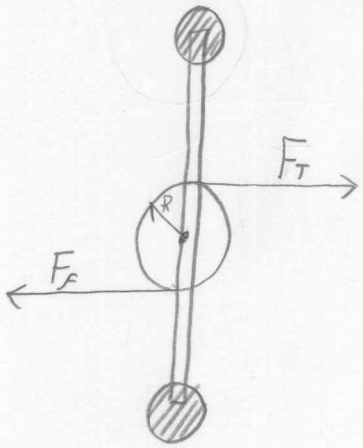
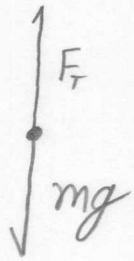
Lab Using Torque





$$R(F_T - F_f) = I\alpha \qquad mg - F_T = ma$$

$$F_T = mg - ma$$

$$R(mg - ma - F_f) = I\frac{a}{R}$$

$$F_f = mg - ma - I\frac{a}{R^2}$$

$$\boxed{F_f = mg - \left(m + \frac{I}{R^2}\right)a}$$

Relate a to t and d

$$y = \cancel{y_0}^{\,0} + \cancel{v_0 t}^{\,0} + \tfrac{1}{2}at^2$$

$$d = \tfrac{1}{2}at^2 \Rightarrow a = \frac{2d}{t^2}$$

$$\boxed{F_f = mg - \left(m + \frac{I}{R^2}\right)\frac{2d}{t^2}}$$

Lab using Work/Energy

$U_I = mgd$ $\quad K_I = 0$

$U_F = 0$ $\quad K_F = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$

$W_c = -F_c d$

$$mgd - F_c d = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$$

$$\omega = \frac{v}{R}$$

$$mgd - F_c d = \frac{1}{2}I\frac{v^2}{R^2} + \frac{1}{2}mv^2$$

Relate v to t and d:

$y = y_0^{\circ} + v_0^{\circ}t + \frac{1}{2}at^2$ $\quad v = v_0^{\circ} + at$

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

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

$v = \frac{2d}{t^2}t$

$v = \frac{2d}{t}$

$$mgd - F_c d = \frac{1}{2}\frac{I}{R^2}\frac{4d^2}{t^2} + \frac{1}{2}m\frac{4d^2}{t^2}$$

$$F_c = mg - \frac{I}{R^2}\frac{2d}{t^2} - m\frac{2d}{t^2}$$

$$\boxed{F_c = mg - \left(m + \frac{I}{R^2}\right)\frac{2d}{t^2}}$$