ONE-DIMENSIONAL COLLISION

Momentum conservation, kinetic energy, and restitution

Name: _____	Period: _____	Date: _____

INVESTIGATION QUESTION **What is conserved in a collision, and how does restitution affect the outcome?**

TIME 30 minutes	SIMULATION BuildPhysics > One-dimensional collision	UNIT 4 Linear Momentum

Learning targets

- Compare total momentum before and after collisions.
- Distinguish elastic, partially inelastic, and perfectly inelastic collisions.
- Use restitution and kinetic-energy data to characterize a collision.

Model before you measure

Treat both carts as one system during the brief collision. External horizontal impulse is negligible.	$p_{total,i} = p_{total,f}$ $e = (v_{2f} - v_{1f})/(v_{1i} - v_{2i})$

Important: Momentum should be tested for the two-cart system. Kinetic energy is conserved only in an elastic collision.

Pre-lab prediction | 4 minutes

1. Predict what happens to total momentum as restitution changes from 0 to 1.

_____

2. Predict what happens to total kinetic energy as restitution increases.

_____

3. For equal masses with cart 2 initially at rest, predict the elastic-collision velocities.

_____

PART A Change restitution

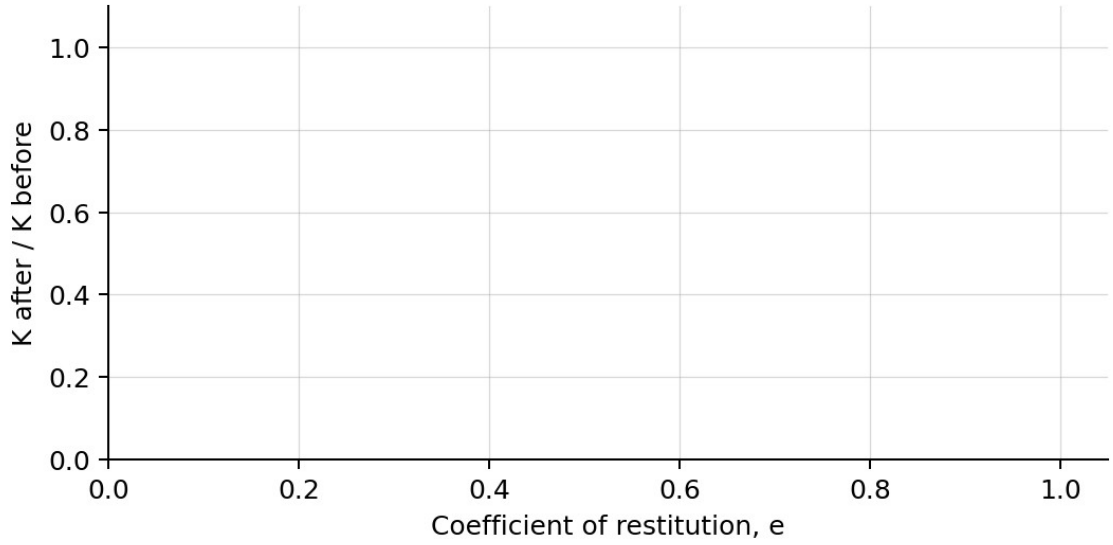
Setup | 3 minutes

- ☐ Load One-dimensional collision. Keep friction off.
- ☐ Record both masses and initial velocities. Keep them fixed for all Part A trials.
- ☐ Turn on Energy and momentum totals. Graph p_x and velocity for each cart.
- ☐ Set both carts to the listed restitution, reset, run through one collision, and pause after separation.

System data: Record total p_x and total kinetic energy immediately before and immediately after the collision.

Data table | 10 minutes

Restitution e	Total p_x before (kg·m/s)	Total p_x after (kg·m/s)	K before (J)	K after (J)	K after / K before
0.00					
0.25					
0.50					
0.75					
1.00					



4. Plot K after / K before versus restitution. Draw a smooth trend.

PART B Change the mass ratio

Mass-ratio test | 7 minutes

Controlled inputs: Use e = 1.00. Keep cart 1's mass and initial velocity fixed. Keep cart 2 initially at rest.

Cart 2 mass (kg)	Cart 1 final v_x (m/s)	Cart 2 final v_x (m/s)
0.50		
1.00		
2.00		
4.00		

Analysis | 7 minutes

5. How closely was total momentum conserved in all Part A trials?

6. How did restitution affect kinetic energy retained by the two-cart system?

7. How did increasing cart 2's mass change the two final velocities?

8. Explain why momentum can be conserved even when kinetic energy is not.

Claim-Evidence-Reasoning conclusion

Evaluate this claim: A collision with conserved momentum must also conserve kinetic energy.

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measured trials or graph features.
REASONING	Connect your evidence to system momentum, restitution, and energy transformation.

Exit ticket

Two carts stick together after colliding. Name the conserved quantity and write the equation used to find their shared final velocity.