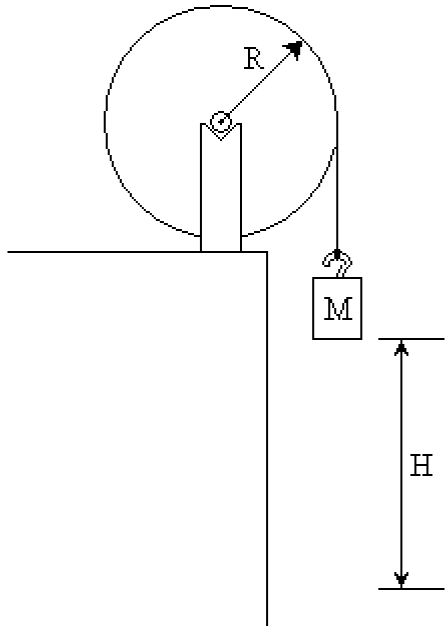
Determining Moment of Inertia of a Wheel



t_1 is the time, in seconds, for mass M to fall height H. Wheel has radius R.

Acceleration, a_0, of the weight:

$$a_0 = \frac{2H}{t_1^2}$$ **eq. 1**

Tension, T, in the string:

$$T = M(g - a_0)$$ **eq. 2**

Torque, τ, on the wheel:

$$\tau = T\,R$$ **eq. 3**

Angular acceleration, α, of the wheel:

$$\alpha = \frac{a_0}{R}$$ **eq. 4**

Moment of inertia, I, of the wheel:

$$I = \left(\frac{g t_1^2}{2H} - 1\right) M R^2$$ **eq. 5**

Example:

This is a sample calculation given the following values:

$M = 2.5\ kg$	Mass of the free weight.
$R = 0.4\ m$	Radius of inner surface of the wheel around which the string is wrapped.
$H = 0.6\ m$	Height the free-weight will fall. This is what will be timed.
$t_1 = 3.5\ s$	Time for free-weight to fall through height H.
$g = 9.8\ m/s^2$	Acceleration of gravity (approximate).

$$\mathrm{I} = \left(\frac{9.8 \times 3.5 \times 3.5}{2 \times 0.6} - 1\right) \times 2.5 \times 0.4 \times 0.4 = 39.6$$

The units for the calculation work out as follows:

$$\left(\frac{m \times s \times s}{s \times s \times m}\right) kg \times m \times m = kg\ m^2$$

The final value for the moment of inertia, I, of the wheel is:

$$\mathrm{I} = 39.6 kg\ m^2$$