Here are a few extra study questions. The circled ones apply to the first quiz.

2.8 Review Assignment

1. Determine the momentum of an 82 kg linebacker running south at 5.2 km/h.

$\vec{p} = m\vec{v}$

$= (82\ kg)(5.2\ \frac{km}{h})$

$= 426.4\ kg\,km/h$

$= 4.3 \times 10^2\ kg\frac{km}{h} \times \frac{1}{3600\,s} \times \frac{1000\,m}{1\,km}$

$= 1.2 \times 10^2\ kg\,m/s$

The momentum is 1.2×10^2 kg•m/s, south.

2. A 200 g ball is dropped from a height of 80 cm. Calculate its momentum as it makes contact with the floor.

$\Sigma E = \Sigma E'$

$mgh = \frac{1}{2}mv^2$

$v = \sqrt{2gh}$

or $v_f^2 = v_i^2 + 2ad$ then $p = mv$

$\vec{p} = mv$

$= m\sqrt{2gh}$

$= (0.200\ kg)\sqrt{2(9.81\ m/s^2)(0.80\ m)}$

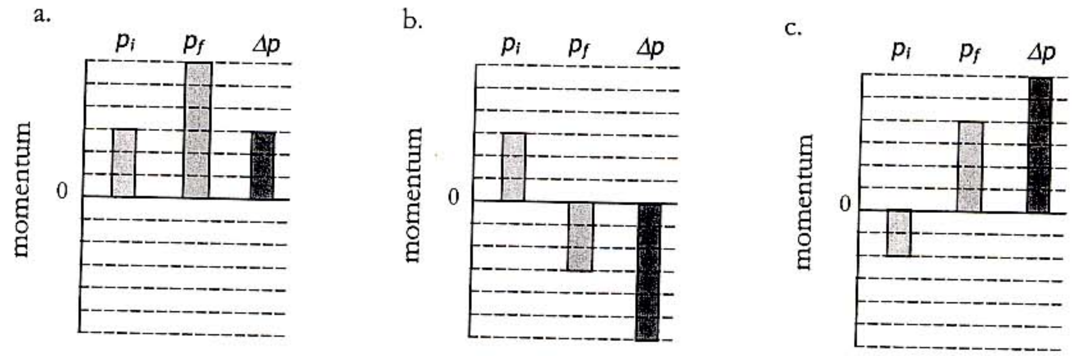
$= 0.79\ kg\,m/s$

The ball's momentum is 0.79 kg•m/s, downwards.

3. Modern vehicles have bumpers designed to crush upon impacted. Many older vehicles had hard metal bumpers that were designed not to crush upon impact. Use physics terminology and formulae to describe how a modern bumper works to reduce or prevent injuries to occupants of the vehicle.

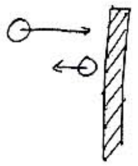
The bumper will increase the time of the impact to decrease the force of the impact according to $Ft = m\Delta v$.

4. Momentum and impulse may be represented using bar graphs as shown below. Draw the missing bar graph representing impulse for each situation.



5. Two children throw identical balls with the same velocity towards a house. The first ball hits a wall and bounces directly back at half of its contact speed. The second ball hits a window, breaks it and continues through at half of its contact speed. Did the two balls experience the same impulse? Explain.

1



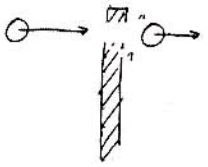
$Ft = m\Delta v$

$Ft = m(v_f - v_i)$

$= m(-0.5v - v)$

$Ft = mv(-1.5)$

2



$Ft = m\Delta V$

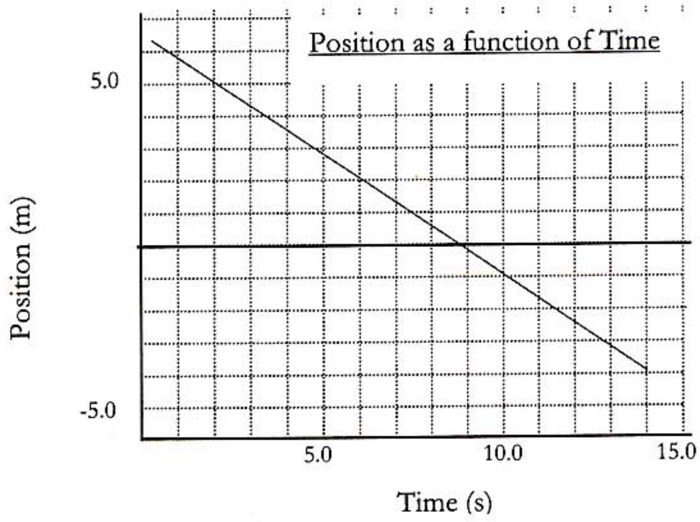
$= m(V_f - V_i)$

$= m(0.5v - v)$

$Ft = mv(-0.5)$

No. The two balls did not experience the same impulse. The first ball changed direction and therefore had a greater change in velocity resulting in a greater change in momentum (i.e., impulse)

6. The position of a 2100 kg truck over time was recorded and graphed as shown as it travelled at a constant velocity to the west. Use the graph to determine the car's momentum.

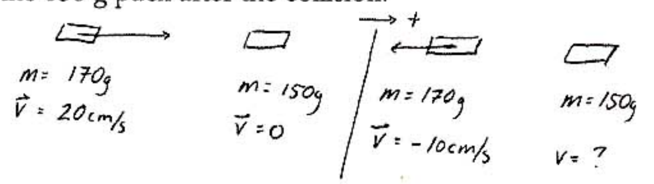


$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1.0\,m - 5.0\,m}{10.0\,s - 2.0\,s} = \frac{-6.0\,m}{8.0\,s} = -0.75\,m/s$$

$$\vec{p} = mv$$
$$= (2100\,kg)(-0.75\,m/s)$$
$$= -1575\,kg\,m/s$$
$$= -1.6 \times 10^3\,kg\,m/s$$

The car's momentum is 1.6×10^3 kg•m/s, west.

7. A 170 g puck travels to the right at 20 cm/s and collides with a stationary 150 g puck on an air table. After the collision the 170 g puck is moving left with 10 cm/s. Determine the velocity of the 150 g puck after the collision.



$$\Sigma P = \Sigma P'$$

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$\frac{m_1 v_1 - m_1 v_1'}{m_2} = v_2' = \frac{(170g)(20cm/s) - (170g)(-10cm/s)}{(150g)}$$

$$= 34 \ cm/s$$

The puck's velocity is 34 cm/s to the right after the collision.

8. A 1400 kg car moving at 20 m/s crashes into a solid barrier and comes to a complete stop. The car's crumple zone compresses a distance of 0.20 m during the collision.

a. Calculate the impulse acting on the car.
b. Calculate the magnitude of the stopping force acting on the car.
c. Determine the number of "g" forces acting on an occupant in the car.

$m = 1400kg$, $v_i = 20m/s$, $v_f = 0$, $d = 0.20m$

$$\vec{F}t = m\Delta\vec{v} = m(v_f - v_i) = 1400kg(0 - 20m/s) = -2.8 \times 10^4 \ kg\,m/s$$

$$F = ma = m\left(\frac{v_f^2 - v_i^2}{2d}\right) = 1400kg\left(\frac{-(20m/s)^2}{2(0.20m)}\right) = -1.4 \times 10^6 \ N$$

$\vec{g}$ force

$$\vec{a} = \frac{v_f^2 - v_i^2}{2d} = -1000 m/s^2 \,/\, 9.81 m/s^2 = 102 \ \vec{g}'s$$

a. The impulse acting on the car is 2.8×10^4 N•s.
b. The magnitude of the stopping force acting on the car 1.4×10^6 N.
c. The number of "g" forces acting on an occupant in the car is 102 g's.

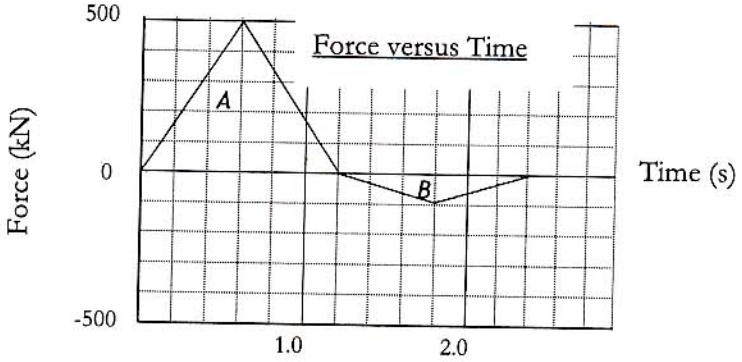
9. A study by Streff and Geller had people race a go-kart around a track. It was found that when the drivers wore a seatbelt they drove faster than when they did not wear a seatbelt. A similar study regarding wearing bicycle helmets found that wearing a helmet resulted in riskier riding. A compensation for using safety equipment by modifying other behaviours to the level of risk an individual is comfortable with seemed to occur. The study of risk compensation calls into question the effectiveness of many laws such as mandatory seat belt laws. Discuss the pros and cons of laws mandating the use of safety equipment. Use your own experience and analyze your thoughts on risk compensation.

Answers will vary but students should be able list risks and benefits and give their opinion on the personal acceptability of the risks. While personal acceptability is important students should be aware of how the consequences of the risks could impact others and society.

Possible benefits	Possible risks

10. When force is plotted on the y-axis of a graph and time is plotted on the x-axis, the area between the graph and the x-axis may be interpreted as impulse.

11. Rowing is an Olympic sport and may be analyses using the science of biomechanics. Part of the analysis is a net force versus time graph showing the two main stages of rowing as shown below.



a. Identify the section of the graph (A or B) that you would want to reduce or eliminate to improve the overall speed of the boat.

b. Use the graph to determine the net impulse.

B has a negative impulse. That would mean a small amount of slowing

(A) Area = $\frac{b \times h}{2} = \frac{(1.2s)(500kN)}{2} = 6.0 \times 10^5 N\cdot s$

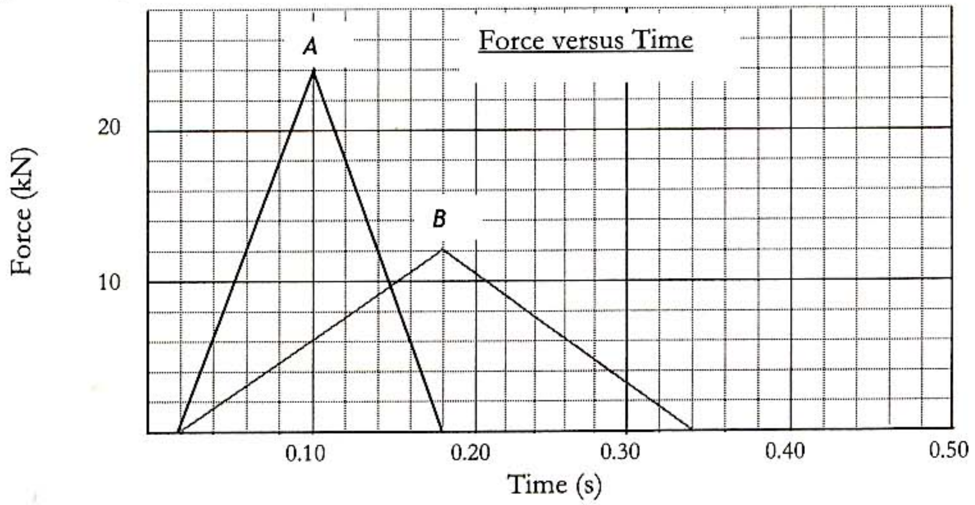
(B) Area = $\frac{b \times h}{2} = \frac{(1.2s)(-100kN)}{2} = -1.2 \times 10^5 N\cdot s$

Net Impulse $= 6.0 \times 10^5 N\cdot s + (-1.2 \times 10^5 N\cdot s)$

$= 4.8 \times 10^5 N\cdot s$

b. The net impulse is 4.8×10^5 N•s.

12. A car carrying a driver and passenger of equal mass crashes. The driver had an airbag while the passenger did not. The net force that varies with time for the driver and for the passenger are graphed and presented below.



a. Identify the graph (A or B) that represents what happens to the
   i. driver. [B]
   ii. passenger. [A]

b. Use the graph to determine the impulse on the passenger.

c. Use the graph to determine the impulse on the driver.

$I_{passenger}$ = Area of B
= ½ b × h
= (0.5)(0.32 s × 12 × 10³ N)
= 1920 N·s or 1.9 kN·s

I_{driver} : Area of A
= ½ b × h
= (0.5)(0.16 s × 24 × 10³ N)
= 1920 N·s or 1.9 kN·s

d. Should the driver and passenger (they have identical mass) have equal impulses? Explain.

Yes. Since both the car and passenger were moving at the same initial velocity, the change in momentum (impulse) they experience will be the same as they come to a stop.

e. Use the graph to explain why wearing having an airbag can be safer during a car crash.

Wearing a seatbelt increases the amount of time it takes to come to a stop allowing the object to experience a lesser magnitude of force. ($F \propto 1/t$).