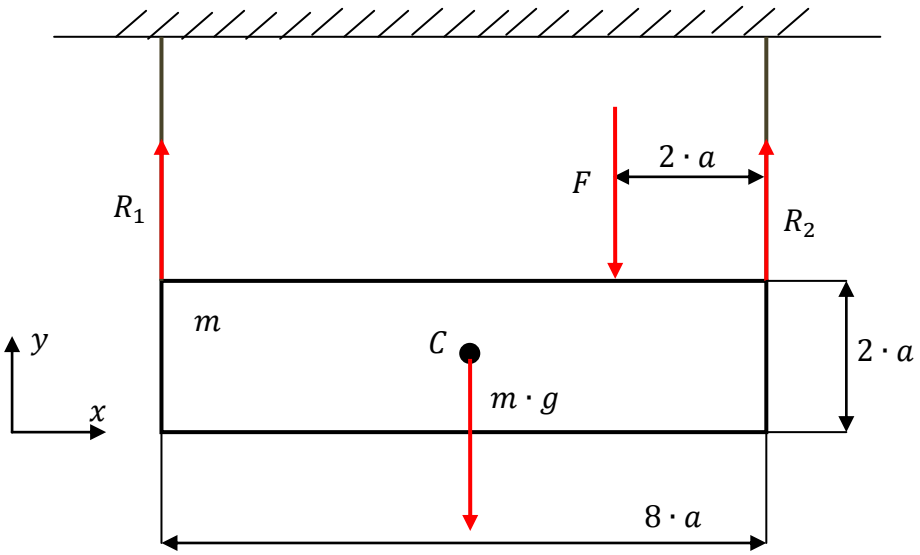
# Mechanics statics – equilibrium equations

Beam is hanged to ceiling via two ropes. Ropes are massless. Beam has mass $m$. Force $F$ works in specified beam's point. In example equilibrium equations for system have to calculated. Reaction forces in ropes also have to be calculated. Beam is under gravity field. Beam has length $8 \cdot a$. Gravity force which works on beam has to be placed in beam's gravity center $C$.

KNOWN: $m[kg], a[m], F[N], g[\frac{m}{s^2}]$




As is seen from drawing, forces work only in y axis direction.

$$\Sigma F_{iy} = 0 \rightarrow -m \cdot g - F + R_1 + R_2 = 0$$

Sum of torques around beam's gravity center $C$. Torques which work in clockwise direction are assumed as positive. Torques which work in counter-clockwise direction are assumed as negative.

$$\Sigma T_{ic} = 0 \rightarrow R_1 \cdot 4 \cdot a + F \cdot 2 \cdot a - R_2 \cdot 4 \cdot a = 0$$

There are two unknowns. Unknowns are reaction forces in ropes $R_1$ and $R_2$.

Reaction force $R_1$ is calculated from equilibrium equations for torques around gravity center point $C$.

$$R_1 \cdot 4 \cdot a = -F \cdot 2 \cdot a + R_2 \cdot 4 \cdot a$$

$$R_1 = -\frac{1}{2} \cdot F + R_2$$

Obtained expression for reaction force $R_1$ is inserted to equilibrium equation for forces in y axis direction.

$$-m \cdot g - F + R_1 + R_2 = 0$$

$$-m \cdot g - F + \left(-\frac{1}{2} \cdot F + R_2\right) + R_2 = 0$$

$$-m \cdot g - F - \frac{1}{2} \cdot F + R_2 + R_2 = 0$$

$$2 \cdot R_2 = m \cdot g + F + \frac{1}{2} \cdot F$$

$$2 \cdot R_2 = m \cdot g + \frac{3}{2} \cdot F$$

$$R_2 = \frac{1}{2} \cdot m \cdot g + \frac{3}{4} \cdot F$$

Expression for reaction force $R_2$ is inserted to equation for reaction force $R_1$.

$$R_1 = -\frac{1}{2} \cdot F + R_2$$

$$R_1 = -\frac{1}{2} \cdot F + \left(\frac{1}{2} \cdot m \cdot g + \frac{3}{4} \cdot F\right)$$

$$R_1 = \frac{1}{2} \cdot m \cdot g + \frac{1}{4} \cdot F$$