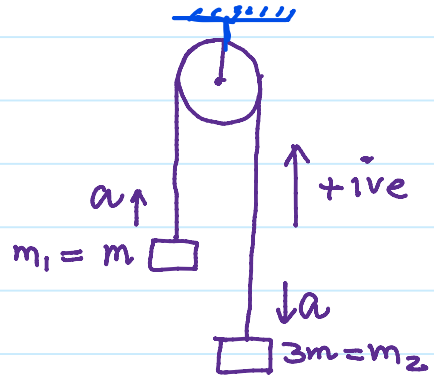
Ex: A pulley fixed to the ceiling carries a string with bodies of masses m and 3m attached to its ends. The masses of the pulley and that of the strings are negligible and friction is absent. Find the acceleration of the centre of mass.



$$a = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g = \left(\frac{3m - m}{3m + m}\right) g = \frac{2m}{4m} g$$

$$\boxed{a = g/2}$$

$m_1 = m$, $m_2 = 3m$

$a_1 = g/2$, $a_2 = -g/2$

$$a_{cm} = \frac{m_1 a_1 + m_2 a_2}{m_1 + m_2}$$

$$a_{cm} = \frac{m \times g/2 + 3m \times (-g/2)}{m + 3m} = \frac{\frac{mg}{2} - \frac{3mg}{2}}{4m} = \frac{-\frac{2mg}{2}}{4m}$$

$$\boxed{a_{cm} = -g/4}$$ ✓

Note :

$$M\vec{a}_{cm} = \vec{F}^{ext} \quad \text{— (1)}$$

$$\vec{a}_{cm} = \frac{\vec{F}^{ext}}{m} \quad \text{— (2)}$$

If $\vec{F}^{ext} = 0$, $\vec{a}_{cm} = 0 \Rightarrow \vec{v}_{cm} = \text{const}$

* So, initially $\vec{v}_{cm} = 0$ even in absence of $\vec{F}^{ext}$