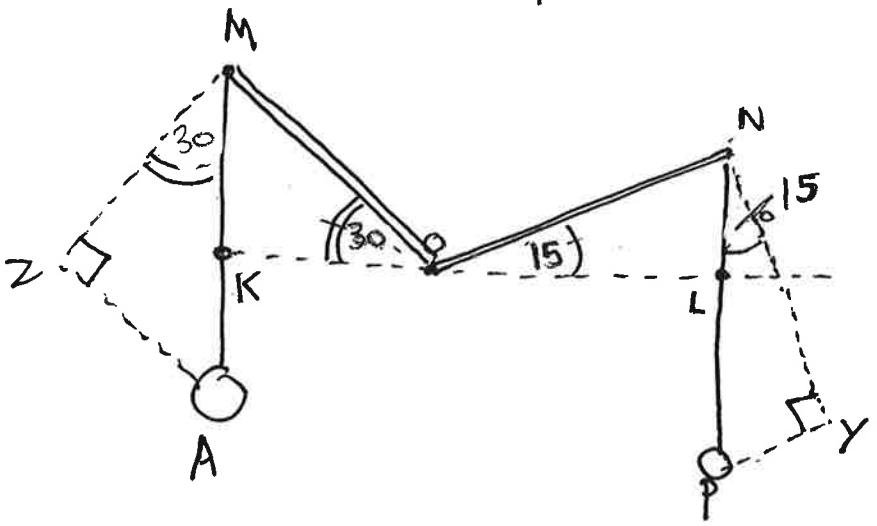
EX 22.3

Newton's wheel problems

The relevant parts of the wheel are sketched here.



$W_A = \frac{2}{3}$, $W_p = 1$

$\overline{ON} = 1$

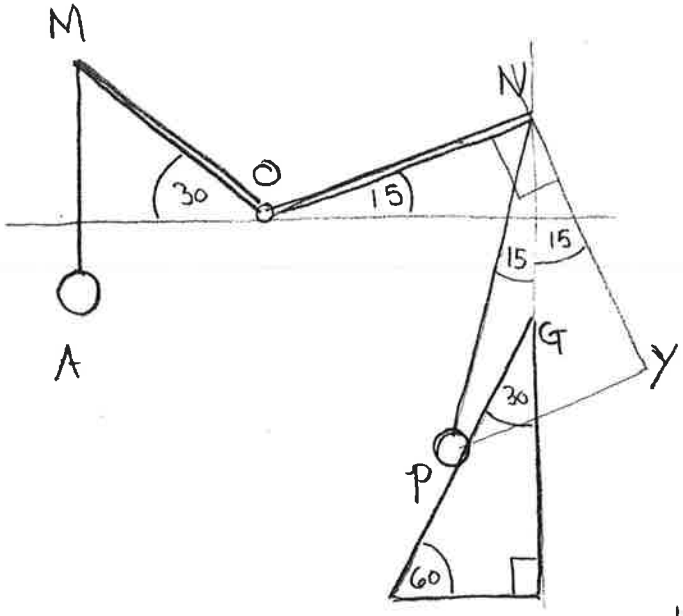
$\overline{OM} = ?$

1) For equilibrium, the CW & CCW moments produced by W_A and W_p must equal. So

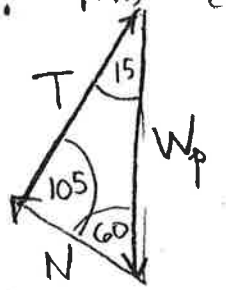
$$\overline{OM}\ W_A \cos(30) = \overline{ON}\ W_p \cos(15°)$$

$$\overline{OM} = \frac{\cos(15)}{\frac{2}{3}\cos(30)}$$

$$\boxed{\overline{OM} = 1.67_m}$$



Once again, the moment turning the wheel CCW is given by $\overline{OM} \cdot W_A \cdot \cos(30)$. What is the moment turning it CW? I need to find the force being exerted by the string at N. This force produces a moment given by $T\cos(\measuredangle pN_y) = T\cos(30)$. So what is T? It must be such that T and the normal force exerted by the surface pG and the weight W_p cancel (by Newton's 2nd law). This can be found using a triangle.



Using the law of sines:

$$\frac{\sin 15}{N} = \frac{\sin 60}{T} = \frac{\sin 105}{W}$$

Therefore $T = W_p \dfrac{\sin 60}{\sin 105}$

$$\overline{OM}\, W_A \cos(30) = \overline{ON}\, W_p \frac{\sin(60)}{\sin(105)} \cos(30)$$

Finally $\overline{OM} = \overline{ON} \dfrac{W_p}{W_A} \dfrac{\sin 60}{\sin 105} = (1\text{m})\left(\frac{3}{2}\right) = \boxed{1.34\text{m}}$