

## Momentum, Impulse and Momentum Change

Read from **Lesson 1** of the **Momentum and Collisions** chapter at **The Physics Classroom**:

<http://www.physicsclassroom.com/Class/momentum/u4l1a.html>

<http://www.physicsclassroom.com/Class/momentum/u4l1b.html>

**MOP Connection:** Momentum and Collisions: sublevels 1 and 2

### Momentum

- The momentum of an object depends upon the object's \_\_\_\_\_. Pick two quantities.
  - mass - how much *stuff* it has
  - acceleration - the rate at which *the stuff* changes its velocity
  - weight - the force by which gravity attracts *the stuff* to Earth
  - velocity - how fast and in what direction it's *stuff* is moving
  - position - where the *stuff* is at

- Momentum is a \_\_\_\_\_ quantity.
  - scalar
  - vector

- Which are **complete** descriptions of the momentum of an object? Circle all that apply.

- |                  |                      |                                   |
|------------------|----------------------|-----------------------------------|
| a. 2.0 kg/s      | b. 7.2 kg•m/s, right | c. 6.1 kg•m/s <sup>2</sup> , down |
| d. 4.2 m/s, east | e. 1.9 kg•m/s, west  | f. 2.3 kg•m/s                     |

- The two quantities needed to calculate an object's momentum are \_\_\_\_\_ and \_\_\_\_\_.

- Consider the mass and velocity values of Objects A and B below. Compared to Object B, Object A has \_\_\_\_\_ momentum.

- |   |                   |
|---|-------------------|
| a. two times the  | b. four times the |
| c. eight times the  | d. the same       |
| e. one-half the   | f. one-fourth the |
| g. ... impossible to tell without knowledge of the F and a. |                   |



- Calculate the momentum value of ... . (Include appropriate units on your answers.)

- ... a 2.0-kg brick moving through the air at 12 m/s.
- ... a 3.5-kg wagon moving along the sidewalk at 1.2 m/s.

- With what velocity must a 0.53-kg softball be moving to equal the momentum of a 0.31-kg baseball moving at 21 m/s?

### Impulse and Momentum Change

- Insert these words into the four blanks of the sentence: **mass, momentum, acceleration, time, impact, weight, impulse, and force.** (Not every word will be used.)

In a collision, an object experiences a(n) \_\_\_\_\_ acting for a certain amount of \_\_\_\_\_ and which is known as a(n) \_\_\_\_\_; it serves to change the \_\_\_\_\_ of the object.



## Momentum and Collisions

9. A(n) \_\_\_\_\_ causes and is equal to a change in momentum.  
 a. force                      b. impact                      c. impulse                      d. collision
10. Calculate the impulse experienced by .... (Show appropriate units on your answer.)  
 a. ... a 65.8-kg halfback encountering a force of 1025 N for 0.350 seconds.  
 b. ... a 0.168-kg tennis ball encountering a force of 126 N that changes its velocity by 61.8 m/s.

11. Determine the impulse ( $I$ ), momentum change ( $\Delta p$ ), momentum ( $p$ ) and other values.

A 7-ball collides with the 8-ball.

$I = \underline{\hspace{2cm}}$   
 $\Delta p = \underline{\hspace{2cm}}$

$m = 0.1 \text{ kg}$        $m = 0.1 \text{ kg}$   
 $v = 4 \text{ m/s}$        $v = 1 \text{ m/s}$

$P_1 = \underline{\hspace{2cm}}$        $P_2 = \underline{\hspace{2cm}}$

A moving medicine ball is caught by a girl on ice skates.

$m = 10 \text{ kg}$        $I = -50 \text{ N}\cdot\text{s}$        $m = 10 \text{ kg}$   
 $v = 6 \text{ m/s}$        $\Delta p = \underline{\hspace{2cm}}$        $v = \underline{\hspace{2cm}} \text{ m/s}$

$P_1 = \underline{\hspace{2cm}}$        $P_2 = \underline{\hspace{2cm}}$

A car is at rest when it experiences a forward propulsion force to set it in motion. It then experiences a second forward propulsion force to speed it up even more. Finally, it brakes to a stop.

$I = \underline{\hspace{2cm}}$        $I = \underline{\hspace{2cm}}$        $I = \underline{\hspace{2cm}}$   
 $\Delta p = \underline{\hspace{2cm}}$        $\Delta p = \underline{\hspace{2cm}}$        $\Delta p = \underline{\hspace{2cm}}$

**At rest**       $F_{\text{app}} = 4000 \text{ N}$        $F_{\text{app}} = 6000 \text{ N}$        $F_{\text{frict}} = 8000 \text{ N}$       **Stopped**  
 $t = 4.0 \text{ s}$        $t = 3.0 \text{ s}$        $t = \underline{\hspace{2cm}} \text{ s}$

$P_1 = \underline{\hspace{2cm}}$        $P_2 = \underline{\hspace{2cm}}$        $P_3 = \underline{\hspace{2cm}}$        $P_4 = \underline{\hspace{2cm}}$

A tennis ball is at rest when it experiences a forward force to set it in motion. It then strikes a wall where it encounters a force that slows it down and finally turns it around and sends it backwards.

$I = \underline{\hspace{2cm}}$        $I = \underline{\hspace{2cm}}$        $I = \underline{\hspace{2cm}}$   
 $\Delta p = \underline{\hspace{2cm}}$        $\Delta p = \underline{\hspace{2cm}}$        $\Delta p = \underline{\hspace{2cm}}$

**Stopped**       $F_{\text{app}} = 60 \text{ N}$       **Moving Right**       $F_{\text{wall}} = \underline{\hspace{2cm}} \text{ N}$        $v = 0 \text{ m/s}$        $F_{\text{wall}} = 120 \text{ N}$       **Moving Left**  
 $t = 0.1 \text{ s}$        $t = 0.05 \text{ s}$        $t = 0.04 \text{ s}$

$P_1 = \underline{\hspace{2cm}}$        $P_2 = \underline{\hspace{2cm}}$        $P_3 = \underline{\hspace{2cm}}$        $P_4 = \underline{\hspace{2cm}}$