

1. Define momentum. Give the equation and unit.

Momentum is moving inertia – the tendency of an object to resist a change to its current motion.

Equation: p (momentum) = mv Unit: $\frac{\text{kg} \cdot \text{m}}{\text{s}}$

2. Two cars, one twice as heavy as the other, move down a hill at the same speed. Compared to that of the lighter car, the momentum of the heavier car is twice, 2x as much.

3. a. For a constant force, if the duration of impact upon an object is doubled, how is the impulse affected?

Impulse is doubled.

- b. How is the resulting change in momentum affected?

Momentum is doubled.

4. If the time of impact in a collision is extended by four times, by how much is the force of impact altered?

Force of impact is one-quarter (1/4).

5. Define impulse. Give its equation and unit.

Impulse is an action / reaction / force that causes a change in momentum.

Equation: Impulse = $F \cdot \Delta t$ Unit: $\text{N} \cdot \text{s}$, or $\frac{\text{kg} \cdot \text{m}}{\text{s}}$

Use the impulse-momentum equation to answer questions 6-9:

6. Why is it important to "follow through" when trying to hit a home run?

Following through maximizes the length of time the bat is in contact with the ball. This maximizes the impulse, allowing the greatest change in momentum and the greatest change in velocity.

7. Why does it hurt more when you fall on a concrete floor than on a wooden floor?

A concrete floor "gives" less than a wooden floor. The amount a floor "gives" indicates how much time it is in contact with you when stopping your momentum. Both floors provide the same impulse – the amount of force needed to bring your body to zero. If contact time is less for a concrete floor, the amount of force exerted must be greater to give the same impulse.

8. Why are car dashboards, steering wheels, and boxing gloves padded?

These padded items are designed to increase the amount of time it takes to stop the person, thus decreasing the actual amount of force delivered by the objects.

9. How can a karate "chop" break a board?

A karate chop is a quick motion, minimizing the time that the martial artist's hand is in contact with the board. Less time in contact means more force transferred to the board when the hand's momentum is countered by the board.

10. What is the momentum of a golf ball with a mass of 62 g moving at 73 m/s?

$$62 \text{ g} = 0.062 \text{ kg}$$

$$\text{momentum} = mv = (0.062 \text{ kg})(73 \frac{\text{m}}{\text{s}}) = \boxed{4.5 \frac{\text{kg}\cdot\text{m}}{\text{s}}}$$

11. If in the problem above, the impact between the ball and club lasted for $2.0 \times 10^{-3} \text{ s}$, what force acted on the ball? What force acted on the club?

$$F \cdot t = m \cdot v \quad F = \frac{m \cdot v}{t}$$

$$F = \frac{4.5 \frac{\text{kg}\cdot\text{m}}{\text{s}}}{2 \times 10^{-3} \text{ s}} = \boxed{2300 \text{ N}}$$

12. For how long a time must a tow truck pull with a force of 550 N on a stalled 1200 kg car to give it a forward velocity of 2.0 m/s?

$$F \cdot t = m \cdot v \quad t = \frac{m \cdot v}{F}$$

$$t = \frac{(1200 \text{ kg})(2.0 \frac{\text{m}}{\text{s}})}{550 \text{ N}} = \boxed{4.4 \text{ s}}$$