ROLLING LAUNCH INTO PROJECTILE MOTION

Rotational inertia, horizontal launch speed, and projectile range

Name: ____________________________	Period: ____________	Date: ______________

INVESTIGATION QUESTION **How does rotational inertia affect the range of a rolling object launched from the same height?**

TIME	SIMULATION	UNIT 6
30 minutes	BuildPhysics > Rolling launch into projectile motion	Energy & Momentum of Rotating Systems

Learning targets

- Connect rolling energy on a ramp to horizontal launch speed.
- Compare the projectile ranges of a solid disk and a hoop.
- Separate the rolling stage from the airborne stage.

Model before you measure

The disk and hoop have equal mass, radius, release height, and track geometry. Both leave the same table edge horizontally.	$mgh = ½mv_x^2 + ½I\omega^2$ $t = \sqrt{(2H/g)}$ $R = v_x t$

Important: Use $g = 9.8$ m/s². The two objects have the same flight time when they leave the same height with zero initial vertical velocity.

Pre-lab prediction | 4 minutes

1. Which object should have the greater horizontal launch speed?

____

2. Which object should land farther from the table?

____

3. Predict whether the two objects have the same flight time.

____

PART A Compare disk and hoop launches

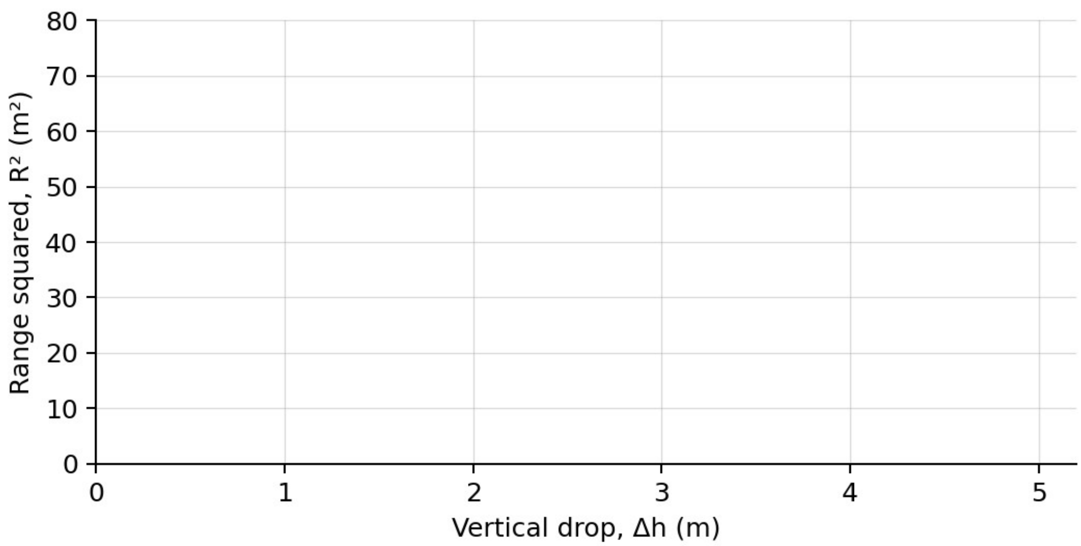
Setup | 3 minutes

- ☐ Load Rolling launch into projectile motion. Verify equal mass, radius, release height, and track geometry.
- ☐ Turn on trails and graph speed, rotational kinetic energy, translational kinetic energy, and y-position.
- ☐ Run both objects through the ramp and projectile flight. Record launch speed, flight time, and range.
- ☐ Repeat at four equal release-height differences above the table edge.

Range measurement: Measure horizontal range from the table edge directly below the launch point to the first ground contact.

Data table | 10 minutes

Release Δh (m)	Disk launch v_x (m/s)	Disk flight t (s)	Disk range R (m)	Hoop launch v_x (m/s)	Hoop flight t (s)	Hoop range R (m)
1.0						
2.0						
3.0						
4.0						



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

PART B Change rotational inertia at fixed release height

Inertia-factor test | 7 minutes

Controlled trial: Choose one rolling object. Keep mass, radius, release height, and table height fixed while changing the inertia factor.

Inertia factor c	Launch speed v_x (m/s)	Flight time (s)	Range (m)
0.25			
0.50			
0.75			
1.00			

Analysis | 7 minutes

5. Why did the disk and hoop have nearly equal flight times but different ranges?

6. How did inertia factor affect launch speed and range?

7. Why is R^2 proportional to release-height difference for a fixed object and table height?

8. Identify the energy transformations during the ramp stage and the motion principles during the airborne stage.

Claim-Evidence-Reasoning conclusion

Evaluate this claim: The hoop lands closer because it experiences a smaller gravitational force than the solid disk.

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measured trials or graph features.
REASONING	Use rolling-energy partition, equal flight time, and horizontal launch speed.

Exit ticket

A rolling object leaves a table horizontally. If its launch speed is reduced by 20% while table height stays fixed, predict the change in range.