

Momentum notes

*****Momentum*****

$$p = mv$$

“p” is the momentum of the object measured in kg-m/s

“m” is the mass of the object measured in Kilograms (kg)

“v” is the velocity of the object measured in m/s

Example:

A 1000kg car is traveling at 8.0m/s. What is the momentum of the car?

$$p = mv$$

$$p = (1000kg)(8.0 \text{ m/s}) = 8000kg \text{ m/s}$$

*****Conservation of momentum*****

These problems will involve two objects. The two objects will interact through one of the following methods: crash into each other and bounce apart, explode apart or crash and stick together.

--Crash into each other and bounce apart (inelastic collision)----

In this type of problem, two objects will crash into each other and will bounce off with new speeds. All you have to do is add the momentum up for every object before they crash (put this on the left side of the equal sign). On the right side of the equal sign, add up the momentum of each object after they crash. Make sure to keep track of signs. If objects travel down, south or left or west they are negative velocities. If the object travels up, North, or right or east, they are positive velocities. In every problem you will know all information except one variable. You will use math to solve for that variable. (Variables are M's and V's and stuff like that)

$$M_1V_1 + M_2V_2 = M_1V_1 + M_2V_2$$

Before After

Example: A 4.0kg red ball is traveling to the right at 10m/s, while a 5.0kg green ball is traveling to the left at 3.0m/s. They crash together and after the collision, the green ball is traveling to the right at 7.0m/s. What is the velocity of the red ball after the collision?

$$M_1V_1 + M_2V_2 = M_1V_1 + M_2V_2$$

$$(4.0kg)(10 \text{ m/s}) + (5.0kg)(-3.0 \text{ m/s}) = (4.0kg)(V) + (5.0kg)(7.0 \text{ m/s})$$

$$40 - 15 = 4V + 35$$

$$25 = 4V + 35$$

$$-10 = 4V$$

V = - 2.5m/s , so the red ball will be traveling 2.5m/s to the left after the crash.

Momentum notes

---Explosion problems----

As before you must keep track of all momentum before and after the interaction. Here there are two objects bound together somehow. They are pushed apart (or exploded apart). We start with one object (consisting of both masses connected together) then they become two. The equation would now look like this:

$$(M_1+M_2)V = M_1V_1 + M_2V_2$$

Before After

Example: A 70kg kid is standing on a 5.0kg skateboard that is not moving. She jumps forward off the skateboard with a speed of 1.5m/s. The skateboard goes flying in the opposite direction at what velocity?

$$\begin{aligned}(M_1 + M_2)V &= M_1V_1 + M_2V_2 \\ (70kg + 5kg)(0 \text{ m/s}) &= (70kg)(1.5 \text{ m/s}) + (5.0kg)(V) \\ 0 &= 105 + 5V \\ -105 &= 5V\end{aligned}$$

$V = -21 \text{ m/s}$, SO the skateboard's velocity is negative because it's the opposite of the kid's velocity. If the kids velocity was to the right then the skateboards velocity was to the left. If the kid's velocity was to the left, then the skateboard's velocity would be to the right. (In this problem we don't know specifically, because it didn't say the exact direction of the kids jump)

----Crash and stick together (perfectly inelastic collision)----

Very similar to the last example, but opposite. Here there are two objects that crash together and become one object. The equation would look like so:

$$M_1V_1 + M_2V_2 = (M_1+M_2)V$$

Before After

Example: An 800 kg car is traveling to the east at 15m/s. It crashes in to a 1500kg truck that was going west at 10 m/s. When they crash the become entangled and move as one object at what speed?

$$\begin{aligned}M_1V_1 + M_2V_2 &= (M_1 + M_2)V \\ (800kg)(15 \text{ m/s}) + (1500kg)(-10 \text{ m/s}) &= (800kg + 1500kg)V \\ 12000 - 15000 &= 2300V \\ -3000 &= 2300V\end{aligned}$$

$V = -1.3 \text{ m/s}$ So they will move off together to the west. This is because the truck had more momentum to begin with.