$\Delta U_w + K_T + K_R - W_f = 0$ cons. of energy

$\Delta U_w = \Delta U_h + \Delta U_m \rightarrow 0$ cancels friction

Constants

$\Delta S = 0.015\,m$

$R_{wheel} = 0.200 \pm 0.002\ m$

$M_w = 1.5\,kg$

$m_h = 0.060\,kg$

$m_L = 922.3 \pm 0.1\ g$

$\Delta U_m + K_T + K_R = 0$

$-Mgy + \frac{1}{2} Mv^2 + \frac{1}{2} I\omega^2 = 0$

$Mgy = \frac{1}{2}(M + I/r^2)\, v^2$

$$\boxed{v^2 = \frac{gy}{\frac{1}{2}(1 + I/Mr^2)}}$$

$$\frac{v^2}{y} = \frac{2g}{1 + I/Mr^2}$$

$\Downarrow$

$$I/Mr^2 = \frac{2g}{\frac{v^2}{y}} - 1$$

$\Downarrow$

$$\frac{v^2}{y} = \frac{2g}{1 + I/Mr^2}$$

$$I = M_h r^2 \left(\frac{2g}{\frac{v^2}{y}} - 1 \right)$$

$$\frac{v_w^2}{y_w} = 1.357 \pm 0.008\ m/s^2$$

$$I_w = M_h r^2 \left(\frac{2g}{\frac{v_w^2}{y_w}} - 1 \right)$$

$= 0.8075\ kgm^2$

$$\frac{v_{w+L}^2}{y_{w+L}} = 0.717 \pm 0.002\ m/s^2$$

$$I_{w+L} = M_h r^2 \left(\frac{2g}{\frac{v_{w+L}^2}{y_{w+L}}} - 1 \right)$$

$$I_L = I_{w+L} - I_w = M_h r^2 \left(\frac{2g}{\frac{v_{w+L}^2}{y_{w+L}}} - \frac{2g}{\frac{v_w^2}{y_w}} \right) = 2gM_h r^2 \left(\frac{1}{\frac{v_{w+L}^2}{y_{w+L}}} - \frac{1}{\frac{v_w^2}{y_w}} \right)$$

$= 0.03097\ kgm^2$

$$\delta_{I_L} = \sqrt{\delta^2_{I_L r} + \delta^2_{I_L \frac{v_{w+L}^2}{y_{w+L}}} + \delta^2_{I_L \frac{v_w^2}{y_w}}} = \sqrt{\left(\delta_r \cdot 4gM_h r \left(\frac{1}{\frac{v_{w+L}^2}{y_{w+L}}} - \frac{1}{\frac{v_w^2}{y_w}} \right)\right)^2 + \left(\delta_{\frac{v_{w+L}^2}{y_{w+L}}} \cdot 2gM_h r^2 \left(\frac{1}{\frac{v_{w+L}^2}{y_{w+L}}}\right)^2\right)^2 + \left(\delta_{\frac{v_w^2}{y_w}} \cdot 2gM_h r^2 \left(\frac{1}{\frac{v_w^2}{y_w}}\right)^2\right)^2}$$

$= 0.0007\ kgm^2$

$$\boxed{I_L = 0.0310 \pm 0.0007\ kgm^2}$$

$r = 0.1845 \pm 0.0005\ m$

(predicted)

$$I_{L_p} = Mr^2 = 0.0314\ kg\,m^2$$

$$\delta I_{L_p} = \delta_{I_{L_p} r} = \delta_r M r = 0.0008\ kg\,m^2$$

$$\boxed{I_{L_p} = 0.0314 \pm 0.0008\ kg\,m^2}$$

(Does not agree, as larger than experimental value)

$$\delta_{v^2} = 2\frac{\Delta s^2}{\Delta t^3}\delta_{\Delta t}$$

$$= \frac{2v^3}{\Delta s}\delta_{\Delta t}$$

Predicting I as $\frac{3}{4}MR^2 = 0.045$

Seed data: BD = 0201
~~$\delta\Delta t$~~ $J = 0.045$
$\Delta t = 0.0005$

$y = i \cdot \Delta s$

$v = \frac{\Delta s}{\Delta t}$

$\left(\frac{\Delta s}{\Delta t}\right)^2 = \frac{2gy}{1 + I/mR^2}$

$\Delta t = \sqrt{\frac{\Delta s^2(1 + I/mR^2)}{2gy}}$

$\delta_{\Delta t} = 0.0002$

$\delta_{v^2} = 2\frac{\Delta s^2}{\Delta t^3}\delta_{\Delta t}$

(Derived earlier)

$I = Mr^2\left(\frac{2y}{\frac{v^2}{g}} - 1\right)$

$= 0.046$

$\delta I = 0.02$

$\boxed{I = 0.05 \pm 0.02 \text{ kgm}^2}$