LESSON MAKER PRO

Momentum in Motion

Track what changes and what stays the same.

HIGH SCHOOL · PHY.3.2

PHY.3.2 "Use mathematical and computational analysis to explore conservation of momentum and impulse."

NAME _____ DATE _____

TWO USEFUL RULES

Choose right as positive and left as negative. An object's momentum is p = mv, and the impulse on it is J = Favg × time = m(vfinal - vinitial). When external forces are negligible during a collision, the total momentum before equals the total momentum after.

WORKED EXAMPLE

A 7 kg cart moves right at 5 m/s, then moves left at 1 m/s after a force acts for 3 s. Find the impulse on the cart and the average force.

1. Use signed velocities: vinitial = +5 m/s and vfinal = -1 m/s.
2. J = m(vfinal - vinitial) = 7(-1 - 5) = -42 N·s.
3. Favg = J/time = -42/3 = -14 N.

Answer: Impulse: 42 N·s left. Average force: 14 N left.

PRACTICE 6 problems

1 A 2 kg cart speeds up from 8 m/s right to 12 m/s right. What impulse acts on it?

ANSWER _____

2 A 4 kg cart moving at 10 m/s right stops in 2 s. What is the average net force on it?

ANSWER _____

3 An average force of 8 N left acts on a cart for 6 s. What impulse does the cart receive?

ANSWER _____

4 A 2 kg cart moving at 12 m/s right hits a stationary 6 kg cart. The 2 kg cart stops. If external forces are negligible, what is the 6 kg cart's speed and direction after the collision?

ANSWER _____

5 A 4 kg cart moves at 10 m/s right, and a 6 kg cart moves at 2 m/s left. They collide and stick together. If external forces are negligible, what is their final velocity?

ANSWER _____

6 Two carts start at rest and push apart. A 2 kg cart moves at 8 m/s right. What is the velocity of the other cart if its mass is 4 kg and external forces are negligible?

ANSWER _____

APPLY IT Show your work

1 At a skatepark, a 40 kg rider moving at 6 m/s right steps onto a stationary 20 kg skateboard. The rider and board then roll together. If external forces are negligible during the step, what is their speed and direction just afterward?

WORK SPACE

ANSWER _____

2 During a soccer drill, a 0.60 kg ball starts at rest. A kick sends it at 10 m/s right after 0.20 s of contact. What is the average net force on the ball during contact?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A 2 kg cart moving at 8 m/s right hits a stationary 6 kg cart. They stick together, and external forces are negligible. Find their final velocity and the impulse on the 2 kg cart. Show how you used momentum conservation and impulse.

WORK SPACE AND ANSWER

Momentum in Motion

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A 2 kg cart speeds up from 8 m/s right to 12 m/s right. What impulse acts on it?	**8 N·s right**
2	A 4 kg cart moving at 10 m/s right stops in 2 s. What is the average net force on it?	**20 N left**
3	An average force of 8 N left acts on a cart for 6 s. What impulse does the cart receive?	**48 N·s left**
4	A 2 kg cart moving at 12 m/s right hits a stationary 6 kg cart. The 2 kg cart stops. If external forces are negligible, what is the 6 kg cart's speed and direction after the collision?	**4 m/s right**
5	A 4 kg cart moves at 10 m/s right, and a 6 kg cart moves at 2 m/s left. They collide and stick together. If external forces are negligible, what is their final velocity?	**2.8 m/s right**
6	Two carts start at rest and push apart. A 2 kg cart moves at 8 m/s right. What is the velocity of the other cart if its mass is 4 kg and external forces are negligible?	**4 m/s left**

PART 2 · APPLY IT

1. **4 m/s right** Conserve horizontal momentum: (40)(6) + (20)(0) = (40 + 20)v. Thus v = 240/60 = 4 m/s right.
2. **30 N right** The impulse is 0.60(10 - 0) = 6 N·s right. Divide by 0.20 s to get an average net force of 30 N right.

CHALLENGE

Final velocity: (2 × 8 + 6 × 0)/(2 + 6) = 2 m/s right. Impulse on the 2 kg cart: 2(2 - 8) = -12 N·s, or 12 N·s left.

Accept signed answers when the chosen positive direction is clear, such as -20 N for 20 N left. Accept 14/5 m/s right for 2.8 m/s right.