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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
250	20	37.33	26.53	11.15	0.71068845	0.29868738	0.4202789
250	30	37.33	26.81	10.34	0.71818912	0.27698902	0.385677
250	40	37.33	26.26	10.88	0.70345567	0.29145459	0.4143184
250	10	37.33	25.99	10.61	0.69622288	0.28422181	0.4082339
100	20	14.87	10.4	4.37	0.69939475	0.2938803	0.4201923
200	20	30.51	20.72	8.77	0.6791216	0.28744674	0.4232625
400	20	58.93	41.81	16.98	0.70948583	0.28813847	0.4061229

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?
   It is always around .7 that gets converted. It is the same for different masses/angles.
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?
   It is always around .3 that gets converted. IT is the same for different masses/angles.
c. Determine the ratio of rotational KE to translational KE.
   i. Which fraction is this closest to?
      2/5
   ii. Does this change for different masses/angles?
      No please stop asking

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d. How might your final column change if you had a cylindrical disk instead of a ball (same radius)?
   It will be close to ½ instead of 2/5. (Based on the formula for moment of inertia)