Crash Course

Compare what stays constant in two cart collisions

PHY.3.4 "Design and conduct investigations to compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions using probe systems, online simulations, and/or laboratory experiences."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the two total quantities you must compare, circle the masses and velocities needed to calculate them, and number the two collision runs in the table.

Two Ways to Collide

1. Two 0.50 kg carts roll on a level track in an ideal simulation. Cart A moves right at 2.0 m/s, and cart B starts at rest. One run uses spring bumpers; another uses hook-and-loop pads that make the carts stick. The table reports velocities. Positive numbers mean motion to the right.

CART VELOCITIES IN TWO SIMULATED COLLISIONS

Collision	A before (m/s)	B before (m/s)	A after (m/s)	B after (m/s)
Spring bumpers	2.0	0	0	2.0
Carts stick	2.0	0	1.0	1.0

2. To test conservation, treat both carts as one system. Add their momenta before contact, then add them after contact. Each cart's momentum is its mass times its signed velocity. For kinetic energy, add one-half times each mass times its speed squared. Squaring speed makes kinetic energy positive even for leftward motion.

3. Compare the totals for the two runs rather than judging by how fast cart A moves alone. The pads can turn some motion energy into sound, heat, and deformation, although the carts' total momentum remains conserved in this ideal setup. In a lab, record several probe trials and check whether friction or measurement error changes your totals.

2 ANSWER WITH EVIDENCE

Use the passage

1. For the spring-bumper run, calculate the carts' total momentum before and after contact. Show both totals with units.

2. For the spring-bumper run, calculate total kinetic energy before and after contact. What does the comparison show?

3. For the sticking run, calculate total momentum before and after contact. How does this compare with the spring-bumper run?

4. For the sticking run, calculate total kinetic energy before and after contact. How does this differ from the spring-bumper run, and where could the missing energy go?

3 YOUR TURN

Your own words

Design a probe-cart test using two carts of different masses to compare a sticking collision with a bouncing collision. State what you will measure, what you will keep the same, how you will compare total momentum and kinetic energy, and what results you predict.

PART 1 · READ AND MARK

Underline the two total quantities you must compare, circle the masses and velocities needed to calculate them, and number the two collision runs in the table. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	For the spring-bumper run, calculate the carts' total momentum before and after contact. Show both totals with units.	**Before: 1.0 kg·m/s. After: 1.0 kg·m/s.**
2	For the spring-bumper run, calculate total kinetic energy before and after contact. What does the comparison show?	**Before: 1.0 J. After: 1.0 J. Kinetic energy is conserved.**
3	For the sticking run, calculate total momentum before and after contact. How does this compare with the spring-bumper run?	**Before: 1.0 kg·m/s. After: 1.0 kg·m/s. Total momentum is conserved in both runs.**
4	For the sticking run, calculate total kinetic energy before and after contact. How does this differ from the spring-bumper run, and where could the missing energy go?	**Kinetic energy falls from 1.0 J to 0.50 J, unlike the spring-bumper run. Some becomes sound, heat, or deformation energy.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I will use 0.30 kg and 0.60 kg carts on a level track. I will launch the lighter cart toward the resting heavier cart at the same speed in each trial. Motion probes will measure each cart's velocity just before and after impact. I will use hook-and-loop pads for sticking and spring bumpers for bouncing, repeating each setup three times. For each trial, I will add mass times signed velocity for both carts before and after impact. I will also add one-half mass times speed squared for both carts before and after impact. Momentum should stay nearly constant in both setups; kinetic energy should decrease more when the carts stick.

Accept equivalent calculations with correct units. In the investigation plan, accept other feasible collision materials if the student measures both carts before and after impact, controls launch conditions, and compares both system totals.