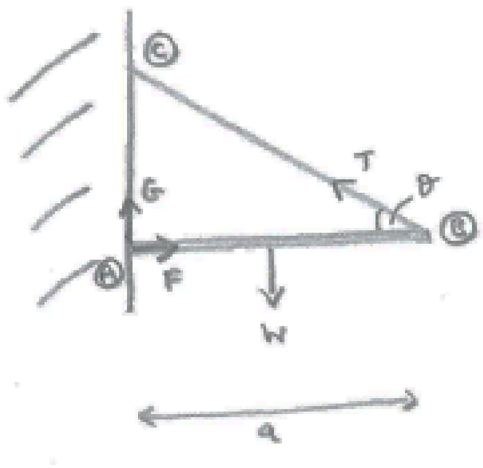
Forces – Q5 [Practice/M] (2/6/21)

[Alternative Moments Methods]



A rod AB is attached to a wall at A, and held in a horizontal position by a rope BC.

Show that, as an alternative to resolving forces horizontally and vertically, and taking moments about A, it is also possible to:

(a) resolve forces horizontally and take moments about A & B,

or (b) take moments about A, B & C;

but that it is not possible to do the following:

(c) resolve forces vertically and take moments about A & B,

or (d) take moments about A, B & the midpoint of AB

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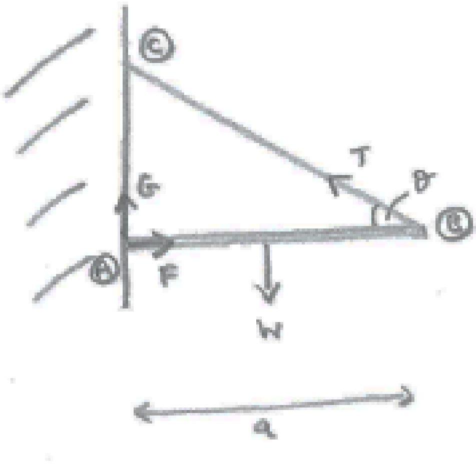

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Solution

Resolving forces horizontally and vertically,

$F = Tcos\theta$ (1) & $W = G + Tsin\theta$ (2)

Taking moments about A gives $(Tsin\theta)a - W\left(\frac{a}{2}\right) = 0$ (3)

Then (3) $\Rightarrow T = \frac{W}{2sin\theta}$

and hence $(1) \Rightarrow F = \frac{Wcot\theta}{2}$

and $(2) \Rightarrow G = W - \frac{W}{2} = \frac{W}{2}$

Following method (a) instead,

resolving horizontally gives $F = Tcos\theta$ (4);

taking moments about A gives $(Tsin\theta)a - W\left(\frac{a}{2}\right) = 0$ (5),

and taking moments about B gives $-Ga + W\left(\frac{a}{2}\right) = 0$ (6)

Then from (6), $G = \frac{W}{2}$;

from (5), $T = \frac{W}{2sin\theta}$,

and from (4), $F = \frac{Wcot\theta}{2}$

Following method (b) instead,

taking moments about A gives $(Tsin\theta)a - W\left(\frac{a}{2}\right) = 0$ (7);

taking moments about B gives $-Ga + W\left(\frac{a}{2}\right) = 0$ (8),

and taking moments about C gives

$F(atan\theta) - W\left(\frac{a}{2}\right) = 0$ (9)

Then from (8), $G = \frac{W}{2}$;

from (7), $T = \frac{W}{2sin\theta}$,

and from (9), $F = \frac{Wcot\theta}{2}$

However, following method (c):

resolving vertically gives $W = G + Tsin\theta$ (10);

taking moments about A gives $(Tsin\theta)a - W\left(\frac{a}{2}\right) = 0$ (11),

and taking moments about B gives $-Ga + W\left(\frac{a}{2}\right) = 0$ (12),

but we have no equation involving F

Also, following method (d):

taking moments about A gives $(Tsin\theta)a - W\left(\frac{a}{2}\right) = 0$ (13);

taking moments about B gives $-Ga + W\left(\frac{a}{2}\right) = 0$ (14),

and taking moments about the midpoint of AB gives

$-G\left(\frac{a}{2}\right) + (Tsin\theta)\left(\frac{a}{2}\right) = 0$,

and once again we have no equation involving F