ROHININ COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF MECHANICAL ENGINEERING

NAME OF THE SUBJECT: ENGINEERING MECHANICS

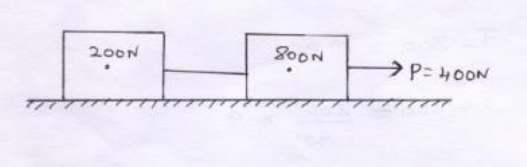
SUBJECT CODE : ME3351

REGULATION 2021

UNIT V: DYNAMICS OF PARTICLES

Problem

Two weight 800N and 400N are connected by a thread and they move along a rough horizontal plane under the action of force P of 400N applied to 800N block, as shown in Fig. Find the acceleration of the weight and tension in the thread.



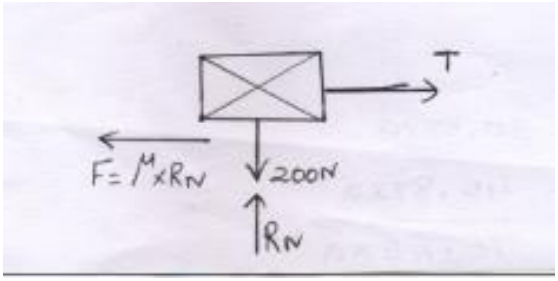
To find

Acceleration a

Tension T

Soln:

Consider block '200N'



$\sum F_Y$=0

$R_N - 200 = 0$

$R_N = 200N$

$\sum F_X$ = m a

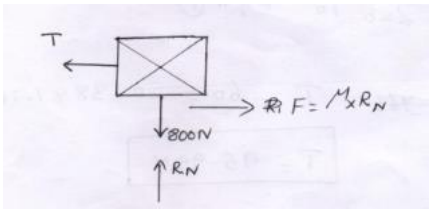
$T = F = m \times a$

$T - \mu \times RN = \frac{200}{9.81} \times a$ μ = 0.3 assume

T−$0.3 \times 200 = 20.38 \times a$

T−$60 = 20.38 \times a$---------->(1)

<u>Consider 800N block</u>



$\sum F_Y$=0

$R_N - 800 = 0$

$R_N = 800N$

$\sum F_X$ = m a

$-T + F_N = \frac{800}{9.81} \times$a

$-T + \mu \times R_N$ =81.54×a

$-T + 0.3 \times 800 = 81.54 \times a$

$-T$ +240=81.54×a

$-T$ +240=81.54×a -------->(2)

Solving Eqn 1&2

T− 60 = 20.38×a

− T+240=81.54×a

180= 101.54×a

a= 180

101.92

a=1.766 m/s^2

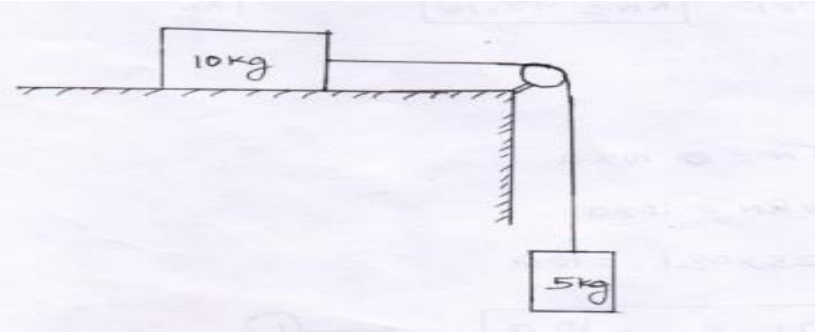
'a' Value sub in Eqn 1

$T - 60 = 20.38 \times 1.766$

$T = 95.99N$

Problem:5

Two blocks of mass 10kg and 5kg are connected as shown in fig. Assume $M_k = 0.25$. Find the acceleration and the tension in the string if pulley is weightless and frictionless.



Given:

$Block\ A = 10kg$

$Block\ B = \ 5kg$

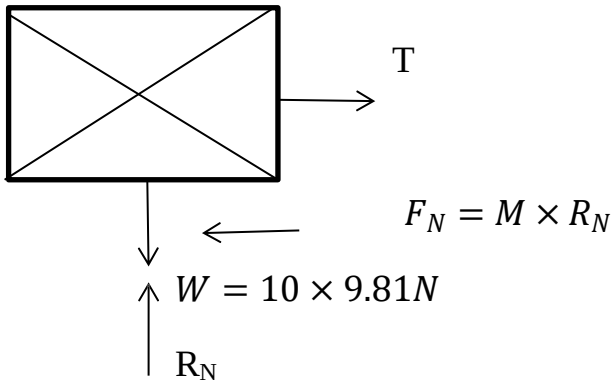
$M_k = 0.25$

To Find:

1. Acceleration a
2. Tension T

Soln:

Consider block A (10kg)



$\sum F_Y = 0$

$R_N - w = 0$

$R_N = w$

$R_N = 98.1\ N$

$\sum F_X = ma$

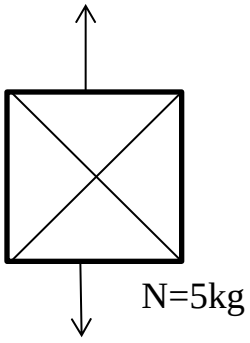
$T - \ F_N = N10 \times a$

$T - M \times R_N = 10 \times a$

$T - 0.25 \times 98.1 = 10a$

$T - \ 24.52 = 10a$ ------> (1)

Consider 5 kg block



$\sum F_Y = \text{m a}$

$T - \ w = m\ a$

$T - 5 \times 9.81 = 5 \times a$

$W = 5 \times 9.81 = 49.05N$

$+T - 49.05 = 5a$------>(2)

Solving Eqn 1&2

$$T - 24.52 = 10\,a$$

$$T - 49.05 = 5\,a$$

$$24.52 = 5\,a$$

$$a = \frac{24.52}{5}$$

$$a = 4.905\ {}^{m}/_{s}\,2$$

'a' Value sub in Eqn 1

$$T - 24.52 = 10\,a$$

$$T = 10\,a + 24.52$$

$$T = 10 \times 4.905 + 24.52$$

$$T = 73.57\ N$$

Problem 6

A block of 1200 N rest on a rough inclined plane at 12° to the horizontal. It is pulled up the plane by means of a light flexible rope running parallel to the plant and passing over a light frictionless pulley at the top of the plane. The portion of the rope beyond the pulley hangs vertically down and carries a weight of 800N at its end.

If Coefficient of friction = 0.2, find a) tension in the rope (b) acceleration with which the body moves up the plane (c) distance moved is after 3sec after starts from rest.

Given:

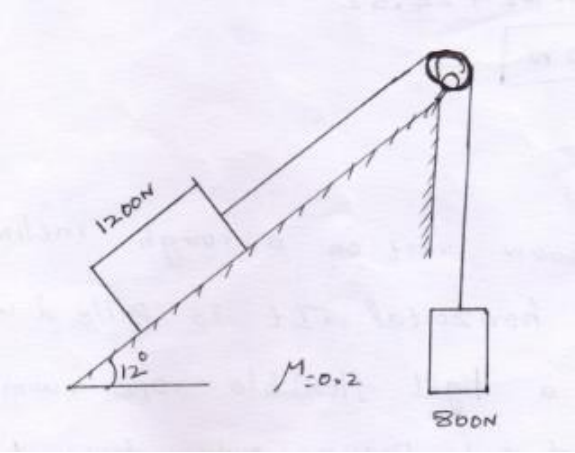
$Coefficient\ of\ friction\ \mu = 0.2$

$Weight\ of\ block\ w = 1200\ N$

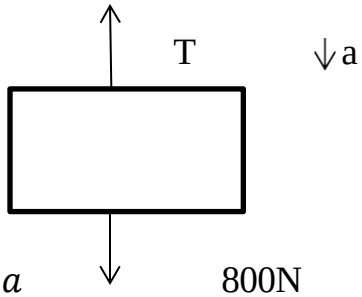
To Find:

1. Tension ‘T’
2. Acceleration ‘a’
3. Distance moved 3sec after starts from rest

Soln:



Consider 800 N block



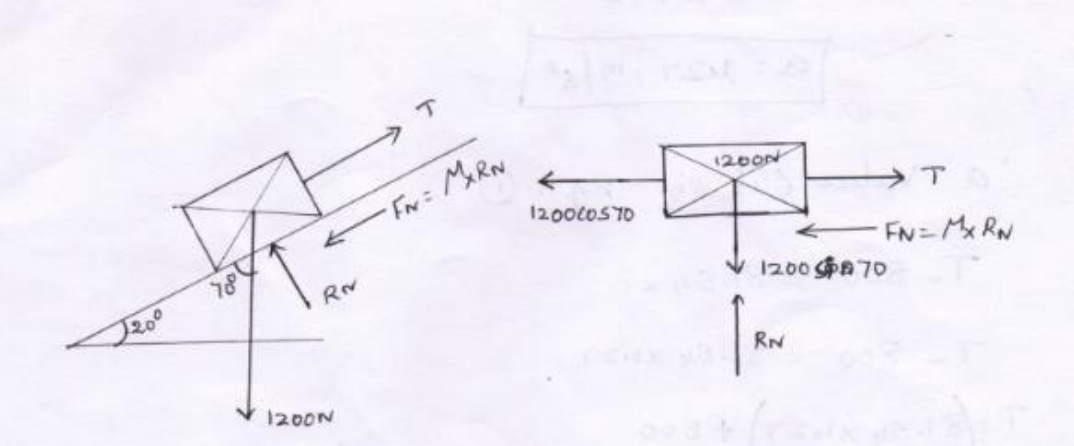
$\sum F_Y =$ m a

$T - 800 =$ m a

$T - 800 = 800/9.81 \times a$

$T - 800 = 81.54\ a$ -----> (1)

Consider 1200 N block:



$\sum F_Y = 0$

$R_N - 1200\ 70 = 0$

$R_N = 1127.63 = 0$

$R_N = 1127.63\ N$

$\sum F_Y =$ m a

$$T - 1200\ cos\ 70 - F_N = m\ a$$

$$T - 1200\ cos - M \times R_N = \frac{1200}{9.81} \times a$$

$$T - 410.42 - 0.3 \times 1127.63 = 122.32 \times a$$

$$T - 410.42 - 338.28 = 122.3 \times a$$

$$T - 748.70 = 122.3 \times a \text{ -------> } \quad (2)$$

Solve Eqn (1) & (2)

$$T - 800 = 81.54\ a$$

$$T - 748 = 122.3\ a$$

$$-51.8 = -40.76\ a$$

$$a = \frac{-51.8}{-40.76}$$

$$a = 1.27\ {}^{m}/_{s}2$$

'a' Value sub in Eqn (1)

$T - 800 = 81.54 \times a$

$T - 800 = 81.54 \times 1.27$

$T = (81.54 \times 1.27) + 800$

$T = 903.55\ N$

Consider kinetic Eqn

To Find Distance

$S = u\,t + \frac{1}{2}\,a\,t2$

$S = 0 \times 3 + 1 / 2(1.27) \times (3)2$

$S = 5.71\ m$

Initial condition

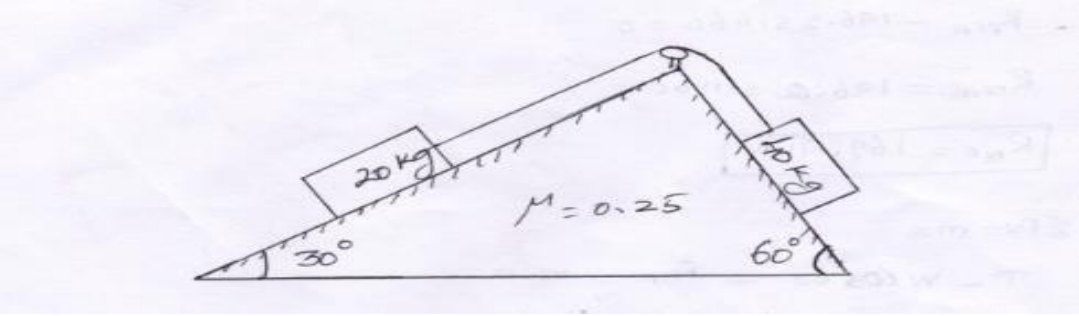
$u = 0$

$a = 1.27\ m/s2$

$t = 3sec$

Problem 7

Two blocks of mass 20 kg and 40 kg are connected by a rope passing over a frictionless pulley as shown in fig. (a) Assuming the coefficient of friction as 0.3 for all contact surfaces. Find the tension in the string and the aueleration of the system. Also compute the velocity of the system after 4 sec starting from rest.



Given:

$Mass\ of\ block\ A\ mA = 20\ kg$

$Mass\ of\ block\ B\ mB = 40\ kg$

$Coefficient\ of\ friction\ \mu\ =\ 0.3$

To Find:

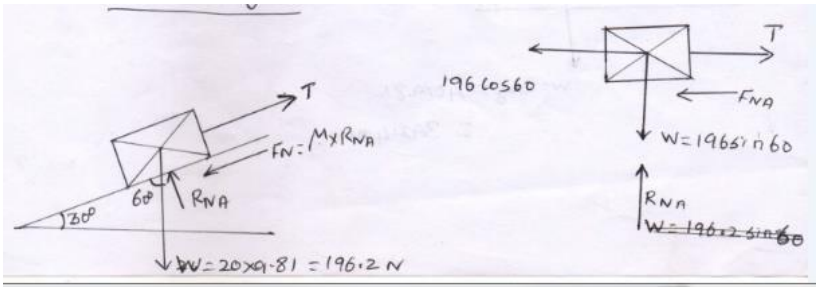
Tension in the string T

Acceleration ‘a’

Velocity of the system after 4 sec

Solution:

Consider 20 kg block



$\sum F_Y = 0$

$R_{NA} - 196.2\ sin\ 60\ =\ 0$

$R_{NA} -\ 196.2\ sin\ 60$

$R_{NA} -\ 169.91\ N$

$\sum F_X =$ m a

$T -\ w\ cos\ 60\ -\ F_{NA} =\ m\ a$

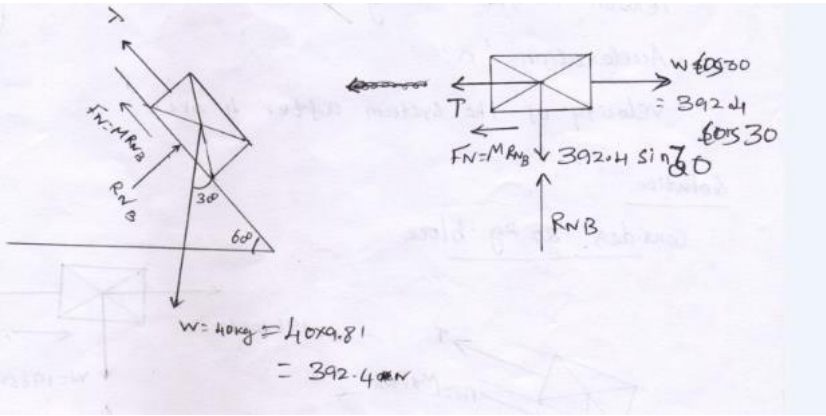
$T -\ 196.2\ cos\ 60\ -\ \mu \times R_{NA} = 20 \times a$

$T - 196.2\ cos\ 60 - 0.3 \times 169.91 = 20 \times a$

$T - 98.1 - 50.973 = 20\ a$

$T - 149.07 = 20\ a$ -----> (1)

Consider 40 kg block



$\sum F_Y$=0

$R_{NB} = -392.4\ sin\ 30 = 0$

$R_{NB} = 392.4 sin\ 30$

$R_{NB} = 196.2N$

$\sum F_x$ =ma

$392.4\ cos\ 30 - T = ma$

$339.82 - 0.3 \times R_{NB} - T = 40 \times a$

$339.82 - 0.3 \times 19.2 - T = 40a$

$280.96 - T = 40a$ ------ >(2)

solve Eqn 1 & 2

T−149.07 = 20a

280.96−T =40a

$$131.89 = 60a$$

$$a = 131.89/60$$

$$a = 2.19\, m/s^2$$

'a' value sub in Eqn (1)

$$T - 149.07 = 20 \times 2.19$$

$$T = 193.03\ N$$

Using kinetic Eqn

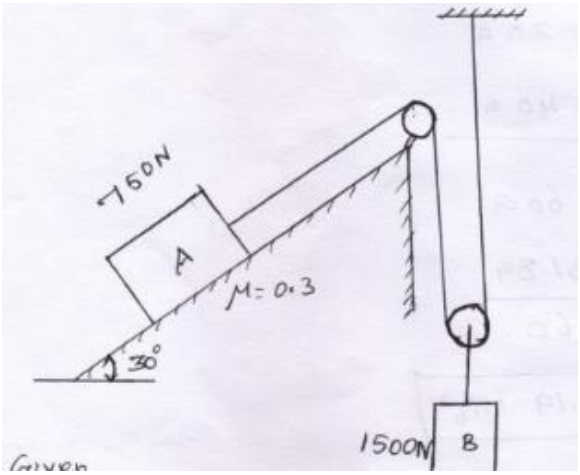
$V = u + at$ u=0 Initial stage

$V = 0 + 2.198 \times 4$ t=4sec

$V = 8.79\, m/sec$

Problem:

Two blocks of weight 750 N and 1500 N start from shown in fig. Find the acceleration of each block and the distance travelled by the 750 N block in 2 sec Also find the tension in the string.



Given:

$Weight\ of\ block\ A\ W_A = 750\ N$

$Weight\ of\ block\ B\ W_B = 1500\ N$

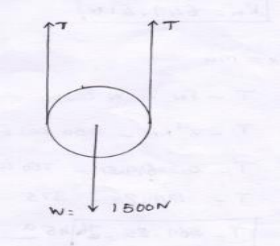
$Coefficient\ of\ friction\ \mu\ =\ 0.3$

To Find:

1. Acceleration
2. Tension
3. Distance travelled by the 750 N in 2 Sec.

Soln

Consider1500N block



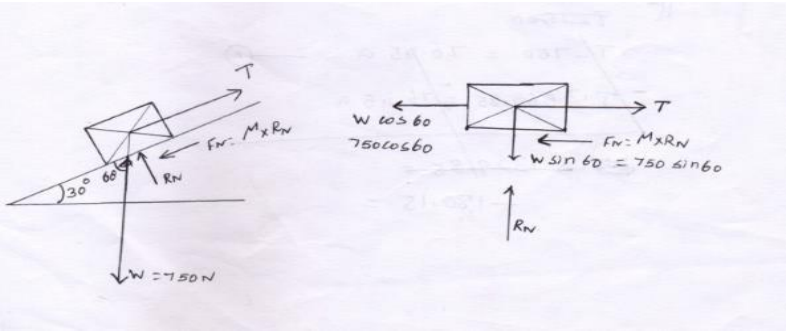
$\sum F_Y = ma$

$2\,T - 1500 = m \times a$

$$2\,T - 1500 = \frac{1500}{9.81} \times a$$

$2\,T - 1500 = 152.90 \times 2a$ ---------> (1)

Consider 750 N block



$\sum F_Y = 0$

$R_N - w \sin 60 = 0$

$R_N = w \sin 60$

$R_N = 750 \sin 60$

$R_N = 649.51N$

$\sum F_X = ma$

$T - F_N - w \cos 60 = ma$

$T - \mu R_N - 750 \cos 60 = \frac{750}{9.81} \times a$

$T - 0.3 \times 649.51 - 750 \cos 60 = 76.45 \times a$

$T - 569 - 85 = 76.45a$ ---------(2)

Solve eqn (1) &(2)

$2T - 1500 = 152.90 \times 2\ a$ ----------(1)

$2\ T - 1500 = 305.8\ a$

$\div 2 \qquad T - 750 = 152.9\ a$ --------> (1)

$T - 750 = 152.90 \times a$ -------> (1)

$T - 569.85 = 76.45 \times a$ ----------> (1)

$-\ 180.15 = 76.45\ a$

$a = \frac{-180.15}{76.45}$

$a = -2.35 {}^{m}/_{s^2}$

a value sub in Eqn (1)

$T - 750 = 152.9 \times (-2.35)$

$T - 750 = 152.9 \times (-359.31)$

$T = 750 = -359.31$

$T = -359.3 + 750$

$T = 390.68\ N$

Distance travelled

$s = ut + {}^{1}/_{2}\, at2$ u=0 t=2

$s = 0 \times 2 + {}^{1}/_{2} \times (-2.35) \times (2)2$

$s = -4.7\ m$