LESSON MAKER PRO

Impact in Motion

Connect force, contact time, and momentum change.

HIGH SCHOOL · P.3.d

P.3.d "Qualitatively and quantitatively evaluate the relationship among the force acting on an object, the time of interaction, and the change in linear momentum (impulse) of the object."

NAME _____ DATE _____

IMPULSE CHANGES MOMENTUM

Impulse equals average force multiplied by the time the force acts: impulse = F × Δt = Δp. Impulse is measured in N·s, which is equal to kg·m/s. Choose a positive direction before you calculate. A force in the opposite direction gives a negative change in momentum.

WORKED EXAMPLE

A 14 N force acts on a cart for 5 s. Find the cart's change in momentum.

1. Write the rule: Δp = F × Δt.
2. Substitute: Δp = 14 N × 5 s.
3. Multiply: Δp = 70 N·s.

Answer: 70 kg·m/s in the direction of the force

PRACTICE 6 problems

1 An 8 N force acts on a cart for 4 s. What is its change in momentum?

ANSWER _____

2 An object's momentum increases from 18 kg·m/s to 66 kg·m/s in 6 s. What average force acts on it?

ANSWER _____

3 A force changes an object's momentum by 48 kg·m/s in 12 s. What is the average force?

ANSWER _____

4 A 10 N force changes an object's momentum by 90 kg·m/s. How long does the force act?

ANSWER _____

5 Choose right as positive. A 15 N force acts to the left for 2 s. What is the object's change in momentum?

ANSWER _____

6 One push applies 20 N for 2 s. Another applies 10 N for 4 s in the same direction. Find each impulse and compare the momentum changes.

ANSWER _____

APPLY IT Show your work

1 A skateboarder and board have a combined mass of 60 kg and move at 6 m/s. A braking force of 120 N acts opposite their motion for 1 s. What is their final speed?

WORK SPACE

ANSWER _____

2 A 0.4 kg basketball travels right at 12 m/s, then rebounds left at 8 m/s. Contact lasts 0.2 s. Choose right as positive. What average force acts on the ball?

WORK SPACE

ANSWER _____

CHALLENGE One step up

Choose right as positive. A 2 kg cart starts with momentum of 18 kg·m/s to the right. A force of 11 N acts right for 4 s. Then a force of 8 N acts left for 2 s. Find the cart's total change in momentum and its final velocity.

WORK SPACE AND ANSWER

Impact in Motion

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	An 8 N force acts on a cart for 4 s. What is its change in momentum?	**32 kg·m/s in the direction of the force**
2	An object's momentum increases from 18 kg·m/s to 66 kg·m/s in 6 s. What average force acts on it?	**8 N in the positive direction**
3	A force changes an object's momentum by 48 kg·m/s in 12 s. What is the average force?	**4 N in the direction of the momentum change**
4	A 10 N force changes an object's momentum by 90 kg·m/s. How long does the force act?	**9 s**
5	Choose right as positive. A 15 N force acts to the left for 2 s. What is the object's change in momentum?	**-30 kg·m/s**
6	One push applies 20 N for 2 s. Another applies 10 N for 4 s in the same direction. Find each impulse and compare the momentum changes.	**Each impulse is 40 N·s. The momentum changes are equal.**

PART 2 · APPLY IT

1. **4 m/s** Initial momentum is 60 × 6 = 360 kg·m/s. The impulse is -120 × 1 = -120 N·s, so final momentum is 240 kg·m/s and final speed is 240 / 60 = 4 m/s.
2. **-40 N, or 40 N to the left** The change in momentum is 0.4 × (-8 - 12) = -8 kg·m/s. Average force is -8 / 0.2 = -40 N.

CHALLENGE

The total change in momentum is 11 × 4 - 8 × 2 = 28 kg·m/s to the right. Final momentum is 18 + 28 = 46 kg·m/s to the right, so final velocity is 46 / 2 = 23 m/s to the right.

Accept N·s or kg·m/s for impulse and change in momentum. Accept a negative sign or a leftward direction when right is defined as positive.