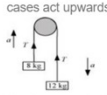
## QUES 06

Two masses 8 kg and 12 kg are connected at the two ends of a light, inextensible string that goes over a frictionless pulley. Find the acceleration of the masses and the tension in the string when the masses are released.

**Sol.** The given system of two masses 8 kg, 12 kg and a pulley can be represented as shown in the following figure. In this case, weights of the two masses act downwards and tension T in the two cases act upwards:




Smaller mass is given by, $m_1$ = 8 kg

Larger mass is given by, $m_2$ = 12 kg

Tension in the string is given by = T

When released, mass $m_2$, owing to its weight, moves downward with acceleration a, and mass $m_1$ moves upward with the same acceleration (as they constitute a single system). Hence,

By applying Newton's second law of motion to the system of masses:

For mass $m_1$:

The equation of motion can be written as given below :

$T - m_1g = ma$ . . .(i) (as the tension T exceeding the weight $m_1g$ causes the motion of mass $m_1$)

For mass $m_2$:

The equation of motion can be written as given below:

$m_2g - T = m_2a$ ...(ii)(here weight $m_2g$ exceeding the tension T causes motion of mass $m_2$)

Adding equations (i) and (ii), we get:

$(m_2 - m_1)g = (m_1 + m_2)a$

$\therefore a = \left(\frac{m_2-m_1}{m_1+m_2}\right)g$ ...(iii)

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Thus, the acceleration of both masses is 2 m/s$^2$.

Substituting the value of 'a' in equation (ii), we get:

$m_2g - T = m_2\left(\frac{m_2-m_1}{m_1+m_2}\right)g$

$T = \left(m_2 - \frac{m_2^2-m_1m_2}{m_1+m_2}\right)g$

$= \left(\frac{2m_1m_2}{m_1+m_2}\right)g$

$= \left(\frac{2\times12\times8}{12+8}\right) \times 10$

$= \frac{2\times12\times8}{20} \times 10 = 96N$

Therefore, the tension in the string is given by 96 N.