ROLLING OBJECTS

Translational and rotational energy on an incline

Name: ____________________________	Period: ____________	Date: ______________

INVESTIGATION QUESTION **How does rotational inertia affect the acceleration and speed of a rolling object?**

TIME	SIMULATION	UNIT 6
30 minutes	BuildPhysics > Rolling objects	Energy & Momentum of Rotating Systems

Learning targets

- Compare the motion of a solid disk and a hoop rolling without slipping.
- Track translational, rotational, and gravitational energy.
- Test how release height and mass affect bottom speed.

Model before you measure

The solid disk and hoop have equal mass, radius, and release conditions. Static friction enforces rolling without slipping but does no net mechanical work.	$mgh = ½mv^2 + ½I\omega^2$ $v = \omega R$ $I = cMR^2$

Important: Use $g = 9.8\ m/s^2$. Keep mass, radius, release height, and track geometry equal when comparing shapes.

Pre-lab prediction | 4 minutes

1. Which should reach the bottom first: the solid disk or the hoop? Explain your prediction.

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2. Which object should have the greater translational speed at the bottom?

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3. Predict whether changing mass affects the bottom speed for the same shape and release height.

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PART A Compare a solid disk and a hoop

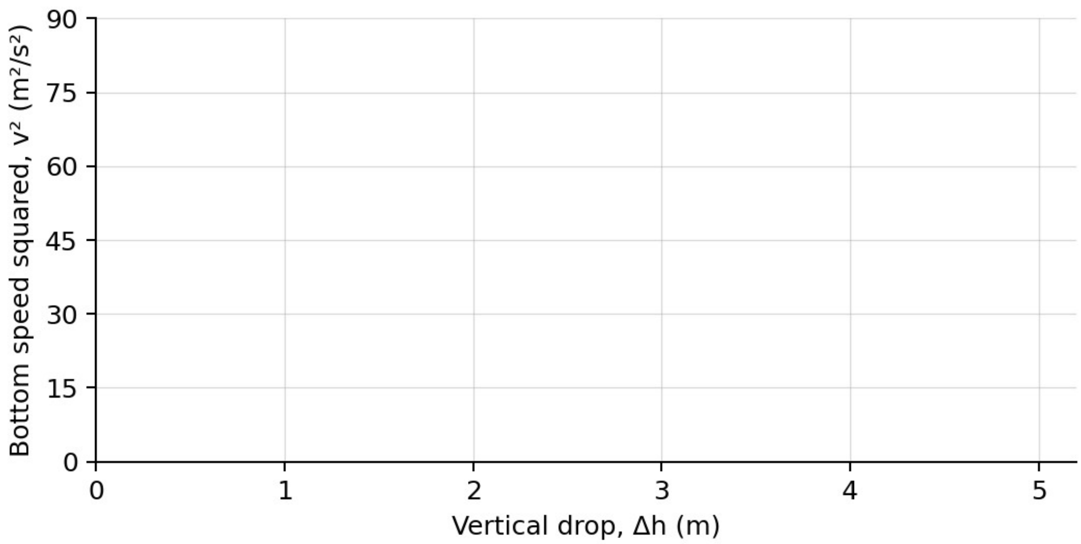
Setup | 3 minutes

- ☐ Load Rolling objects. Verify that the disk and hoop have equal masses, radii, and release heights.
- ☐ Turn on translational kinetic energy, rotational kinetic energy, gravitational potential energy, speed, and angular speed.
- ☐ Reset and run both objects together. Record the arrival time and bottom values for each object.
- ☐ Repeat at four different equal release heights while preserving identical track geometry.

Rolling check: At the bottom, verify that $v \approx \omega R$ for each object before accepting the trial.

Data table | 10 minutes

Vertical drop Δh (m)	Disk v (m/s)	Disk arrival t (s)	Disk Krot / Ktotal	Hoop v (m/s)	Hoop arrival t (s)	Hoop Krot / Ktotal
1.0						
2.0						
3.0						
4.0						



4. Plot v^2 versus Δh for both objects using different symbols. Draw one best-fit line for each.

PART B Change mass at fixed shape and height

Mass test | 7 minutes

Controlled trial: Use the solid disk at one release height. Keep radius, inertia factor, and track unchanged.

Mass (kg)	Bottom speed (m/s)	Arrival time (s)	Total kinetic energy (J)
1.0			
2.0			
4.0			
6.0			

Analysis | 7 minutes

5. How did the disk and hoop differ in bottom speed, arrival time, and energy distribution?

6. Why does the object with greater rotational inertia have less translational speed?

7. How did mass affect speed, time, and kinetic energy in Part B?

8. Explain why static friction can change the energy distribution without reducing total mechanical energy.

Claim-Evidence-Reasoning conclusion

Evaluate this claim: The hoop rolls down the ramp more slowly because it loses more mechanical energy to friction.

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measured trials or graph features.
REASONING	Use energy conservation, rotational inertia, and the rolling condition $v = \omega R$.

Exit ticket

Two rolling objects have the same mass and radius. State which property determines how their kinetic energy is divided between translation and rotation.