Collision in Two Directions

Track momentum through an angled collision

HS-PSII-1.2 "For a system consisting of two objects with no net external forces applied, qualitatively and quantitatively analyze a two-dimensional interaction (i.e...."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle each mass and underline each east and north velocity in the table. Draw a line between each sled's before and after rows to track its contributions to the system's momentum.

A Collision on an Air Table

1. On an air table, two small sleds collide at an angle. Sled A has a mass of 2 kg, and sled B has a mass of 1 kg. Jets of air reduce friction, while gravity and the table's upward push balance. Treat the two sleds as one system with no net external force during the brief collision.

2. Choose east and north as positive directions. The table records each sled's velocity before and after contact. To find one sled's eastward momentum, multiply its mass by its eastward velocity. Do the same for northward momentum. Add the two sleds' contributions separately for each direction. A combined speed alone cannot test conservation.

SLED VELOCITIES AROUND THE COLLISION

Sled and time	Mass (kg)	East velocity (m/s)	North velocity (m/s)
A before	2	3	0
B before	1	0	2
A after	2	2	1
B after	1	2	0

3. The collision changes both paths, but a push between the sleds is an internal force. One sled can lose momentum in a direction while the other gains the same amount. Compare the system's totals before and after in both directions. If either total changes, the measurements or the no-net-external-force model needs another look.

2 ANSWER WITH EVIDENCE

Use the passage

1. Calculate the system's total eastward momentum before and after the collision. Show both sums.

2. Calculate the system's total northward momentum before and after the collision. Show both sums.

3. How much does sled A's momentum change in each direction? State whether each change is a gain or a loss.

4. How do sled B's momentum changes compare with sled A's? What happens to the system's total momentum?

3 YOUR TURN

Your own words

Invent a different collision: a 2 kg sled starts at 1 m/s east and 2 m/s north, while a 1 kg sled starts at 4 m/s east and 0 m/s north. Give final velocities that change both components for both sleds, then calculate the system's before and after momentum totals in each direction to show they match.

Collision in Two Directions

PART 1 · READ AND MARK

Circle each mass and underline each east and north velocity in the table. Draw a line between each sled's before and after rows to track its contributions to the system's momentum. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Calculate the system's total eastward momentum before and after the collision. Show both sums.	**Before: 2(3) + 1(0) = 6 kg·m/s east. After: 2(2) + 1(2) = 6 kg·m/s east.**
2	Calculate the system's total northward momentum before and after the collision. Show both sums.	**Before: 2(0) + 1(2) = 2 kg·m/s north. After: 2(1) + 1(0) = 2 kg·m/s north.**
3	How much does sled A's momentum change in each direction? State whether each change is a gain or a loss.	**Sled A loses 2 kg·m/s of eastward momentum and gains 2 kg·m/s of northward momentum.**
4	How do sled B's momentum changes compare with sled A's? What happens to the system's total momentum?	**B gains 2 kg·m/s eastward and loses 2 kg·m/s northward. Its changes cancel A's in each direction, so the system's total momentum remains constant.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

After the collision, the 2 kg sled moves at 3 m/s east and 1 m/s north. The 1 kg sled moves at 0 m/s east and 2 m/s north. Before the collision, total momentum is 2(1) + 1(4) = 6 kg·m/s east and 2(2) + 1(0) = 4 kg·m/s north. Afterward, it is 2(3) + 1(0) = 6 kg·m/s east and 2(1) + 1(2) = 4 kg·m/s north.

Accept any final velocity pairs that change both components for both sleds and yield 6 kg·m/s east and 4 kg·m/s north. Momentum must be checked separately in each direction.