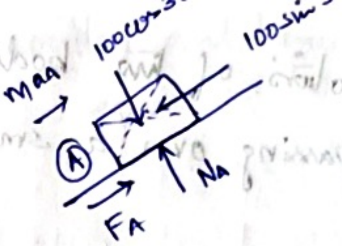
Resolving the forces along the plane



$$F_A + m_A a_A - 100\sin 30 = 0$$

$$\mu_A N_A + m a_A - 100\sin 30 = 0$$

$$(0.25 \times 86.6) + \left(\frac{100}{9.81} a_A\right) - 100\sin 30 = 0$$

$$a_A = 2.78\, m/s^2.$$

let t = time at which the blocks A and B touches each other, after released at same time from rest.

S_A = Distance travelled by Block A in time t

S_B = " " " " B in " "

To find S_A

$$s = ut + \tfrac{1}{2}at^2 \qquad u_A = 0$$

$$S_A = u_A t + \tfrac{1}{2} a_A t^2 \qquad a_A = 2.78\, m/s^2$$

$$S_A = 0 + (\tfrac{1}{2} \times 2.78 \times t^2)$$

$$S_A = 1.39t^2$$

$$S_B = u_B + \tfrac{1}{2} a_B t^2 \qquad u_B = 0, \quad a_B = 3.63\, m/s^2$$

$$S_B = 0 + \tfrac{1}{2} \times 3.63 \times t^2$$

$$S_B = 1.815t^2$$

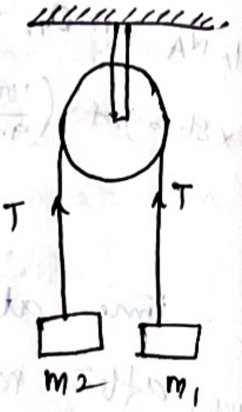
when two blocks touches each other then

$$S_B = S_A + 6$$

$$1.815t^2 = 1.39t^2 + 6$$

$$\boxed{t = 3.75\text{ sec}}$$

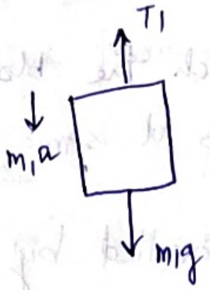
Motion of two bodies connected by a string and passing over a smooth pulley



a = acceleration of bodies in m/s^2

T = Tension in the string in N

Consider the mass m_1



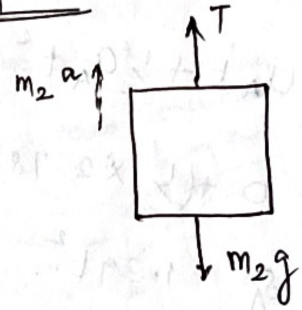
The FBD of m_1 along with inertia force (m_1a)

applying $\Sigma V = 0$

$T_1 - m_1g - m_1a = 0$ (or) $T - m_1g = m_1a \rightarrow$ (1)

$m_1 < m_2$

Consider the mass m_2



$\Sigma V = 0$

$T + m_2a - m_2g = 0$

$m_2a = m_2g - T \Rightarrow$ (2)

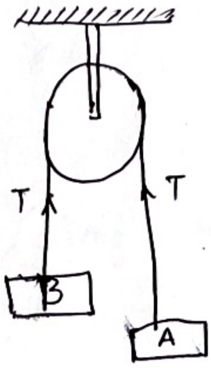
On solving (1) & (2) we can find a, and T.

(P) Two blocks A and B of weight 80N and 60N are connected by string passing through a smooth pulley as shown. Calculate the acceleration of body and the tension in the string.

Given

Weight of block A $W_A = 80N$

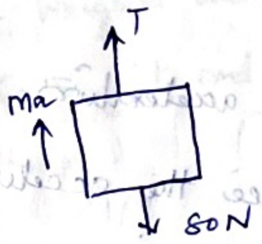
" " " B $W_B = 60N$



The string is passing through smooth pulley and hence the tension on each side of the string will be equal.

Block A moves ↓ Block B moves ↑.

Considering the Block A (moving downwards)

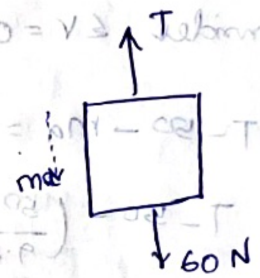


$\Sigma V = 0 \ (\uparrow +)$

$T - 80 + ma = 0$

$T - 80 + \left(\frac{80}{9.81} a\right) = 0 \qquad T + 8.155a = 80 \rightarrow (1)$

Block B (moving ~~down~~ upwards)



$\Sigma V = 0 \ (\uparrow +)$

$T - 60 - ma = 0$

$T - 60 - \left(\frac{60}{9.81} a\right) = 0 \qquad T - 6.116a = 60 \rightarrow (2)$

On solving (1) & (2), we get a and T

$T + 8.155a = 80$

$T - 6.116a = 60$

$a = 1.401 \, m/s^2$

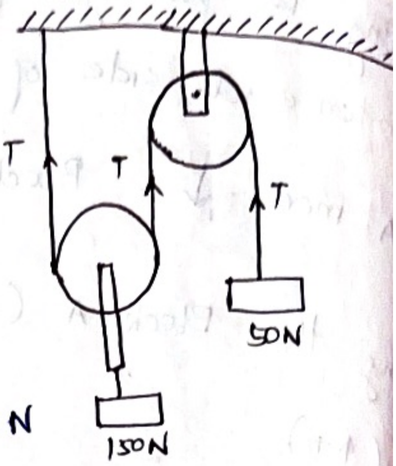
sub a in (1)

$T = 68.57 \, N$

(P) Two blocks of weight 150N and 90N are connected by a string and passing over a frictionless pulley as shown. Determine the acceleration of blocks A and B and tension in the string.

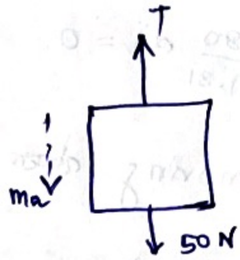
acceleration of two blocks will be not equal becoz

50N block supported by one string
150N " " " two strings



hence acceleration of block 50N is twice the acceleration of block 150 N

Consider 50N (moving upwards)



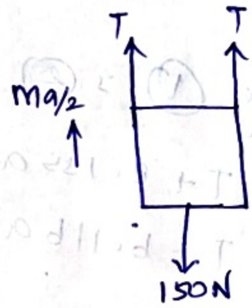
Consider $\Sigma V = 0$

$$T - 50 - ma = 0$$

$$T - 50 - \left(\frac{50}{9.81} a\right) = 0$$

$$T - 5.09a = 50 \rightarrow (1)$$

Consider 150N (moving downwards)



here $a = \frac{a}{2}$ $\quad T = 2T$ → Tension

$$2T - 150 + \frac{ma}{2} = 0$$

$$2T + \left(15.29 \times \frac{a}{2}\right) = 150$$

$$2T + 7.645a = 150 \rightarrow (2)$$

Solve (1) & (2)

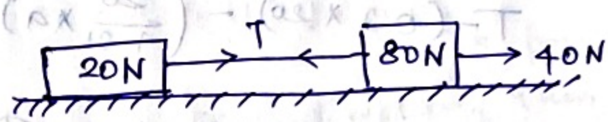
$a = 2.805\ m/s^2$ $\quad T = 64.278$ N

Acceleration of 50N block $a = 2.805\ m/s^2$

" " 150N " $\frac{a}{2} = 1.402\ m/s^2$

(P) ~~Two blocks of weight 80N and~~

(P) Two weights 80N and 20N are connected by a thread and move along a rough horizontal plane under the action of a force 40N, applied to the first weight of 80N as shown. The coefficient of friction between the sliding surfaces of the weights and the plane is 0.3. Determine the acceleration of the weights and the tension in the thread using D'Alembert's principle.

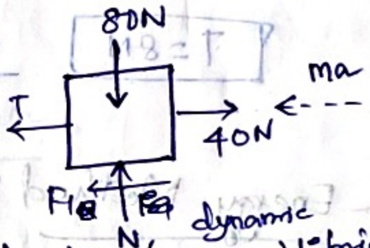


Soln:

a = acceleration of the weights

T = Tension in the thread.

Consider 80N Block.



With the forces, the block will move towards right.

D'Alembert's principle states the body is in equilibrium condition, with the imaginary force "ma" (called inertia force) in opposite direction.

$\Sigma V = 0 \; (\uparrow +)$

$N_1 - 80 = 0$ (or) $N_1 = 80N$

$\Sigma H = 0 \; (\rightarrow +)$

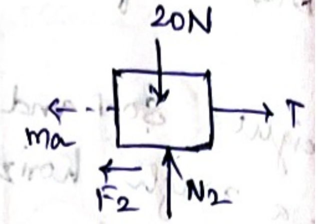
$40 - T - F_1 - ma = 0$

$40 - T - (\mu N_1) - ma = 0$

$40 - T - (0.3 \times 80) - \left(\frac{80}{9.81} \times a\right) = 0$

$T + 8.155a = 16 \rightarrow (1)$

Consider 20N



$\Sigma V = 0 \ (\uparrow +)$

$N_2 - 20 = 0 \quad N_2 = 20\,N$

$\Sigma H = 0 \ (\rightarrow +)$

$T - F_2 - ma = 0$

$T - (\mu N_2) - ma = 0$

$T - (0.3 \times 20) - \left(\frac{20}{9.81} \times a\right) = 0$

$T - 2.038a = 6 \rightarrow (2)$

from eqn (1) & (2)

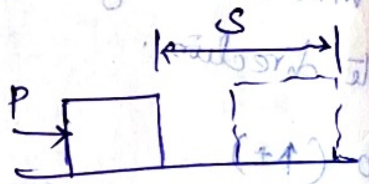
$\boxed{T = 8N}$ $\quad \underline{a = 0.981\ m/s^2}$

Work - Energy Method:

Work ⇒ Product of force and displacement of body.

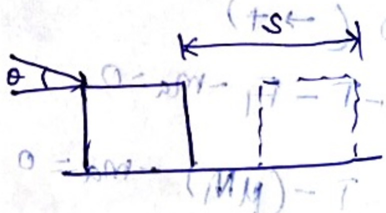
Work done = Force × Distance moved

$= P \times S$



Workdone = Component of force in direction of motion × distance moved

$= P\cos\theta \times S$.



Note:-

1) If WD = 0 if displacement = 0.

2) If force, acting normal to displacement direction will have no work on body.

(i.e) $\theta = 90°$. will have no work on body.

If force and displacement are at right angles then the WD = 0.

3) If the body moves in the same direction of the force, then the WD is ~~zero~~ +ve.

4) If the body moves in the opposite direction of force then the WD is −ve.

$$1\,Nm = 1\text{ Joule}.$$

$$\text{Power} = \frac{\text{Work done}}{\text{time}} = \frac{\text{Force} \times \text{Distance}}{\text{time}}.$$

$$= \text{Force} \times \frac{\text{Distance}}{\text{Time}} = \text{Force} \times \text{Velocity}.$$

Unit of Power = 1 watt.

Energy :-

↳ The capacity of doing work is known as Energy.

Energy
- → Potential Energy
- → kinetic Energy.

Potential Energy → Capacity to do work by virtue of position of the body

(P.E)

$$P.E = \text{Force} \times \text{distance}$$
$$= mg \times h = mgh.$$

Kinetic Energy:

It is the capacity to do work by virtue of motion of body.

work done $= P \times s$ $\quad P = ma$

$v^2 = u^2 + 2as$

$v = 0 \Rightarrow 0 = u^2 + 2as$

$0 = u^2 - 2as$ (due to retardation)

$a = \frac{u^2}{2s}$

Retarding force $P = ma$ or $P = m\left(\frac{u^2}{2s}\right)$

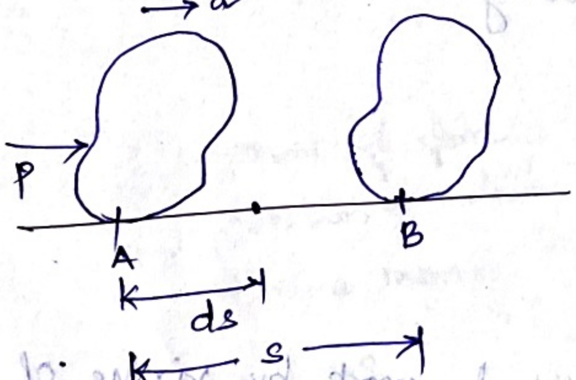
$K.E = P \times s$

$= \frac{mu^2}{2s} \times s$

$K.E = \frac{mu^2}{2}$

$K.E = \frac{1}{2} mv^2$

Work - Energy Equation :-



$P = ma$

$: \frac{W}{g} a \to$ (1)

$= \frac{ds}{dt} \qquad a = \frac{dv}{dt}$

$\cdot ds = \frac{W}{g} a\, ds$

$= \frac{W}{g} \cdot v \cdot \frac{dv}{ds} \cdot ds$

$= \frac{W}{g} \cdot v \cdot dv$

= Workdone = Force x distance

$\frac{W}{2g} u^2$ = Inital K.E

$\frac{W}{2g} v^2$ = Final K.E

Workdone = Final KE − Inital KE

ange in K.E = $\frac{W}{2g}(v^2 - u^2)$.

Two weights 80N and 20N are connected by a
d and move along a rought horizontal plane under
ction of force 40N, applied to the first weight of
as shown. The coefficient of friction between the s
g surfaces of weights and plane is 0.3. Determine the
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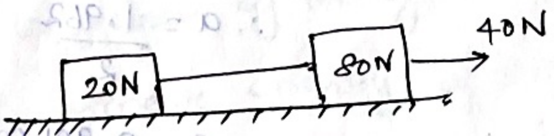
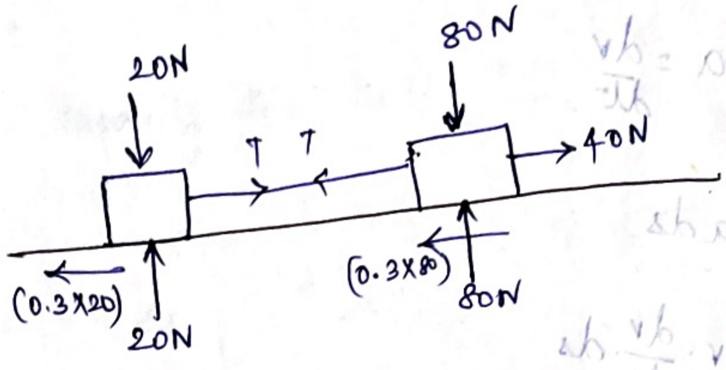
energy eqn.





S → distance moved | u, v → initial & final velocity

With the action of 40N force, the system will move horizontally and forwards right. Net force along this direction Σ

$$\Sigma F_x = 40 - (0.3 \times 20) - (0.3 \times 80)$$

$$= 10N$$

Now applying the work-energy equation,

$$(\Sigma F_x \times S) = \frac{W_1 + W_2}{2g}(v^2 - u^2)$$

ie, $10 \times S = \frac{20+80}{2 \times 9.81}(V^2 - 0)$

($u = 0$, because the system starts moving from rest)

$\therefore 10S = \frac{100}{2 \times 9.81} V^2$ or $V^2 = 1.962S$

Substitute $V^2 = 1.962S$ in the equation $V^2 = u^2 + 2as$

ie $1.962S = 0 + 2as$

$\therefore a = \frac{1.962}{2}$

$a = 0.981 \ m/s^2$

To find T

Apply work-energy equation on any one body.