

Momentum and Impulse

- Momentum
- Inertia
- Impulse
- Newton's
Second Law
- Importance of
follow through
- Applications



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Momentum

- A team is said to have Momentum if they are “on a roll,” or “hard to stop”
- In physics, it’s the same



Momentum

- _____
- Any moving body has momentum



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Momentum and Inertia

- Inertia is a tendency for an object to keep doing what it's doing
- The “momentum” of an object is the quantification of its Inertia or _____



Linear Momentum

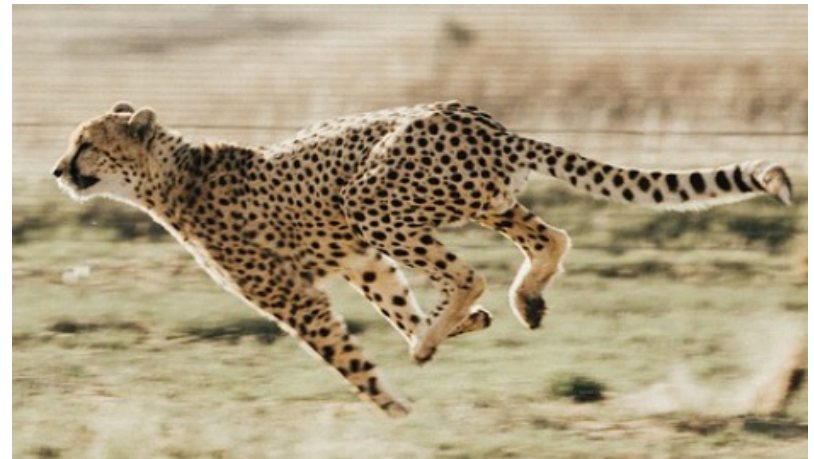
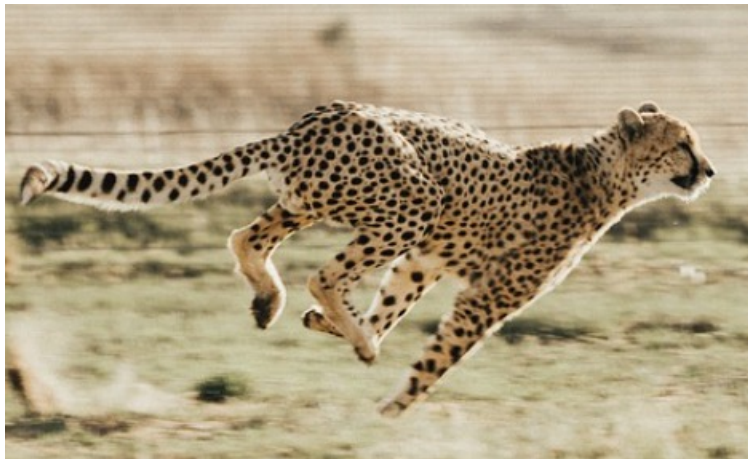
- The linear momentum of any object can be calculated by:

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

- Where m is the mass in kg
- v is the velocity in m/s
- *What are the units of momentum?*

Momentum

Momentum is a vector quantity – so direction **IS** important!



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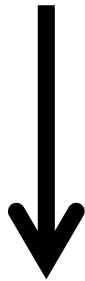
Check Your Understanding

A car possesses momentum. How would the momentum change if ...

- a) its velocity was doubled. $\vec{p} = m\vec{v}$
- b) its mass was doubled.
- c) its velocity was tripled and its mass was cut in half.

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Will it break?



From Newton's Second Law

$$\sum \vec{F} = m\vec{a}$$

$$\vec{F}_{net} = m \left(\frac{\vec{v}_f - \vec{v}_i}{\Delta t} \right)$$

$$\vec{F}_{net} \Delta t = m(\vec{v}_f - \vec{v}_i)$$

$$\vec{F}_{net} \Delta t = m\vec{v}_f - m\vec{v}_i$$

$$\vec{F}_{net} \Delta t = \vec{p}_f - \vec{p}_i$$

$$\vec{F}_{net} \Delta t = \Delta \vec{p}$$

Impulse

- _____

$$\text{Impulse} = F_{\text{net}}\Delta t = \Delta p$$

- Its direction is the same as the change in momentum



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Impulse

$$F_{net}\Delta t = \Delta p$$

If you are trying to catch a ball and you move your hands back with the ball as it approaches, you will increase the time needed to stop the ball and thus, decrease the F required $\rightarrow$ hurts less!



Check Your Understanding

You're driving a car which has a mass of 1.0×10^3 kg and is traveling at 30.0 km/h. You lose control and it smashes into a concrete wall, stopping the momentum of your car in 0.10 s.

- a) What is the momentum of your car at impact?
- b) What Force is required to stop the car?
- c) If you hit a padded wall instead which brings the car to a stop in 0.50 s, what Force will be required?
- d) What is the purpose of airbags with respect to momentum and impulse?

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Following Through

- Following through means that you continue your motion after you've made contact
- If you stop your motion at impact, you will reduce the impact time
- _____

$$F_{net}\Delta t = \Delta p$$



What is Their Function?



Check Your Understanding

A baseball of mass 0.152 kg , travelling horizontally at 37.5 m/s [fwd], collides with a baseball bat. The collision lasts for 1.15 ms . Immediately after the collision, the baseball travels horizontally at 49.5 m/s [backwards].

- a) Determine the momentum of the baseball just prior to being hit.
- b) What is the average force applied by the bat to the baseball?

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