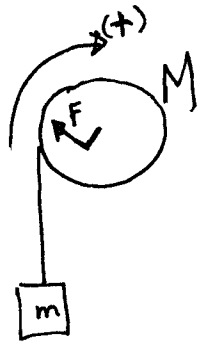
10-37



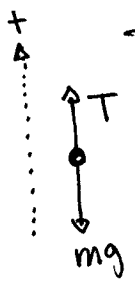
$m = 50$ kg

$I = 0.920$ kgm^2 $\quad R = 0.25$ m

crank handle radius $= 0.12$ m $\rightarrow b = 0.12$

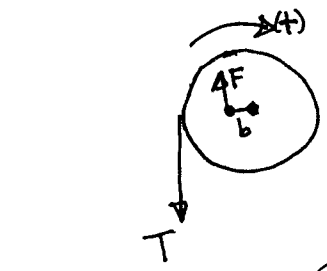
want to have $a = 1.20$ m/s^2

mass



$ma = T - mg$

pulley



$I\alpha = \Sigma\tau$

$I\alpha = Fb - TR$

No slipping
$a = R\alpha$

$I\frac{a}{R} = Fb - TR$

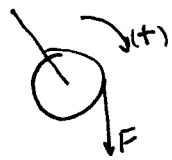
$50(1.2) = T - 50(9.8)$

$T = 550$ Newtons $\longrightarrow$ $0.920\,\frac{1.20}{0.25} = F(0.12) - 550(0.25)$

1375

$F = 1183$ Newtons

10-36



$M = 15$ kg

$R = 0.12$ m

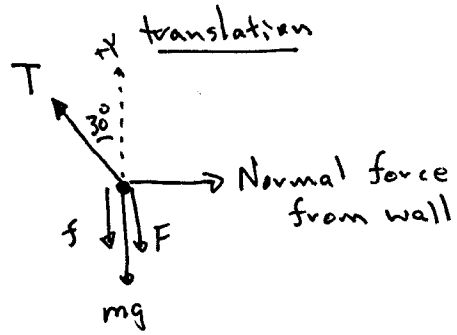
$I = 0.12$ kg m^2

$\mu_k = 0.2$

$F = 40$ Newtons

ONE OBJECT

translation



$ma_x = \sum F_x$'s

$ma_x = N - T\sin 30^\circ$

$ma_y = \sum F_y$'s

$ma_y = T\cos 30^\circ - f - mg - F$

$ma_y = T\cos 30^\circ - \mu N - mg - F$

In this problem there is no translational motion $\therefore a_x = 0$ $a_y = 0$

$0 = N - T\sin 30^\circ$

$0 = T\cos 30^\circ - \mu N - mg - F$

$N = T\sin 30^\circ$

$0 = T\cos 30^\circ - \mu T\sin 30^\circ - mg - F$

$0 = T(\cos 30^\circ - \mu \sin 30^\circ) - mg - F$

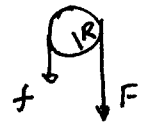
$0 = T(\cos 30^\circ - 0.2\sin 30^\circ) - 15(9.8) - 40$

$T = 244$ Newtons

$N = 244\sin 30^\circ$

$= 122$ Newtons

rotation



the other forces do not impact the rotation (i.e. they don't cause Torques)

$I\alpha = FR - fR$

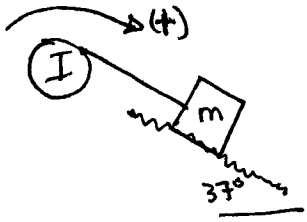
$\frac{I}{R}\alpha = F - f$

$= F - \mu N$

$\frac{0.12}{0.12}\alpha = 40 - 0.2(122)$

$\alpha = 15.6$ rad/sec^2

10-39



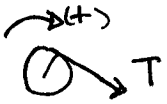
$m = 5$ kg

$M = 20$ kg $\quad R = 0.2$ m $\quad I = \frac{1}{2}MR^2 = 0.4$ kg m^2

$\mu = 0.2$

--- Two objects ---

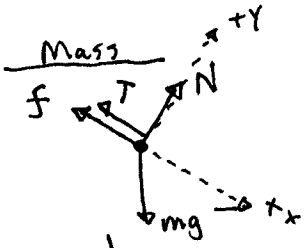
Pulley



$I\alpha = \Sigma\tau$

$I\alpha = TR$

Mass



$ma_x = \Sigma F_x$'s

$ma_x = mg\sin\theta - f - T$

$= mg\sin\theta - \mu N - T$

$ma_y = \Sigma F_y$'s

$m\cancel{a_y} = N - mg\cos 37^\circ$

0

$N = mg\cos 37^\circ$

$ma_x = mg\sin 37^\circ - \mu mg\cos 37^\circ - T$

No slipping

$a = R\alpha$

$\alpha = \frac{a}{R}$

then:

$I\frac{a}{R} = TR$

$\frac{I}{R^2}a = T$

Then to get the acceleration add both equations

$$\left(m + \frac{I}{R^2}\right)a = mg\sin 37^\circ - \mu mg\cos 37^\circ$$

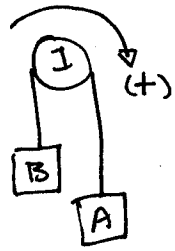
$$a = \frac{mg\sin 37^\circ - \mu mg\cos 37^\circ}{m + I/R^2}$$

To get the tension

$$T = \frac{I}{R^2}a = \frac{I}{R^2}\,\frac{mg\sin 37^\circ - \mu mg\cos 37^\circ}{m + I/R^2}$$

10-40 Atwoods Machine

3 objects



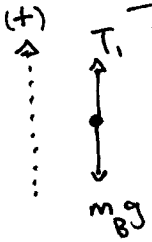
$m_A = 5\ kg$

$m_B = 2\ kg$

$I = 0.2\ kgm^2$

$R = 0.1\ m$

mass B



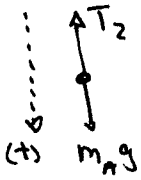
$$m_B a = T_1 - m_B g$$

pulley

$$I\alpha = \Sigma \tau$$

$$I\alpha = T_2 R - T_1 R$$

mass A



$$m_A a = m_A g - T_2$$

No slipping

$$a = R\alpha$$

$$\alpha = \frac{a}{R}$$

then

$$I\frac{a}{R} = T_2 R - T_1 R$$

$$\frac{I}{R^2} a = T_2 - T_1$$

$$m_B a = T_1 - m_B g$$

$$m_A a = m_A g - T_2$$

Add the 3 equations

$$\left(m_B + m_A + \frac{I}{R^2}\right) a = m_A g - m_B g$$

$$a = \frac{m_A g - m_B g}{m_B + m_A + I/R^2}$$

then to get the tensions

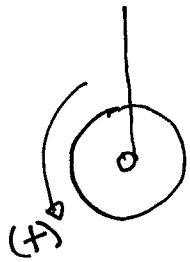
$$m_B a = T_1 - m_B g \rightarrow T_1 = m_B a + m_B g = m_B\left[\frac{m_A g - m_B g}{m_B + m_A + I/R^2}\right] + m_B g$$

$$m_A a = m_A g - T_2 \rightarrow T_2 = m_A g - m_A g = m_A g - m_A\left[\frac{m_A g - m_B g}{m_B + m_A + I/R^2}\right]$$

10-42 Yo-yo

There is only one object which translates and rotates

axle radius = b



The yo-yo is made from two disks

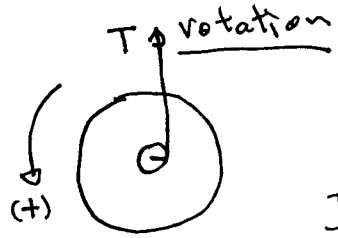
$$I = \tfrac{1}{2}mR^2 + \tfrac{1}{2}mR^2 = mR^2$$

translation

$$Ma = \Sigma F$$

$$Ma = Mg - T$$

rotation



$$I\alpha = \Sigma \tau$$

$$I\alpha = Tb$$

The Tension force acts at the radius "b"

Note $M = 2m$ two disks

No slipping

$$a = b\alpha$$

axle

$$\alpha = a/b$$

$$I\frac{a}{b} = Tb$$

$$\frac{I}{b^2}a = T$$

$$Ma = Mg - T$$

Add equations

$$\left(M + \frac{I}{b^2}\right)a = Mg$$

$$a = \frac{Mg}{M + \frac{I}{b^2}} \longrightarrow \frac{2mg}{2m + mR^2/b^2} = \frac{2g}{2 + R^2/b^2}$$

Then with

$$T = \frac{I}{b^2}a = \frac{I}{b^2}\,\frac{2g}{2 + R^2/b^2}$$