Worksheet momentum solutions

**1.** A car with a mass of 1Mg is at rest at a stoplight. When the light turns green, the car's engine applies a force resulting in a net force of 2kN acting on the car to the east for 10s.

 **a)** Calculate the acceleration that the car experiences.

$$F=ma\rightarrow a=\frac{F}{m}=\frac{2kN}{1Mg}=\frac{2x10^{3}N}{1x10^{3}kg}=2\frac{m}{s^{2}}$$

 **b)** Calculate the impulse on the car.

$$J=F∆t=\left(2x10^{3}N\right)\left(10s\right)=2x10^{4}Ns$$

 **c)** Calculate the final velocity of the car at the end of the 10 seconds.

$$v=at+v\_{o}=\left(2\frac{m}{s^{2}}\right)\left(10s\right)+\left(0\frac{m}{s}\right)=20\frac{m}{s}$$

 **d)** Calculate the initial momentum of the car.

$$p\_{o}=mv\_{o}=\left(1x10^{3}kg\right)\left(0\frac{m}{s}\right)=0\frac{kgm}{s}$$

 **e)** Calculate the final momentum of the car.

$$p=mv=\left(1x10^{3}kg\right)\left(20\frac{m}{s}\right)=2x10^{4}\frac{kgm}{s}$$

 **f)** Calculate the change in momentum and compare this value to the value you got in part **b)**.

$$∆p=p-p\_{o}=2x10^{4}\frac{kgm}{s}-0\frac{kgm}{s}=2x10^{4}\frac{kgm}{s}$$

Notice that the change in momentum is equal to the impulse. This is always the case.

Also notice that the units $Ns=\frac{kgm}{s}$.

**2.** Football player A is running due east when he jumps into the air at a 13o angle slamming into football player B's head with his lower torso. Football player B was running due west. After the collision, football player B comes to a halt while player A flies north west at a 30o angle from the horizontal.

**a)** Draw this situation. Label the angles and the momentum vectors.



**b)** Is this collision elastic or inelastic, and how do you know?

This is an elastic collision due to the football players bouncing off each other.

**c)** Describe this situation algebraically using these two equations: ∑pox = ∑pfx ∑poy = ∑pfy

$∑p\_{ox}=∑p\_{fx}\rightarrow $ $p\_{Aox}-p\_{Bo}=- p\_{Afx}\rightarrow m\_{A}v\_{Ao}\cos(\left(13^{o}\right))-m\_{B}v\_{Bo}=- m\_{A}v\_{Af}\cos(\left(30^{o}\right))$

$$∑p\_{oy}=∑p\_{fy}\rightarrow p\_{Aoy}= p\_{Afy}\rightarrow m\_{A}v\_{Ao}\sin(\left(13^{o}\right))= m\_{A}v\_{Af}\sin(\left(30^{o}\right))$$