WOULD A BUMPER MADE OF DIAMOND OR A BUMPER MADE OF PLASTIC BE SAFER IN A COLLISION, AND WHY?

MOMENTUM

WHAT IS MOMENTUM (P)?

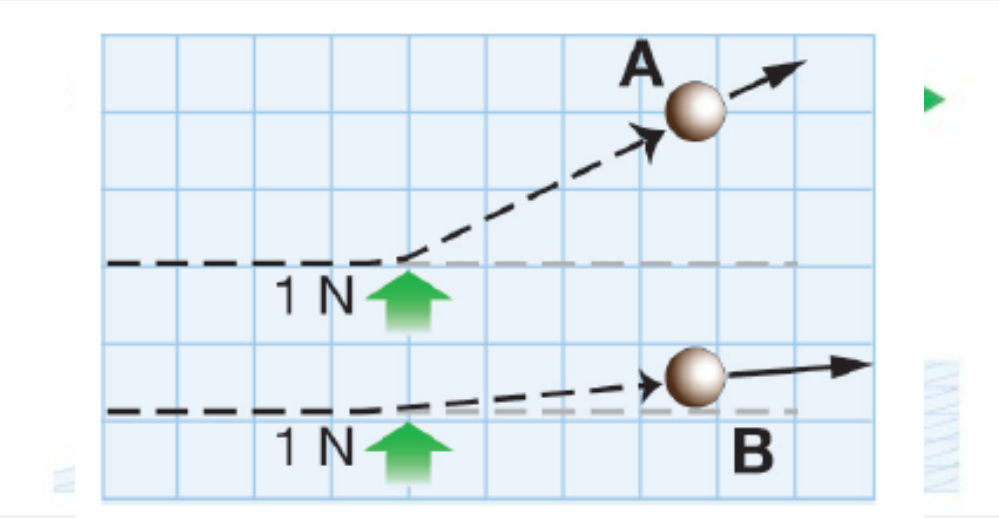
- Tendency of a mass to keep going in the same direction with the same speed
- $p = mv$
- A vector, points in the same direction as velocity
- SI Unit for momentum : kg m/s
- Momentum is conserved

THE MORE MOMENTUM AN OBJECT HAS -

- Harder it is to stop it
- Greater effect it will have if brought to rest by an impact or collision
  - Car moving at 50 mph will do more damage than same car moving at 30 mph

- Ball A is 1 kg moving 1 m/s
- Ball B is 1 kg moving 3 m/s
- If a 1 N upward force is applied to deflect each ball's motion, does the force deflect both balls equally?

- **Ball B deflects much less than ball A when the same force is applied because ball B had a greater initial momentum.**



MOMENTUM VS. INERTIA

- Inertia also describes tendency to resist changes in velocity
- Inertia depends only on mass, and is a scalar
- Momentum is a property of a *moving* mass that resists changes in velocity

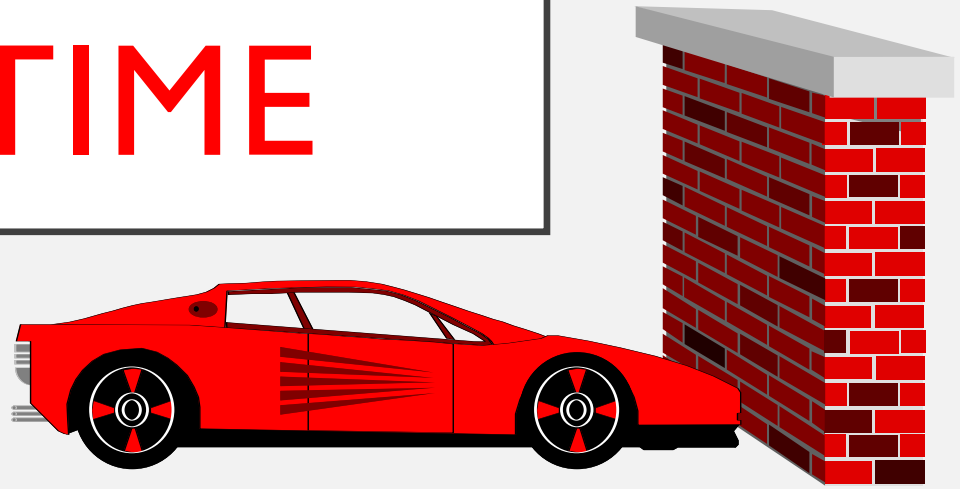
IMPULSE DERIVATION

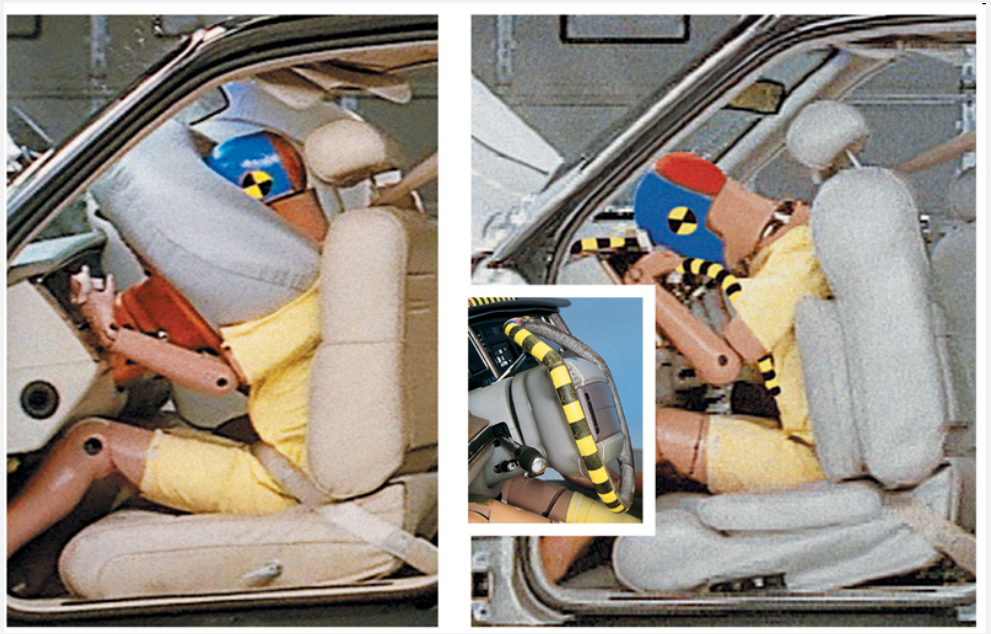
- What causes momentum to change?
- A net force F_{net} accelerates a car with mass m to speed v over the course of time t. What is its change in momentum $\Delta p = m\Delta v$?
- Newton's 2nd Law: $F_{net} = ma$

IMPULSE (J) = FORCE X TIME

- Causes change in momentum
- Force jumps to large value and back to zero in a small amount of time
- Units kg m/s
  - = Ns

STOPPING TIME





$$F_t = F t$$

IMPULSE $F_T = M\Delta V$	IMPULSE $_FT = M\Delta V$

IMPULSE

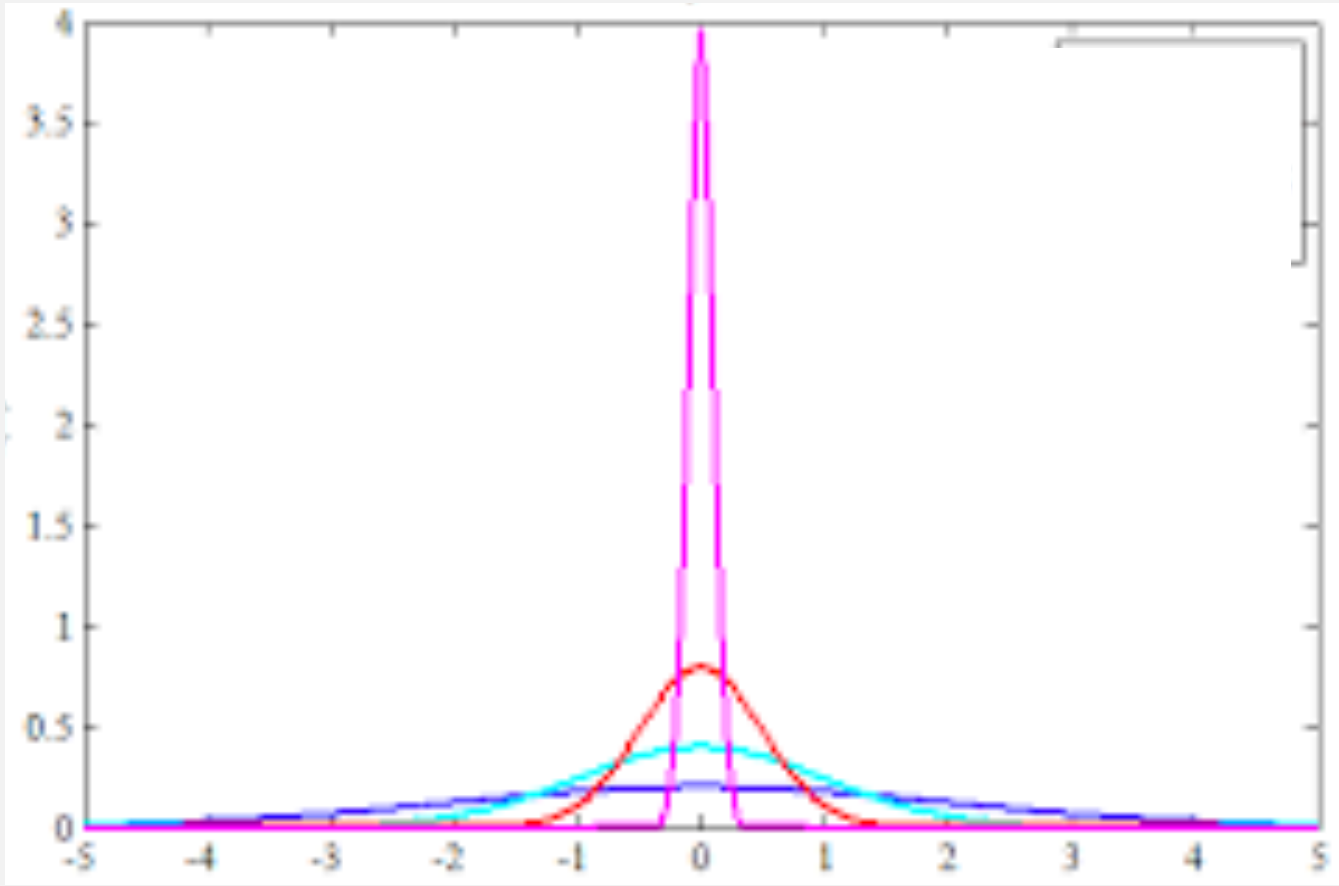
$Ft = m\Delta v$

$F\,t = m\Delta v$

Same amount of force, but **longer time** for longer barrel → velocity of bullet is greater for a gun with longer barrel
What other quantity is also greater for a gun with a longer barrel?

IMPULSE (J)

- Force vs. time graph
- Area under curve = impulse
- All 4 graphs have same impulse
  - $J = F_t = {}_F t = m\Delta v$



A 0.4 KG WATER POLO BALL TRAVELING AT 15 M/S HITS THE GOALIE OVER ABOUT 0.25 S OF CONTACT, BRINGING THE BALL TO REST. WITH WHAT FORCE DID THE BALL HIT THE GOALIE?

$$F\Delta t = m\Delta v$$

F = mv/t

F = 0.4 kg x 15 m/s / 0.25s

F = 24 N

INSTEAD OF BRINGING THE WATER POLO BALL TO REST, THE BALL RICOCHETS OFF THE GOALIE IN THE SAME AMOUNT OF TIME. WOULD THE FORCE OF THE BALL ON THE GOALIE BE GREATER, LESS OR THE SAME?

$$F\Delta t = m\Delta v$$

Greater: larger change in velocity from one direction to the other

WOULD A BUMPER MADE OF DIAMOND OR A BUMPER MADE OF PLASTIC BE SAFER IN A COLLISION, AND WHY?

Change in momentum is the same: car still needs to be brought to rest.
Softer bumper = longer time and smaller force

WHAT EXAMPLES FROM YOUR LIFE ILLUSTRATE MOMENTUM AND IMPULSE?