Rolling Motion – Inquiry
AP Physics C

Objective: I can describe the effects of torque on a rolling object by calculating the rotational kinetic energy and total kinetic energy of a rolling object and comparing their values.

https://www.compadre.org/Physlets/mechanics/ex11_3.cfm

Background

When objects are moving, they have kinetic energy. Objects can move in a couple of different ways:

1. Translational motion (the entire object moves together – each segment of the object has the same "overall" motion); and
2. Rotational motion (every segment of the object rotates the same way, but has a different instantaneous translational speed as they're all going in circular motion).

So far, we have discussed translational kinetic energy $K_t = \frac{1}{2}mv^2$. The rotational kinetic energy of a solid object is given by $K_r = \frac{1}{2}I\omega^2$ and an object can have both types of KE at once if it is rolling! In this lab, you will be comparing the relationship between translational and rotational kinetic energy for rolling objects.

Procedure/Questions

A solid ball of radius 1 m is rolling down an incline. Record your data in a table and answer the questions below.

Mass (kg)	Angle (degrees)	Initial GPE (J)	Final Translation KE (J)	Final rotational KE (J)	K_t/U	K_r/U	K_r/K_t
100	10	15	10	3	10/15=2/3	3/15=1/5	3/10
200	20	30	22.5	9	22.5/30	9/30	0.4
350	30	51	40	12.5	40/51	12.5/51	0.3125
475	40	58	50	20	50/58	20/58	0.4

You can click and hold on the graph to read values of energy as a function of time for the ball.

a. What percentage of the initial gravitational potential energy is converted to translational KE according to the graph? Is this the same for different masses/angles?
Around 75% Different masses or angles may vary slightly.
b. What percentage of the initial gravitational potential energy is converted to rotational KE according to the graph? Is this the same for different masses/angles?
Around 27.2%. It is not the same for different masses/angles. Sometimes more sometimes less.
c. Determine the ratio of rotational KE to translational KE.
    i. Which fraction is this closest to? 1/3
    ii. Does this change for different masses/angles? Yes. The ratio changes for different angle/mass combinations.
d. How might your final column change if you had a cylindrical disk instead of a ball (same radius)?

There will be more K_t and less K_r because a cylindrical disk is less likely to rotate, and therefore will actually translate more.