

# RECOIL

We've all seen those ghastly Hollywood action movies (usually featuring either Steven Segal or Chuck Norris if it's of a particularly offensive quality) in which a baddie gets himself or herself shot and subsequently ends up flying backwards due to the impact of the bullet.

To make matters worse, the goodie is likely to be shown standing there after the fact, perfectly upright, gloating and with at least one bikini-clad woman under an arm. Cue the cheesy music.

Now whilst we shooters are not really of the type to let the facts get in the way of a good story, it must be said that the physics behind this sequence of events just doesn't stack up.

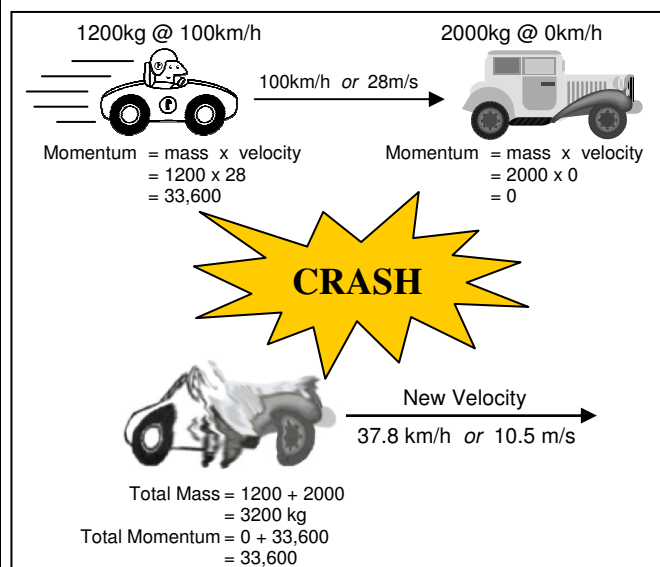
The fundamental tenet being ignored here by the director is the CONSERVATION OF MOMENTUM and, of all the scientific principles to omit, this is a biggie. But let's start at the beginning – what on earth is momentum?

**MOMENTUM = MASS (kg) x VELOCITY (m/s)**

It's a pretty simple formula to use really. Say my car moves at 28 metres per second (28m/s) and it has a mass of 1200kg. Thus, the total momentum of my car is  $28 \times 1200 = 33,600$ .

The conservation of momentum is what keeps the planets orbiting the sun, is what keeps Newton's Cradle clacking away, and is what prevented Big Kev from becoming a ballet dancer back when his heart was still happy to struggle.

Now, the *conservation of momentum* basically works like this: TOTAL MOMENTUM BEFORE must be equal to the TOTAL MOMENTUM AFTERWARDS. Here's an example:



What's happened here is that all of the momentum of the sports car is conserved (ie. both before and after have momentums of 33,600) and is subsequently transferred into the combined mass of the sports car / limo wreck.

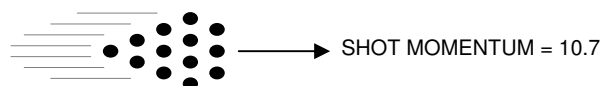
And because the wreck is heavier, but only has the same total momentum as before, the velocity (or speed) of the whole system must decrease to compensate.

Now believe it or not, EXACTLY the same thing happens when you're shooting. You fire the gun, with the explosion of the gunpowder giving the shot forwards momentum.

Typically, we shoot one ounce of lead (0.028kg) at a speed of 1250 feet per second (381m/s).

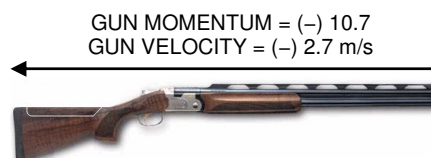


After converting these archaic units (fps) to metric (m/s), we find that the momentum of the shot after it has left the gun should be  $0.028\text{kg} \times 381\text{m/s} = 10.7 \text{ kgm/s}$

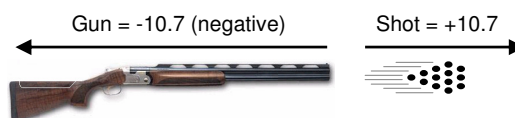


Now here's the kicker (pun intended) – because the momentum of the whole system (ie. the gun & the shot) was zero BEFORE you've pulled the trigger, it must also be zero AFTER you've pulled the trigger.

The only way this can occur is that the mass of the gun is thrown backwards by an equal amount of momentum with which the shot has moved forwards. For a 4kg gun, a momentum of 10.7 corresponds to a velocity of 2.7m/s.



What has happened is that the backwards momentum of the gun will CANCEL OUT the momentum of the shot, thus our total momentum of zero is conserved. So if we take a look at the overall system momentum:



**TOTAL MOMENTUM = 10.7 – 10.7 = ZERO !!!**

This is all a little over-simplified so don't take it as gospel. For a start, we've omitted the effect the gun powder explosion alone has on the recoil of the gun, or how quickly the gun changes its velocity (ie. speed).

Now applying what we've learned here, let's go back and see what *should* have happened to our dismal actors.

We know that the bad guy has been shot so hard that he's been thrown backwards. Because the total momentum of the system has to be conserved, the good guy should also have been thrown back by an equal amount.

All of this momentum stuff also explains why heavier guns experience significantly less recoil than lighter guns. A heavy gun (say 4kg) will kick back with only **half the speed** of a 2kg gun, given its momentum is the same.

So if you want your gun to gradually kick less and less as things progress then purchase yourself a 'budget' firearm. As it rusts, it'll gain extra weight via the accumulation of iron oxide, thus reducing the recoil...