Two blocks of weights 150N and 50N are connected by a string and passing over a frictionless pulley as shown in figure. Determine the acceleration of blocks A and B & the tension in the string.

Solution:

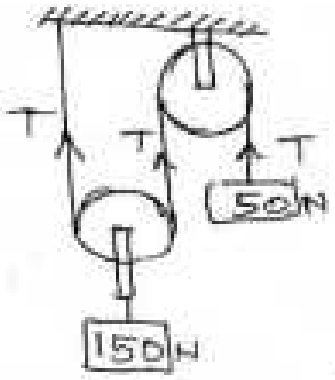
* Weights of blocks 150N & 50N, hence acceleration of these two blocks will not be equal because, the 50N block is supported by a single string.

* But, 150N block is supported by two strings (i.e., string on either side), hence acceleration of block 50N is twice the acceleration of block 150N.

→ Let a = acceleration of block, 50N weight.
T = Tension in the string

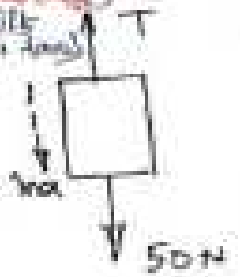
→

150N block is moving downward
50N " " upwards.



Consider 50N Block [moving upwards]

The forces acting on the block along with inertia force



Applying $\Sigma V = 0$

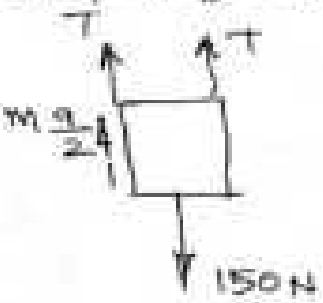
$$T - 50 - ma = 0$$

$$T - 50 - \frac{50}{9.81} \times a = 0$$

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

Consider 150 block [moving downwards]

The forces acting on the block along with the inertia force]



Note that, $a = \frac{a}{2}$ & Tension $= 2T$]

Applying $\Sigma V = 0$

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

$$2T - 150 + \left[\frac{150}{9.81} \times \frac{a}{2}\right] = 0$$

$$2T + \left[15.29 \times \frac{a}{2}\right] = 150$$

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

Solving the equation (i) & (ii) we get "a" and "T"

$a = 2.805 \text{ m/s}^2$ and $T = 64.278 \text{ N}$

∴ Acceleration of 50 N block $(a) = 2.805 \text{ m/s}^2$

∴ Acceleration of 150 N block $\left(\frac{a}{2}\right) = 1.402 \text{ m/s}^2$

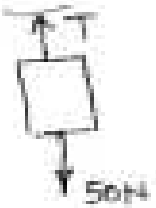
Tension in the string

$T = 64.278 \text{ N}$

Applying Impulse-momentum equation -

$[mu - Ft] = mv$

(Ft) Impulse $= \frac{w}{g}(v-u)$



Consider 50N Block

[Velocity $= 2v$, $u = 0$, $t = t$ sec]

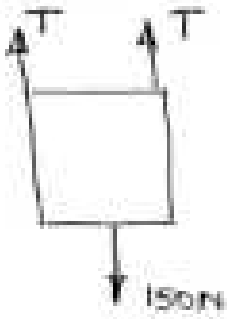
$$(T-50)t = \frac{50}{9.81}(2v-0)$$

[Tension T is in direction of motion, hence it is positive]

$$(T-50)t = \frac{50}{9.81} \times 2v$$

$$T - 50 = 2.548\,v \quad \text{—(1)}$$

Consider 150 N Block



Applying Impulse-Momentum equation,

$$(150-2T)t = \frac{150}{9.81}(v-u)$$

[Tension T is in opposite direction of motion hence it is negative.

$$(150-2T)t = \frac{150}{9.81}v \quad [u=0]$$

$$150 - 2T = 3.822\,v \quad \text{—(2)}$$

Solving the equation (1) & (2)

$v = 5.6$ m/s [Velocity of 150 N Block]

Velocity of 50 N block $= 2v = 11.2$ m/s

$T = 64.278$ N