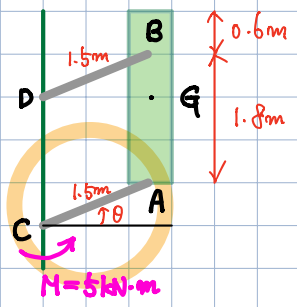
Example 6.2



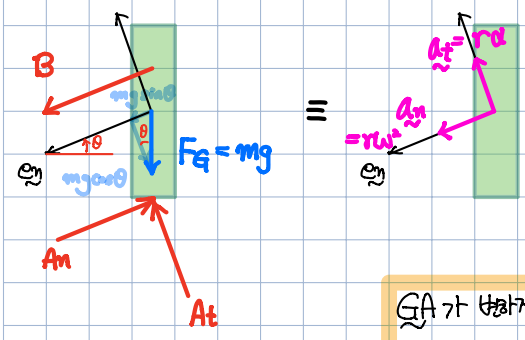
The vertical bar AB = 150 g

The bar is elevated from rest at $\theta = 0°$ with a constant couple $M = 5\,kN\cdot m$ at C

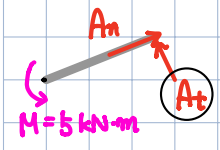
Determine the angular acceleration α of the links as a function of θ.

Find the force B in the link DB at the instant when $\theta = 30°$.

FBD ⟵ Kinematics



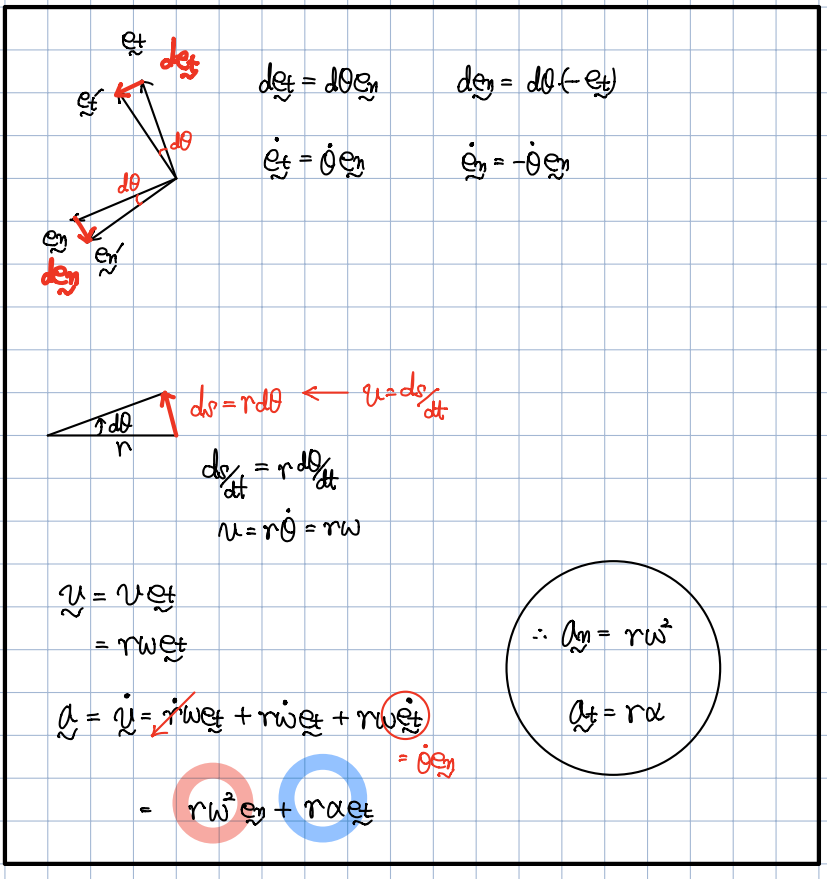
$\overline{a_t} = (a_t)_A = \overline{AC}\,\alpha$



$M = 5\,kN\cdot m$

$= (1.5\,m)\cdot A_t$

$\therefore A_t = 5/1.5 = 3.33\,kN$



$\Sigma F_t = m a_t$

$\Sigma F_t = A_t - mg\cos\theta$

$= (3.3\,kN) - (0.15\,kg)(9.81\,m/s^2)\cdot\cos\theta$

$m a_t = m\bar r\alpha = (0.15\,kg)(1.5\,m)\,\alpha$

$(3.3) - (0.15)(9.81\cos\theta) = (0.15)(1.5)\alpha$

$\alpha = 14.81 - 6.54\cos\theta$ Ans. (rad/s^2)

$\int_0^\omega \omega\,d\omega = \int_0^\theta \alpha\,d\theta$

$= \int_0^\theta (14.81 - 6.54\cos\theta)\,d\theta$

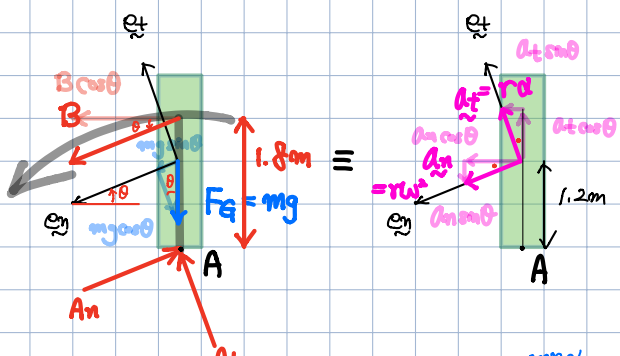
$\frac{1}{2}\omega^2 = 14.81\theta - 6.54\sin\theta$

$\therefore \omega^2 = 29.6\theta - 13.08\sin\theta$

$\theta = 30° \rightarrow \quad \alpha = 9.15\,rad/s^2$

$\omega^2 = 29.6 \times (30°)\cdot \frac{\pi\,rad}{180°} - 13.08\sin 30°$

$= 8.97\,(rad/s)^2$



$\Sigma M_A = m\bar a\cdot d$

$= mr\alpha = (0.15)(1.5)(9.15)$

$= 2.06\,kN$

$\Sigma M_A = (1.8\,m)\cdot(B\cos\theta) = (B\cos 30°)\cdot(1.8)$

$m\bar a\cdot d = (m a_n\cos\theta)(1.2) + (m a_t\sin\theta)(1.2)$

$= (mr\omega^2\cos 30°)(1.2) + (mr\alpha\sin 30°)(1.2)$

$= mr\omega^2 = (0.15)\cdot(1.5)\cdot(8.97) = 2.02\,kN$

$\therefore B = 2.14\,kN$ Ans.