BALLISTIC PENDULUM

Momentum during impact and energy during the swing

Name: _____	Period: _____	Date: _____

INVESTIGATION QUESTION **Can the projectile's launch speed be determined from the pendulum's maximum rise?**

TIME	SIMULATION	UNIT 4
30 minutes	BuildPhysics > Ballistic pendulum	Linear Momentum

Learning targets

- Separate a ballistic-pendulum event into collision and swing stages.
- Use momentum conservation during the perfectly inelastic collision.
- Use mechanical energy during the upward swing to infer launch speed.

Model before you measure

The projectile sticks to the pendulum bob. Momentum applies during impact; mechanical energy applies after impact.	$m_p v_i = (m_p + m_b)V$ $\quad$ $\frac{1}{2}(m_p + m_b)V^2 = (m_p + m_b)g\Delta h$

Important: Use $g = 9.8\ m/s^2$. Do not apply mechanical-energy conservation across the collision itself.

Pre-lab prediction | 4 minutes

1. Which speed is larger: the projectile speed before impact or the combined speed just after impact?

_____

2. If the projectile speed increases, what should happen to maximum rise?

_____

3. Why is kinetic energy not conserved during the sticking collision?

_____

PART A Change projectile launch speed

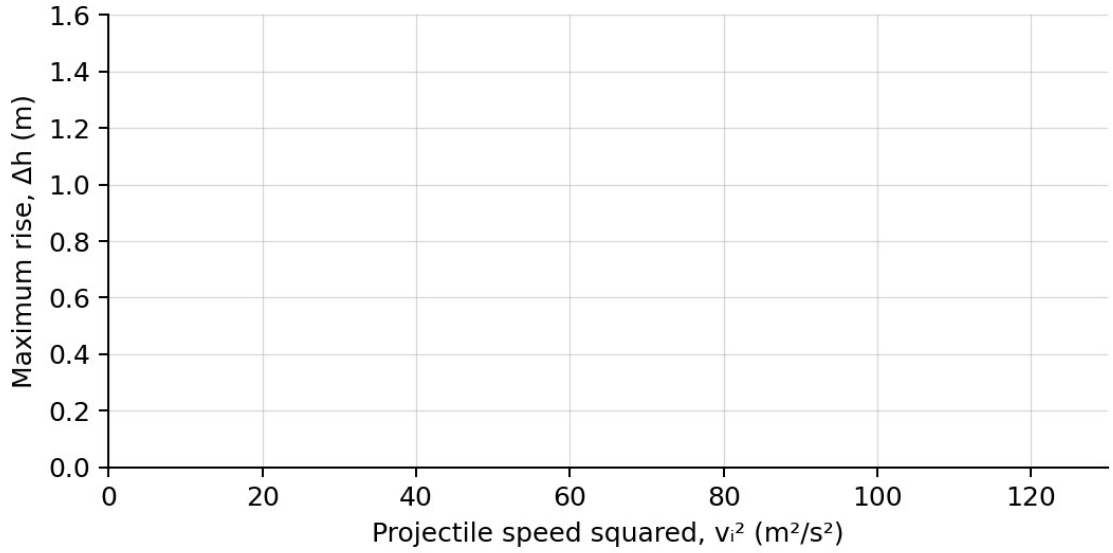
Setup | 3 minutes

- ☐ Load Ballistic pendulum. Record projectile mass m_p and pendulum-bob mass m_b.
- ☐ Turn on momentum and energy totals. Graph p_x, speed, and y-position.
- ☐ Set the projectile to each listed initial speed while keeping both masses fixed.
- ☐ Reset, run through impact and the first swing, pause at maximum rise, and record the values.

Two stages: Record the combined speed immediately after impact and the center-of-mass vertical rise from just after impact to the turning point.

Data table | 10 minutes

Projectile v_i (m/s)	v_i^2 (m²/s²)	Combined V after impact (m/s)	Maximum rise Δh (m)	Calculated v_i (m/s)	Measured total p_x before (kg·m/s)
4.0					
6.0					
8.0					
10.0					



4. Plot maximum rise versus projectile speed squared. Draw a best-fit line.

PART B Change pendulum mass

Mass test | 7 minutes

Fixed launch: Use one projectile speed from Part A and keep projectile mass constant.

Pendulum mass m_b (kg)	Combined speed V (m/s)	Maximum rise Δh (m)	Calculated projectile speed (m/s)
1.0			
2.0			
3.0			
4.0			

Analysis | 7 minutes

5. What relationship did your graph show between Δh and v_i^2?

6. Why must the collision and swing be analyzed with different conservation laws?

7. How did increasing pendulum mass affect combined speed and maximum rise?

8. Compare the calculated projectile speeds with the simulation settings.

Claim-Evidence-Reasoning conclusion

Evaluate this claim: Mechanical energy is conserved from immediately before impact to the maximum swing height.

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measured trials or graph features.
REASONING	Separate the collision interval from the swing and cite momentum and energy evidence.

Exit ticket

A projectile sticks to a pendulum and the combined system rises. State the order in which momentum and energy equations should be used.