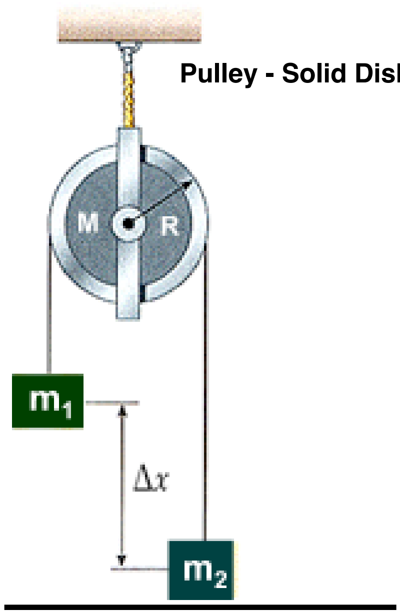
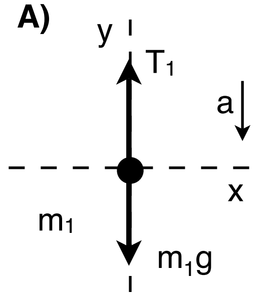
A m_1 = 14.0 kg object and a m_2 = 10.5 kg object are suspended, joined by a cord that passes over a pulley with a radius of 10.0 cm and a Mass of 3.00 kg. The cord has a negligible mass and does not slip on the pulley. The pulley rotates on its axis without friction. The objects start from rest 3.00 m apart. Treating the pulley as a uniform disk. Calculate the time interval required for m_1 to hit the floor with and without the mass of the pulley.

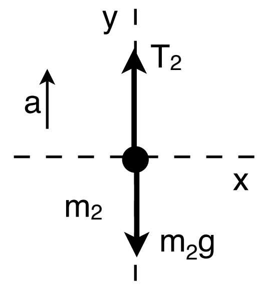


A)

FreeBody Diagrams



$$\Sigma F_y = T_1 - m_1 g = -m_1 a$$

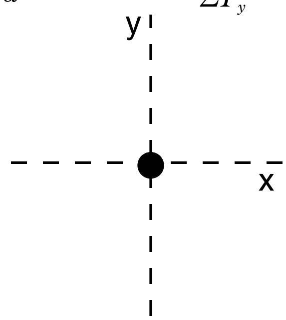


Sum of Forces 1 pt

$\Sigma F_y =$ ____________

FreeBody Diagrams

3 pts



moment of inertia for disk

____

angular to linear velocity

____

Sum of Torques

$\Sigma \tau =$ ____________ 2 pts

B) Let's find the acceleration of the system and then we can find the time.

Simplify and add the three equations 3 pts

=

=

\+ =

____

Solve symbolically for the acceleration 2 pts

$a =$ ____________

Can a ever be > than g? **Yes / No**

C) Solve for the acceleration and use a motion equation to calculate the time interval required for m_1 to hit the floor.

$a =$ ____________

Answer 1 pts

Time for m_1 to hit the floor $\Delta x = v_o t - \frac{1}{2}at^2$

$t =$ ____________

Answer 1 pts

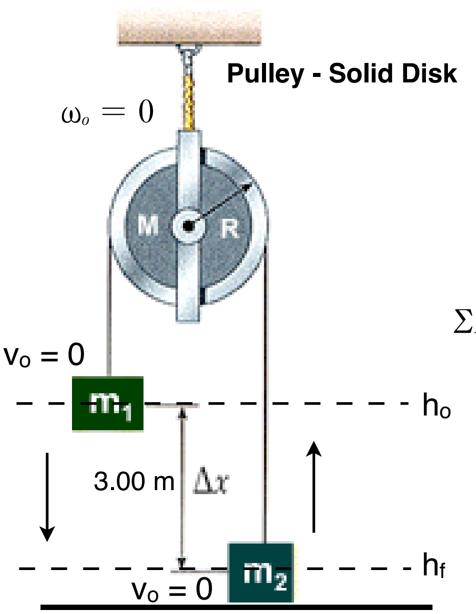
Time for m_1 to hit the floor if the Mass of the pulley is not taken into account.

Will it take **more / less** time to for m_1 to fall to the floor?

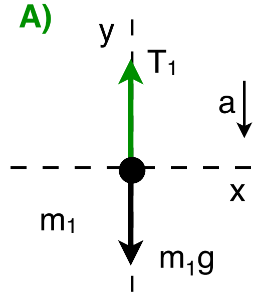
$t =$ ____________

Answer 1 pts

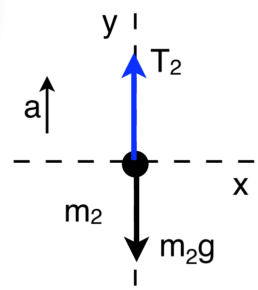
A m_1 = 14.0 kg object and a m_2 = 10.5 kg object are suspended, joined by a cord that passes over a pulley with a radius of 10.0 cm and a Mass of 3.00 kg. The cord has a negligible mass and does not slip on the pulley. The pulley rotates on its axis without friction. The objects start from rest 3.00 m apart. Treating the pulley as a uniform disk. Calculate the time interval required for m_1 to hit the floor with and without the mass of the pulley. Do not use Energy Principles here.



A)



FreeBody Diagrams

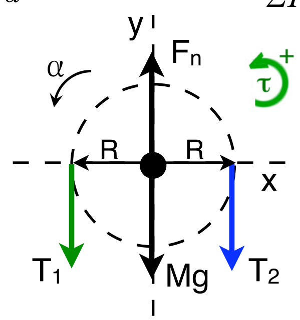


Sum of Forces

$$\Sigma F_y = T_1 - m_1 g = -m_1 a$$

$$\Sigma F_y = T_2 - m_2 g = m_2 a$$

M



moment of inertia for disk

$$I = \frac{1}{2}MR^2$$

angular to linear velocity

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

$$\tau = F_\perp d = I\alpha$$

Sum of Torques

friction is the direct cause of the torque.

$$\Sigma\tau = T_1 R - T_2 R = I\alpha = \frac{1}{2}MR^2\left(\frac{a}{R}\right)$$

B) Let's find the acceleration of the system and then we can find the time.

Three equations - three unknowns

$$m_1 g - T_1 = m_1 a$$

$$T_2 - m_2 g = m_2 a$$

$$+\ T_1 - T_2 = \frac{1}{2}Ma$$

$$m_1 g - m_2 g = m_1 a + m_2 a + \frac{1}{2}Ma$$

Solve symbolically for the acceleration

$$(m_1 - m_2)g = (m_1 + m_2 + \frac{1}{2}M)a$$

$$a = g\frac{(m_1 - m_2)}{(m_1 + m_2 + \frac{1}{2}M)}$$

notice $a \leq g$

C) Now using a motion equation to calculate the time interval required for m_1 to hit the floor.

$$a = 9.8m/s^2 \frac{(14.0 - 10.5)\,kg}{(14.0 + 10.5 + \frac{1}{2}3.00)\,kg} = 1.32\,m/s^2$$

Time for m_1 to hit the floor

$$\Delta x = v_o t - \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2\Delta x}{a}} = \sqrt{\frac{2\,(3.00m)}{1.319m/s^2}} = 2.13\text{ sec}$$

Time for m_1 to hit the floor if the Mass of the pulley is not taken into account.

$$a = 9.8m/s^2 \frac{(14.0 - 10.5)\,kg}{(14.0 + 10.5)\,kg} = 1.43\,m/s^2$$

$$t = \sqrt{\frac{2\Delta x}{a}} = \sqrt{\frac{2\,(3.00m)}{1.43m/s^2}} = 2.05\text{ sec}$$

That's a 3.6% difference in time to fall. Not much! That's why we could leave it out earlier.