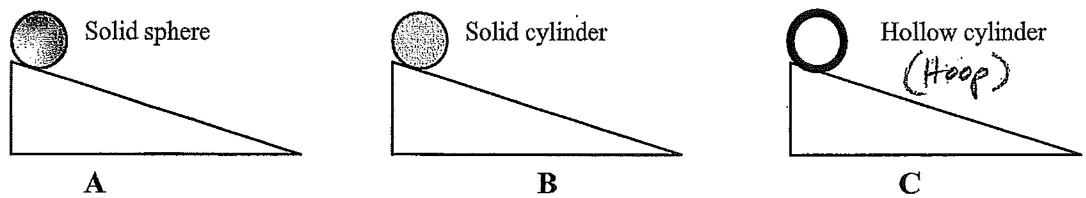
Rotational Energy WS 1

Various Objects Rolling Down a Hill

Shown below are 3 objects of equal mass and radius. The objects are released from rest and roll the same distance down the same hill without slipping.



Which object reaches the bottom first? ____

Rank from fastest to slowest: ____ ____ ____

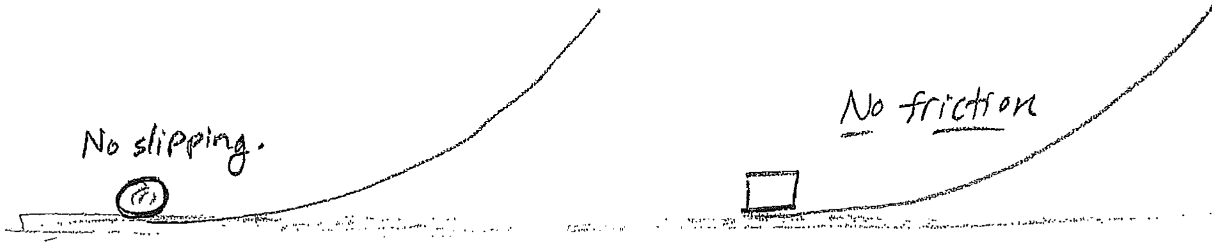
Using E_g, K_t & K_{rot} derive literal equations for the final linear velocity of each object.

$E_g = mgh \qquad K_t = \frac{1}{2}mv^2 \qquad K_{rot} = \frac{1}{2}I\omega^2$

Sphere ($I = \frac{2}{5}mr^2$)	Cylinder ($I = \frac{1}{2}mr^2$)	Hoop ($I = mr^2$)

Does mass affect velocity?

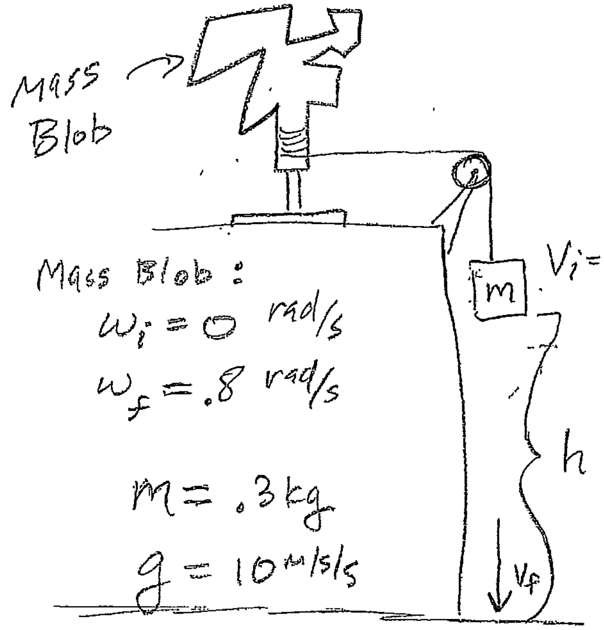
Does radius affect velocity?



$g = 10\ m/s/s$

$K_{trans.} = \frac{1}{2}mv^2 \quad K_{rot} = \frac{1}{2}I\omega^2 \quad U_g = mgh \quad I_{sphere} = \frac{2}{5}mr^2$

1. A sphere with velocity $v = 8\ m/s$ is rolling at the bottom of an incline. What will be the maximum height (Δy) reached by the sphere?
2. A block with velocity $v = 8\ m/s$ is sliding at the bottom of an incline. What will be the maximum height (Δy) reach by the block?



Mass Blob:

$\omega_i = 0$ rad/s

$\omega_f = .8$ rad/s

$m = .3$ kg

$g = 10$ m/s/s

A mass blob is being accelerated angularly by a hanging mass 'm' connected through a massless pulley system. If 'm' falls a distance of $h = 4$ meters and it impacts the ground at $V_f = 2$ m/s what is the moment of inertia for the mass blob?

hint: $\Sigma E_i = \Sigma E_f$

$$\Delta U_g = \Delta K_{rot.} + \Delta K_{trans.}$$

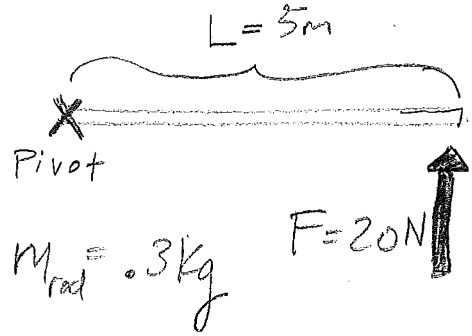
$$mgh = \frac{1}{2} I \omega_f^2 + \frac{1}{2} m v_f^2$$

$$Work = \Delta K_{rotation}$$

$$Work = \tau_{net} \cdot \Delta\theta$$

$$Power = \tau_{net} \cdot \omega$$

$$I_{rod} = \tfrac{1}{3} M L^2$$



1. What is the torque on the rod?

2. Assume the rod begins at rest before the torque acts on the rod for 7.5 seconds reaching $\omega_f = 300$ rad/sec. Find the work done.

a.) Use $Work = \Delta K_{rot}$

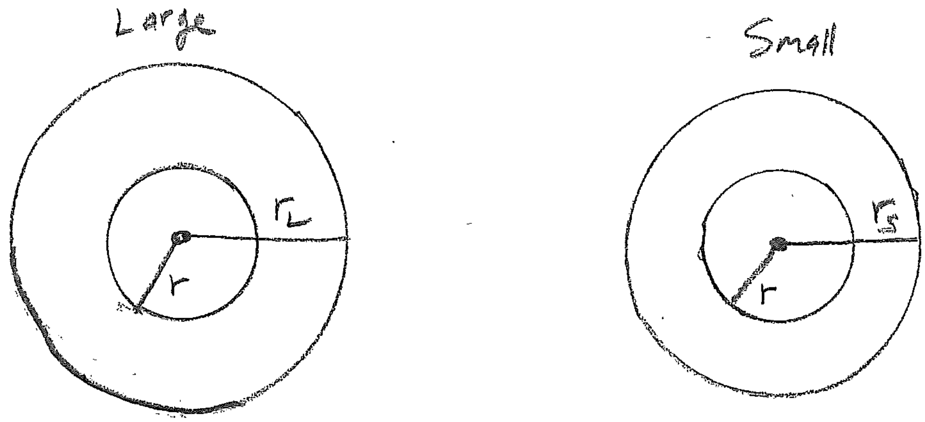
b.) Use $Work = \tau_{net} \cdot \Delta\theta$

hints: $\Delta\theta = \bar{\omega} \cdot t$

$$\bar{\omega} = \frac{\omega_f + \omega_i}{2}$$

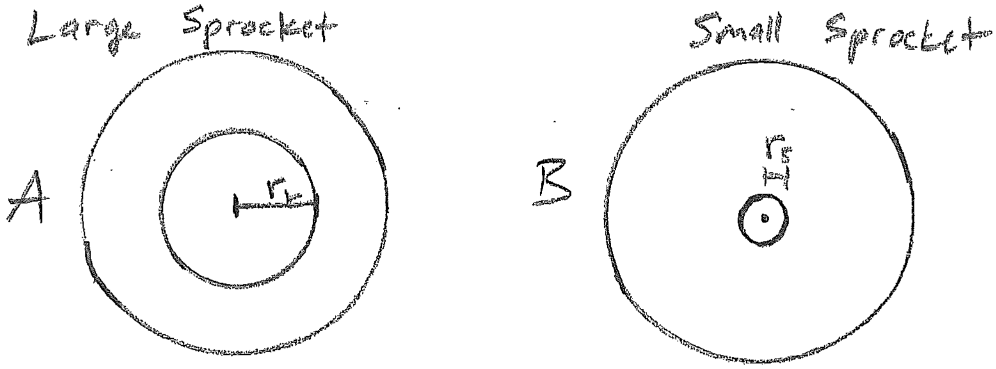
3. If the rod experiences friction such that the torque results in a constant angular velocity of 300 rad/sec, what is the power in and out of the system?

4. Can energy be stored as rotational energy? Give an example.



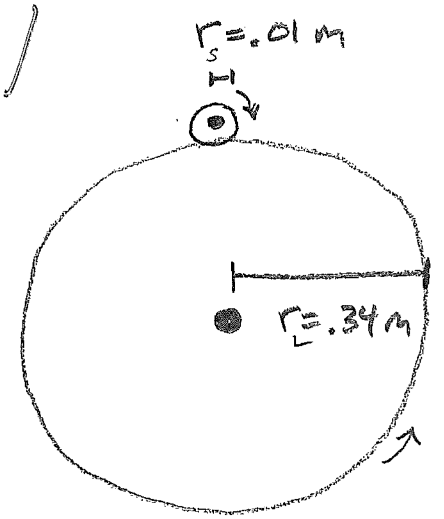
Identical sprockets with radius 'r' are attached to two different rear wheels on a dirtbike. The wheel on the left has radius r_L and is larger than the wheel on the right with radius r_S. $\boxed{r_L > r_S}$ Assume both sprokets are connected to identical engines with identical output shafts and chains.

1. Which wheel will deliver more force to the ground?
2. Which wheel will produce the highest top speed?



Identical rear wheels are attached to two different sprockets of radii r_L and r_S such that $r_L > r_S$. The sprockets are connected to identical engines with identical output shafts and chains.

1. Which wheel will deliver more force to the ground? A B Same
2. Which wheel will achieve greater top speed? A B Same



Assume static friction with no slipping between the two wheels. Not to scale.

1. If the large wheel spins at a constant angular velocity leading to a constant tangential velocity $V_L = 6.7$ m/s, what is the angular velocity of the small wheel?

2. If the small wheel is connected to an engine with power output 746 WATTS, what is the torque of the small wheel? $P = \tau \cdot \omega$

3. What must be the force exerted by the outer rim of the small wheel? Hint: $P = F \cdot V$

Now solve for: $r_L = .34$ m $V_L = 6.7$ m/s

4. The angular velocity of the large wheel.

5. The torque of the large wheel

6. The force exerted by the outer rim of the large wheel.