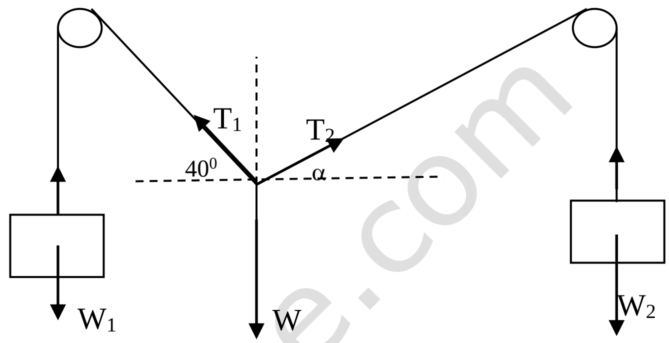
Q- The leg and cast in the figure weigh W = 210 N, with the center of mass as indicated by blue arrow. The counter balance $W_1$ = 140 N. Determine the weight $W_2$ and the angle $\alpha$ needed so that no force exerted on the hip joint by the leg and cast.

The weight of the leg and cast is balanced by the tensions $T_1$ and $T_2$.

Resolving the tensions in horizontal and vertical direction the net horizontal force on the system is given by




$$T_2 \cos \alpha - T_1 \cos 40^0 = 0$$

Gives $T_2 \cos \alpha = T_1 \cos 40^0$

Or $T_2 \cos \alpha = 0.766 * T_1$

As $T_1$ is equal to counter weight $W_1$ and $T_2$ is equal to counter weight $W_2$ we get

$$W_2 \cos \alpha = 0.766 * W_1$$

or $W_2 \cos\ \alpha = 0.766 * 140 = 107.25$ --------------- (1)

Net force on the system in vertical direction is zero and hence we get

$$T_2 \sin \alpha + T_1 \sin 40^0 - W = 0$$

Or $T_2 \sin\alpha + 0.643\, T_1 = 210$

Or $W_2 \sin\alpha + 0.643*140 = 210$

Or $W_2 \sin\alpha = 210 - 89.99 = 120.00$ ---------------- (2)

Squaring and adding equation (1) and (2) we get

$$W_2^2(\cos^2\alpha + \sin^2\alpha) = 107.25^2 + 120.00^2 = 25904.90$$

Gives $W_2$ = 160.95 N

Dividing equation (2) by equation (1) we get

$$\frac{\sin\alpha}{\cos \alpha} = \frac{120.00}{107.25}$$

Or $\tan \alpha = 1.19$

Or $\alpha = 48.21^0$

Hence the weight $W_2$ is **160.95 N**

And the angle $\alpha$ = **$48.27^0$**

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