Puck Collision Puzzle

Predict a missing velocity using momentum and energy

HS-PSII-1.3 "For a system consisting of two objects moving in two dimensions with no net external forces applied, apply the principles of conservation of linear momentum and of mechanical energy to quantitatively predict changes in the linear momentum..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the conditions that keep total momentum and total kinetic energy constant. Circle the measured final velocity pair that helps you predict the missing pair.

Two Pucks, One Collision

1. Two pucks glide across a nearly frictionless air table and collide. During their brief contact, each puck pushes the other, but the pair experiences no net external force. Their total momentum therefore stays constant. The system's horizontal and vertical momentum totals must each remain unchanged. A puck's momentum in either direction equals its mass times that velocity component.

2. In the table, x points right and y points up. Each ordered pair gives horizontal velocity first and vertical velocity second. The blue puck's velocity after the elastic collision is missing, while the silver puck's final velocity was measured. Both pucks have the same mass, so you can use separate momentum totals to find the missing pair.

PUCK VELOCITIES ON AN AIR TABLE

Puck	Mass (kg)	Before velocity (vx, vy) in m/s	After velocity (vx, vy) in m/s
Silver	1	(4, 0)	(3, 3)
Blue	1	(0, 2)	(?, ?)

3. A collision may change each puck's speed even when the system keeps its total momentum. If mechanical energy is conserved and the pucks stay at the same height, total kinetic energy also stays constant. For each puck, calculate kinetic energy as half its mass times the sum of its squared velocity components. Check energy after finding the missing velocity.

2 ANSWER WITH EVIDENCE

Use the passage

1. Calculate the system's total momentum before the collision as an (x, y) pair. Include units.

2. Use momentum conservation to predict the blue puck's velocity pair after the collision. Show how you found each component.

3. What is the silver puck's change in momentum as an (x, y) pair? Include units.

4. Calculate the total kinetic energy before and after the collision. Do your results fit an elastic collision?

3 YOUR TURN

Your own words

Invent a different elastic collision between two 1 kg pucks on a frictionless table. Give each puck's before and after velocity pair (vx, vy) in m/s, then show that total x momentum, total y momentum, and total kinetic energy stay the same.

Puck Collision Puzzle

PART 1 · READ AND MARK

Underline the conditions that keep total momentum and total kinetic energy constant. Circle the measured final velocity pair that helps you predict the missing pair. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Calculate the system's total momentum before the collision as an (x, y) pair. Include units.	**(4, 2) kg·m/s.**
2	Use momentum conservation to predict the blue puck's velocity pair after the collision. Show how you found each component.	**The final x components must total 4, so blue's vx is 4 − 3 = 1 m/s. The final y components must total 2, so blue's vy is 2 − 3 = −1 m/s. Its velocity is (1, −1) m/s.**
3	What is the silver puck's change in momentum as an (x, y) pair? Include units.	**(3 − 4, 3 − 0) = (−1, 3) kg·m/s.**
4	Calculate the total kinetic energy before and after the collision. Do your results fit an elastic collision?	**Before: 8 + 2 = 10 J. After: 9 + 1 = 10 J. Yes, total kinetic energy is conserved.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Before: puck A moves at (2, 0) m/s, and puck B is at (0, 0) m/s. After: A moves at (1, 1) m/s, and B moves at (1, −1) m/s. Total x momentum is 2 kg·m/s before and after. Total y momentum is 0 kg·m/s before and after. Total kinetic energy is 2 J before. After, each puck has 1 J, for a total of 2 J.

Accept any invented velocity pairs that differ from the table's scenario and conserve both momentum components and total kinetic energy. Negative components indicate motion left or down.