$$\boxed{N = F\cos(50)}$$

$\boxed{\hat{j}}$ $\sum F_y = \cancel{ma_y}^{\,0}$

$$-mg - \mu_s \underset{\uparrow\ F\cos(50)}{N} + F\sin(50) = 0$$

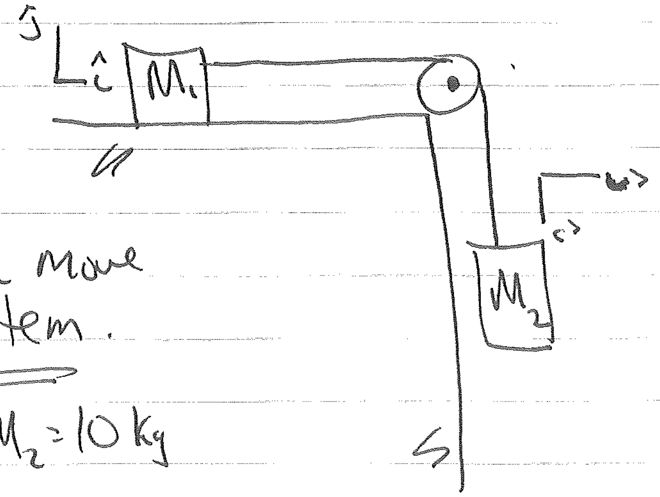
$$-mg + F(-\mu_s \cos(50) + \sin(50)) = 0$$

$$F = \frac{mg}{(\sin(50) - \mu_s(\cos(50))} = 6.45\ N$$

newtons

$$\therefore\ N = F\cos(50) = \underline{\underline{4.15 \text{ newtons}}}$$

EX]



[No friction. *
Massless rope.
Massless pulley

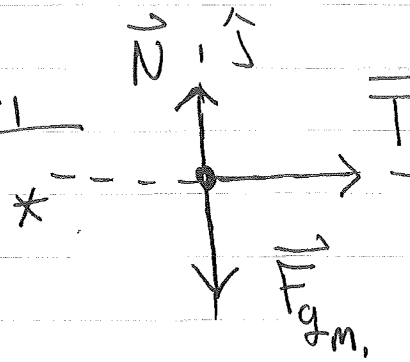
M_1 and M_2 move as a <u>system</u>.

$M_1 = 5\text{ kg}$, $M_2 = 10\text{ kg}$

If starts from rest, how long does it take M_2 to move 2 meters?

= Start w/ Newton:

<u>for M_1</u>



$$\left[\begin{aligned} \vec{F}_{g_{M_1}} &= -M_1 g\,\hat{j} \\ \vec{N} &= +N\,\hat{j} \\ \vec{T} &= +T\,\hat{i} \end{aligned}\right.$$

2^{nd} $\quad \sum \vec{F} = M_1 \vec{a}$

$$\boxed{\hat{j}} \quad \sum F_y = M_1 \cancel{a_y}^{\,0}$$

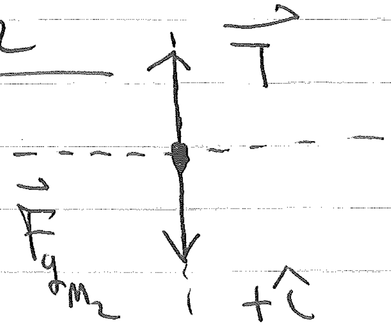
$$-M_1 g + N = 0$$

$$\boxed{N = M_1 g} \quad \boxed{1}$$

$\boxed{\hat{i}}$ $\sum F_x = m_1 a_x$

$$\boxed{T = m_1 a_x} \quad \boxed{2}$$

for m_2



$\vec{T} = -T\,\hat{i}$

$\vec{F}_{g_{m_2}} = +m_2 g\,\hat{i}$

2^{nd} $\boxed{\hat{i}}$ $\sum F_x = m_2 a_x$

$$\boxed{-T + m_2 g = m_2 a_x} \quad \boxed{3}$$

Substitute $\boxed{2}$ into $\boxed{3}$ and solve for a_x:

$\boxed{3} \Rightarrow -m_1 a_x + m_2 g = m_2 a_x$

$$6.53\,\text{m/s}^2 = \frac{m_2 g}{(m_1 + m_2)} = a_x$$

So from $\boxed{2}$, $T = m_1 a_x = 5(6.53) = \underline{32.65\,N}$

For M_2: (Motion w/ constant $a = 6.53\ m/s^2$)

1-d

$t=0,\ v_0=0,\ a=+6.53,\ y_0=0$

$t=t_1$
$y_1 = 2$ meters
$v = v_1$

$+\hat{j}$

$y(t) = y_0 + v_0 t + \frac{1}{2}at^2$
$v(t) = v_0 + at$

$y(t) = 3.265t^2$ $\boxed{1}$
$v(t) = 6.53t$ $\boxed{2}$

@ $t=t_1,\ y_1=2,\ v=v_1$

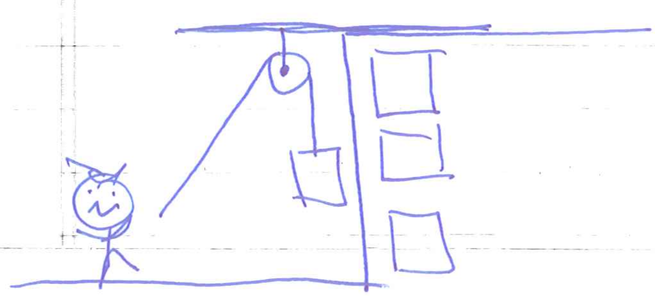
$\boxed{1} \Rightarrow 2 = 3.265t_1^2$
$\therefore t_1 = 0.78$ seconds

Answer

$\boxed{2} \Rightarrow v_1 = 6.53t_1 = 5.1\ m/s$

Ex) A 1000 kg is to be lifted* to the window of a 3rd floor apartment

*@ constant velocity.



Find tensions in the ropes.