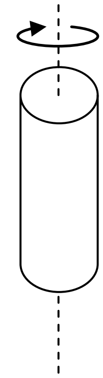
Name ________________
Period__Date__________

Rotation: Worksheet 8 Rotational Energy



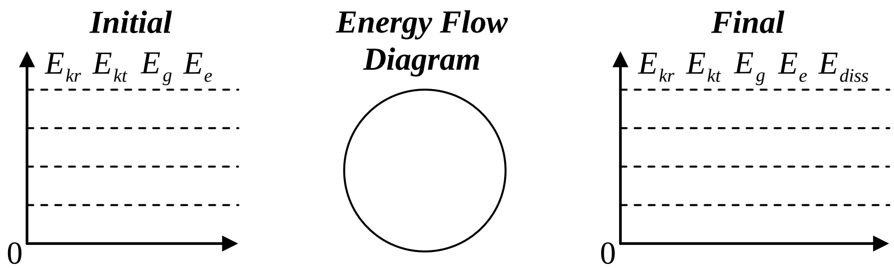
1. A communications satellite is a solid cylinder with mass $1210\ kg$, diameter $1.21\ m$, and length $1.75\ m$. Prior to launching from the space shuttle's cargo bay, it is set spinning at $1.52\ {}^{rev}\!/_{s}$ about the cylinder's axis.
   a. What is the satellite's rotational inertia about its central axis?
   b. Convert the angular velocity to ${}^{rad}\!/_{s}$.
   c. What is the satellite's rotational kinetic energy?

2. A bowling ball of mass $7.3\ kg$ and radius $9.0\ cm$ rolls without slipping down a lane at $3.3\ {}^{m}\!/_{s}$. Calculate its total kinetic energy. The ***rolling*** bowling ball is a solid sphere!

3. Assume the spinning Earth to be a sphere with uniform density, mass $5.98\times10^{24}\ kg$, and radius $6.37\times10^{6}\ m$. Calculate the Earth's
   a. angular speed
   b. rotational inertia
   c. and its rotational kinetic energy.

4. A $32.0\ kg$ wheel, essentially a thin hoop with radius $1.20\ m$, is rotating at $29.3\ {rad}/{s}$. It must be brought to a stop in $15.0\ s$.
   a. Complete the LOL diagram *quantitatively*.

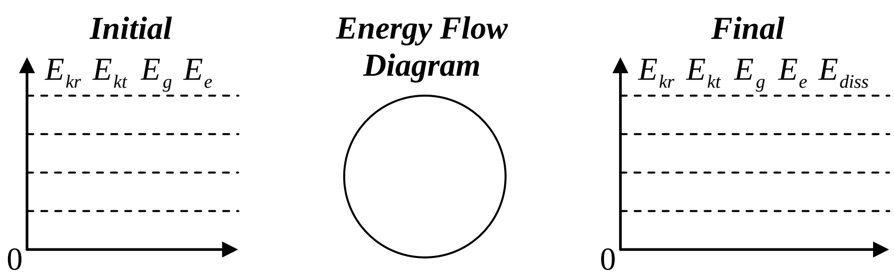
   System? ________________ Energy Conserved: Yes or No?



   b. Calculate the power required to stop the wheel.

5. A meter stick of mass $0.16\ kg$ is held vertically with one end on the floor and is then allowed to fall. Assume that the end on the floor does not slip.
   a. Complete the LOL diagram *quantitatively*.
   b. Find the angular velocity of the stick when it hits the floor.
   (*Hint*: Consider the stick to be a thin rod rotated about one end. You must use the center of mass of the meter stick to determine E_g)

   System? ________________ Energy Conserved: Yes or No?

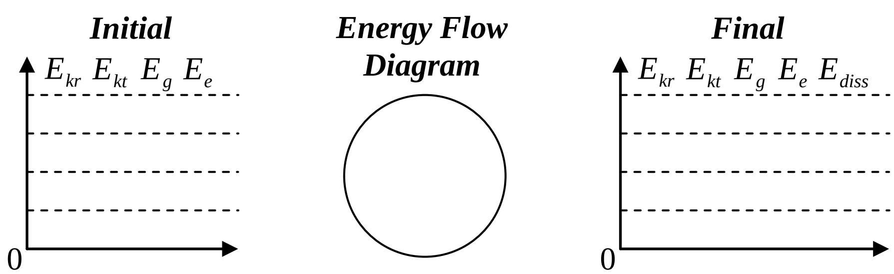


c. What is the linear speed of the top end of the stick when it hits the floor?

d. Does the end of the meter stick accelerate at g, less than g, or more than g on average? Calculate the speed an object has if dropped from a height of $1.0\ m$ and compare.

7. A sphere of radius $0.20\ m$ and mass $1.80\ kg$ starts from rest and rolls without slipping down a 30.0° incline that is $10.0\ m$ long.
   a. Complete the LOL diagram *quantitatively*.
   b. Calculate the sphere's translational (v_f) and rotational (ω_f) speeds when it reaches the bottom of the incline.

System? ____________________ Energy Conserved: Yes or No?



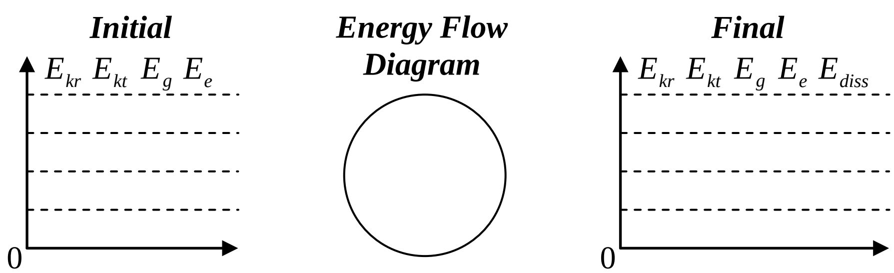
c. What is the ratio of translational E_{kt} to rotational E_{kr} at the bottom? Work symbolically until the very end!

d. How would your answers to (b) and (c) change if the sphere had twice the mass? Explain.

e. How would your answers to (b) and (c) change if the sphere had twice the radius? Explain.

8. Repeat problem #7 for a hoop of the same mass and radius that rolls without slipping down the same incline for the same distance.
   a. Complete the LOL diagram *quantitatively*.
   b. Calculate the sphere's translational (v_f) and rotational (ω_f) speeds when it reaches the bottom of the incline.

System? ________________ Energy Conserved: Yes or No?



c. What is the ratio of translational E_{kt} to rotational E_{kr} at the bottom? Work symbolically until the very end!

d. Compare the translational speed of the sphere at the bottom of the incline to that of the hoop. Justify your answer conceptually.

Suppose both the sphere and the hoop are released on a <u>*frictionless*</u> incline of the same dimensions.

e. Describe the motion of the sphere and disk down the incline.

f. How would the speed of the sphere compare to the speed of the hoop at the bottom of the incline? Explain or compute.

g. How would the speeds at the bottom of the frictionless incline compare to the speeds at the bottom of an incline with some friction? Explain or compute.