

- 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.
  - 2.0 kg/s
  - 7.2 kg•m/s, right
  - 6.1 kg•m/s<sup>2</sup>, down
  - 4.2 m/s, east
  - 1.9 kg•m/s, west
  - 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.
  - two times the
  - four times the
  - eight times the
  - the same
  - one-half the
  - one-fourth the
  - ... 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.)

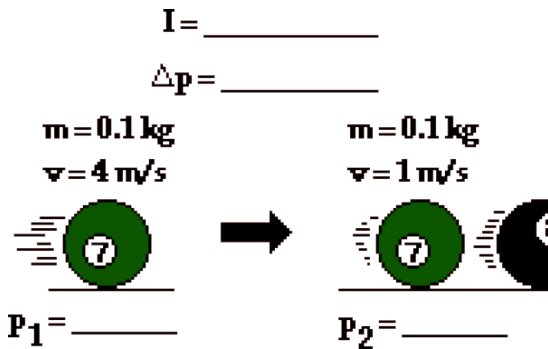
In a collision, an object experiences a(n) \_\_\_\_\_ acting for a certain amount of \_\_\_\_\_ and which is known as a(n) \_\_\_\_\_; it serves to change the \_\_\_\_\_ of the object.



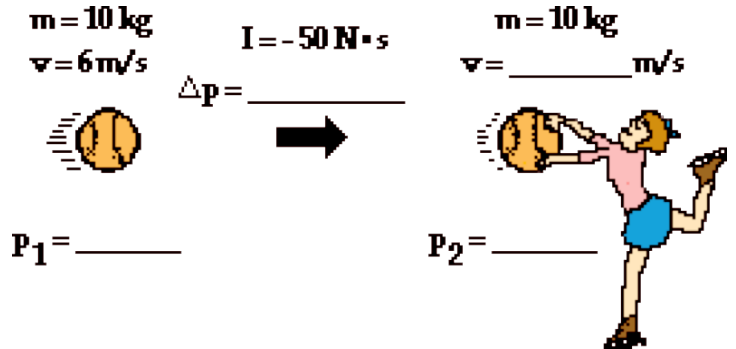
9. A(n) \_\_\_\_\_ causes and is equal to a change in momentum.  
 a. force                      b. impact                      c. impulse                      d. collision
10. Calculate the impulse experienced by .... (Show appropriate units on your answer.)  
 a. ... a 65.8-kg halfback encountering 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.

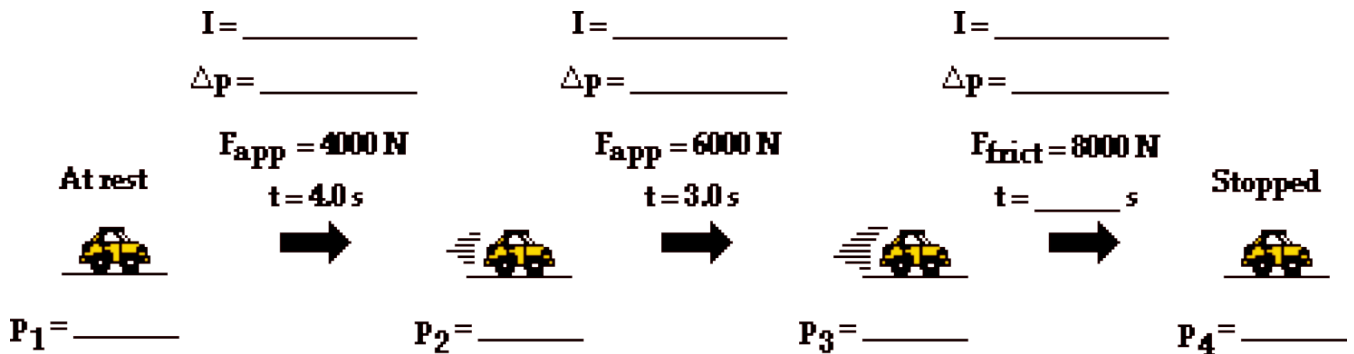
A 7-ball collides with the 8-ball.



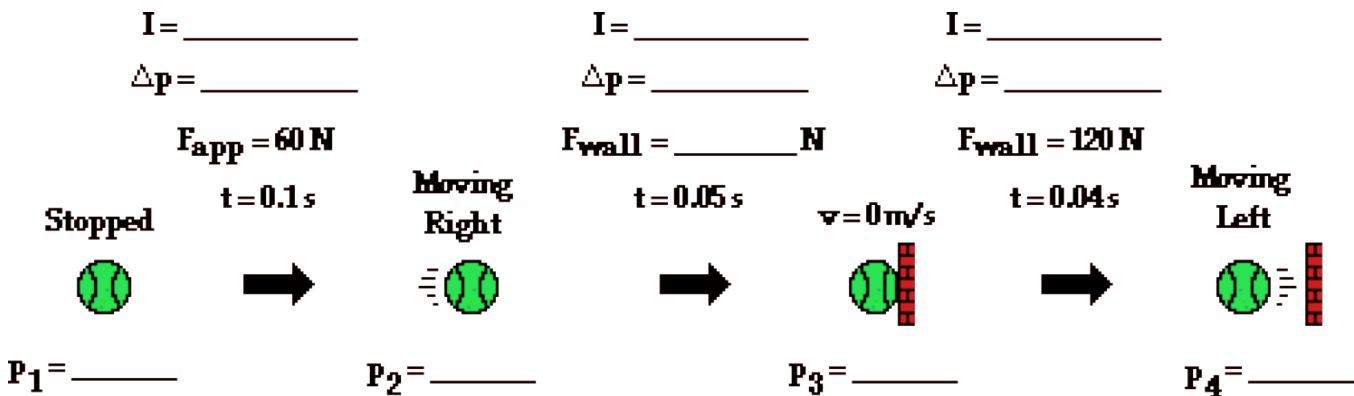
A moving medicine ball is caught by a girl on ice skates.



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.



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.



PSYW = Please Show Your Work

**A car with a mass of 1000 kg is at rest at a stoplight. When the light turns green, it is pushed by a net force of 2000 N for 10 s.**

1. What is the value of the **acceleration** that the car experiences?
2. What is the value of the **change in velocity** that the car experiences?
3. What is the value of the **impulse** on the car?
4. What is the value of the **change in momentum** that the car experiences?
5. What is the **final velocity** of the car at the end of 10 seconds?

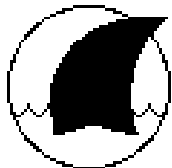


**The car continues at this speed for a while.**

6. What is the value of the change in momentum the car experiences as it continues at this velocity?
7. What is the value of the impulse on the car as it continues at this velocity?

**The brakes are applied to the car, causing it to come to rest in 4 s.**

8. What is the value of the **change in momentum** that the car experiences?
9. What is the value of the **impulse** on the car?
10. What is the value of the **force** (average) that causes the car to stop?
11. What is the **acceleration** of the car as it stops?



**BEWARE**

There is a disease known as *formula fixation* that is common among physics students. It particularly infects those who perceive physics as an applied math course where numbers and equations are simply combined to solve algebra problems. However, this is **not** the true nature of physics. Physics concerns itself with ideas and concepts that provide a reasonable explanation of the physical world. When students divorce the mathematics from the ideas, formula fixation takes root and even mathematical problem solving can become difficult. Do you have *formula fixation*? Test your health by trying these computational problems.

12. A force of 800 N causes an 80-kg fullback to change his velocity by 10 m/s. Determine the impulse experienced by the fullback. **PSYW**
  
13. A 0.80-kg soccer ball experiences an impulse of 25 N•s. Determine the momentum change of the soccer ball. **PSYW**
  
14. A 1200-kg car is brought from 25 m/s to 10 m/s over a time period of 5.0 seconds. Determine the force experienced by the car. **PSYW**
  
15. A 90-kg tight end moving at 9.0 m/s encounters a 400 N•s impulse. Determine the velocity change of the tight end. **PSYW**
  
16. A 0.10-kg hockey puck decreases its speed from 40 m/s to 0 m/s in 0.025 s. Determine the force that it experiences. **PSYW**
  
17. **A Real Brain Twister:** A 0.10-kg hockey puck is at rest. It encounters a force of 20 N for 0.2 seconds that sets it into motion. Over the next 2.0 seconds, it encounters 0.4 Newtons of resistance force. Finally, it encounters a final force of 24 N for 0.05 seconds in the direction of motion. What is the final velocity of the hockey puck? **PSYW**

You may have been *tricked*, but those were not intended as trick questions. The questions were intended to test your understanding of the concepts of momentum change, impulse, mass, force, time and velocity change. How is your understanding level progressing? Do you have formula fixation?