 Name: KEY 01/08/18

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

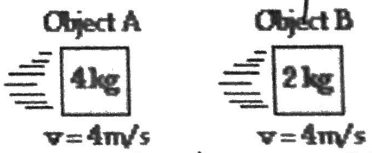
1. The momentum of an object depends upon the object's _____. Pick two quantities.
   a. mass - how much *stuff* it has
   b. acceleration - the rate at which *the stuff* changes its velocity
   c. weight - the force by which gravity attracts *the stuff* to Earth
   d. velocity - how fast and in what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

2. Momentum is a _____ quantity.
   a. scalar b. vector

3. 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^2, down
   d. 4.2 m/s, east e. 1.9 kg•m/s, west f. 2.3 kg•m/s

4. The two quantities needed to calculate an object's momentum are mass and velocity

5. 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.



$p = 16\ kg\,m/s$ $p = 8\ kg\,m/s$

6. Calculate the momentum value of ... . (Include appropriate units on your answers.)
   a. ... a 2.0-kg brick moving through the air at 12 m/s.

$$p = mv = (2\ kg)(12\ m/s) = 24\ kg\,m/s$$

   b. ... a 3.5-kg wagon moving along the sidewalk at 1.2 m/s.

$$p = mv = (3.5\ kg)(1.2\ m/s) = 4.2\ kg\,m/s$$

7. 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?

$p_s = m_s v_s$ $p_B = m_B v_B = (0.31\ kg)(21\ m/s) = 6.51\ kg\,m/s$

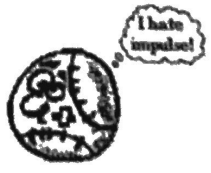
$6.51\ kg\,m/s = (0.53\ kg)\,v_s$ $p_s = p_B$

$\frac{6.51\ kg\,m/s}{(0.53\ kg)} \rightarrow v_s = 12.28\ m/s$

Impulse and Momentum Change

8. 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) force acting for a certain amount of time and which is known as a(n) impulse; it serves to change the momentum 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.

m = 65.8 kg
F = 1025 N
t = 0.350 s
Ft = mΔv
(1025 N)(0.350 s) = Δp
J (impulse) = Ft = (1025 N)(0.350 s)
J = 358.75 Ns

   b. ... a 0.168-kg tennis ball encountering a force of 126 N that changes its velocity by 61.8 m/s.

m = 0.168 kg
F = 126 N
Δv = 61.8 m/s
J = Ft = mΔv
Ft = mΔv
= (0.168 kg)(61.8 m/s)
Ft = 10.38 Ns

11. Determine the impulse (I), momentum change (Δp), momentum (p) and other values.

A 7-ball collides with the 8-ball.

I = -0.3 Ns
Δp = (0.1 kgm/s - 0.4 kgm/s)
= -0.3 kgm/s

m = 0.1 kg, v = 4 m/s → m = 0.1 kg, v = 1 m/s

p_1 = 0.4 kgm/s p_2 = 0.1 kgm/s

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

m = 10 kg, v = 6 m/s
I = -50 N·s
Δp = -50 kgm/s
m = 10 kg, v = 1 m/s

p_1 = 60 kgm/s p_2 = 10 kgm/s

Δp = $p_2 - p_1$
-50 kgm/s = 10 kgm/s - p_1
+60 kgm/s +60 kgm/s
p_1 = 10 kgm/s

p = mv
10 kgm/s = (10 kg) v
10 kg 10 kg
v = 1 m/s

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 = Ft = (4000 N)(4 s) = 16000 Ns I = 18,000 Ns I = -34,000 Ns
Δp = 16,000 kgm/s Δp = 18,000 kgm/s Δp = -34,000 kgm/s

Ft = -34000 Ns
8000 N(t) = -34,000 Ns
8000 N 8000 N
t =

At rest → F_{app} = 4000 N, t = 4.0 s → F_{app} = 6000 N, t = 3.0 s → F_{frict} = 8000 N, t = 4.25 s → Stopped

p_1 = 0 p_2 = 16,000 kgm/s p_3 = 34,000 kgm/s p_4 = 0

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 = 6 Ns I = -6 Ns I = 4.8 Ns
Δp = 6 kgm/s Δp = -6 kgm/s Δp = 4.8 kgm/s

Stopped → F_{app} = 60 N, t = 0.1 s → Moving Right → F_{wall} = -120 N, t = 0.05 s → v = 0 m/s → F_{wall} = 120 N, t = 0.04 s → Moving Left

p_1 = 0 p_2 = 6 kgm/s p_3 = 0 p_4 = 4.8 kgm/s

-6 Ns = Ft
$\frac{-6\ Ns}{0.05\ s} = \frac{F(0.05\ s)}{(0.05\ s)}$
F = -120 N