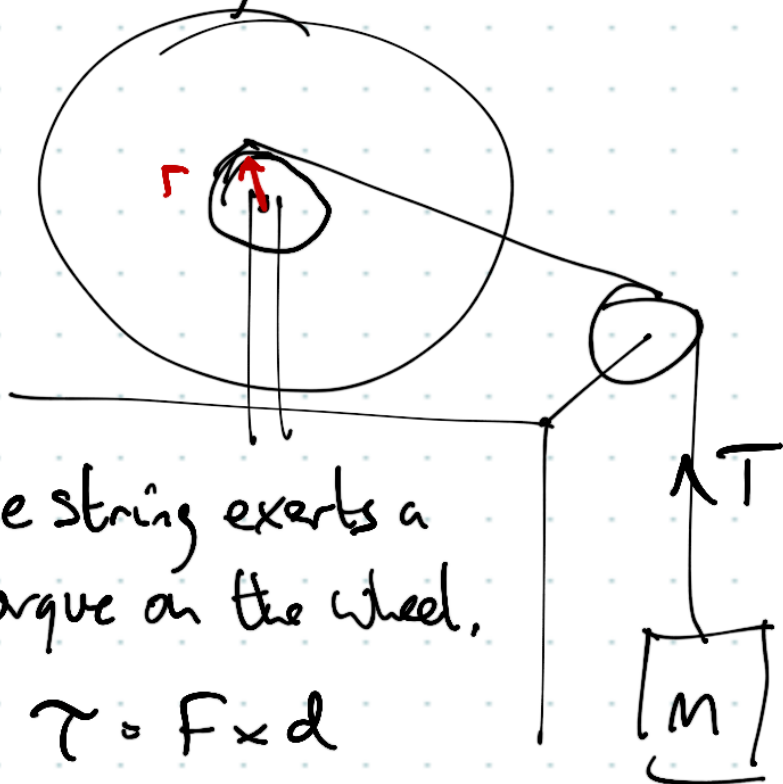


Measuring wheel Inertia?



The string exerts a torque on the wheel,

$$\tau = F \times d$$

$$\tau = (mg - ma) r$$

What is the tension in the string.

$$T = (mg - ma)$$

This is a force...

We measure the fall of the mass over a distance x . We are converting linear to rotational motion

We can say:

$$\tau = F \times d = \text{force} \times \text{distance}$$

$$\tau = I\alpha = \text{Inertia} \times \text{angular acceleration.}$$

$$\tau = \frac{\text{kgm}}{\text{s}^2} \times \text{m}$$

or

$$\tau = \text{kgm}^2 \frac{1}{\text{s}^2} \checkmark$$

So we can use:

$$F \times d = I \alpha$$

$$I = \frac{F d}{\alpha}$$

So this is the equation we need.

$$I = \frac{(mg - ma)r}{\alpha}$$

So what is α ?

OK, so we know $V = r\omega$
and $a = r\alpha$

So $\alpha = a/r$ but what about a ?

if we use: $S = ut + \frac{1}{2}at^2$

for this experiment $u = 0$

$$x = \frac{1}{2}at^2$$

$$a = \frac{2x}{t^2}$$

$$\text{So } \alpha = \frac{a}{r} = \frac{2x}{rt^2}$$

$$I = \frac{(mg - ma)r}{2x} = \frac{(mg - ma)r}{\cancel{2x} \cancel{r} t^2}$$

$$I = \frac{(mg - ma)r^2 t^2}{2x}$$

We can also get rid of lb'a from ma

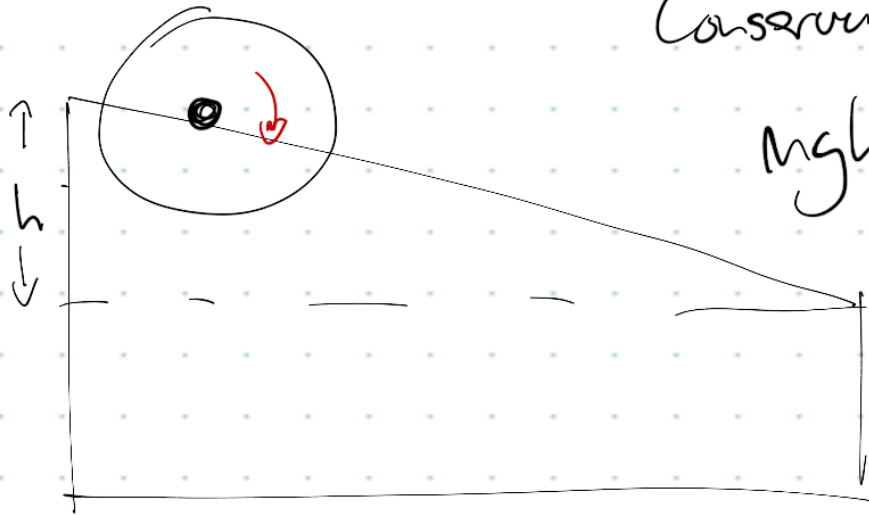
$$I = \frac{\left(mg - \frac{2mx}{t^2}\right)r^2 t^2}{2x}$$

$$I = \frac{mgr^2 t^2}{2x} - \frac{\cancel{2mx} \cancel{r^2} \cancel{t^2}}{\cancel{2t^2} \cancel{x}}$$

So we get

$$\left| I = \frac{mgr^2 t^2}{2x} - mr^2 \right|$$

So how about :



Conservation of Energy :

$$mgh = \frac{1}{2}mv^2$$

Where is the
Inertia?

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$\frac{1}{2}I\omega^2 = mgh - \frac{1}{2}mv^2$$

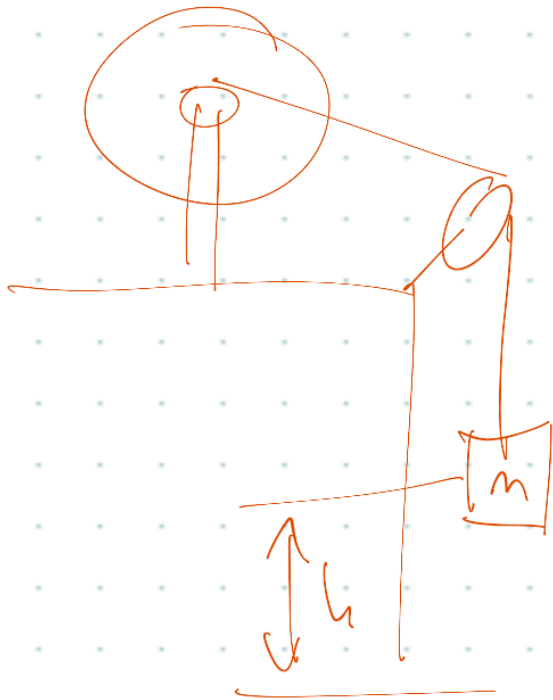
$$I\omega^2 = 2mgh - mv^2$$

$$I = \frac{2mgh}{\omega^2} - \frac{mv^2}{\omega^2} \quad (v = r\omega)$$

$$I = \frac{2mghr^2}{v^2} - \frac{mv^2r^2}{v^2}$$

$$I = \frac{2mghr^2}{v^2} - mr^2$$

Side note:



Can we do the same thing for this case? (Energy)

Conservation of Energy $\rightarrow$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$\Rightarrow$ Same equation

For fun:

$$S = \cancel{ut} + \frac{1}{2}at^2$$

$$S = \frac{1}{2}at^2$$

$$\boxed{a = \frac{2S}{t^2}}$$

$$V^2 = \cancel{u^2} + 2as$$

$$V^2 = 2as$$

$$V^2 = \frac{4s^2}{t^2}$$

So $V = \frac{2S}{t}$ $\Rightarrow$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$