Newton's 3rd Law

For every action.....

(The "Action Reaction Law")

Newton’s Third Law

Action and Reaction

- Newton’s third law describes something else that happens when one object exerts a **force** on another object.

- According to **Newton’s third law of motion**, forces always act in ***equal*** but opposite pairs.

Newton's Third Law

Action and Reaction

- Another way of saying this

For every action, there is an equal but <u>opposite</u> reaction!

Action and Reaction Forces Don’t Cancel

- The forces exerted by two objects on each other are often called and **action-reaction** force pair.

- Action and reaction force pairs don’t **cancel** because they act on different objects.

Newton's Third Law

3

- You constantly use action-reaction force pairs as you move about.
- When you jump, you **push** down on the ground.
- The ground then pushes up on you. It is this **upward** force that pushes you into the air.

Newton's Third Law

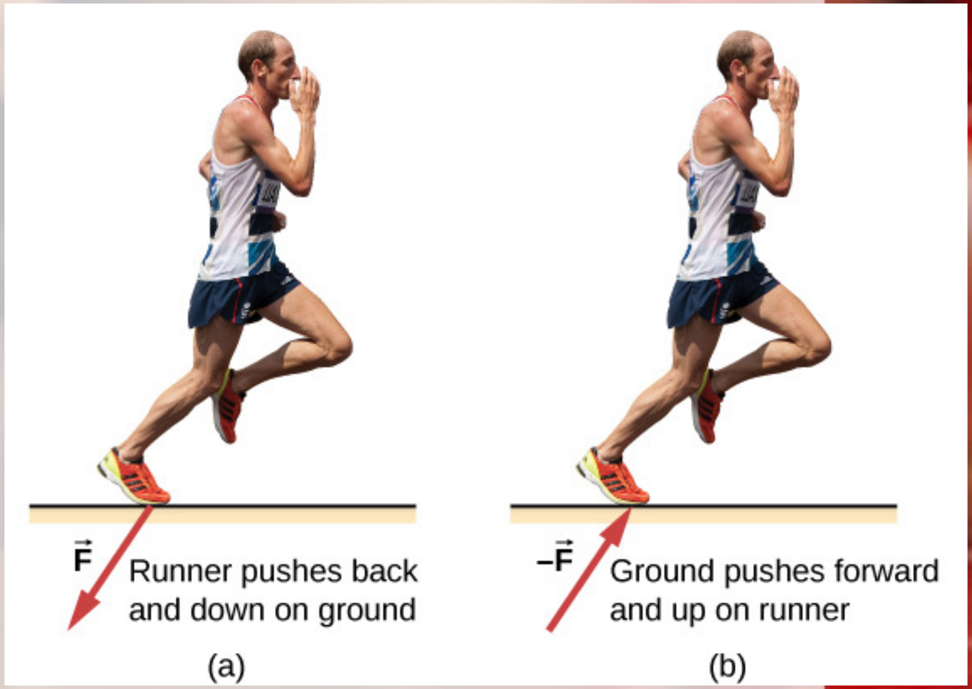
3

- When a bird flies, its wings push air in a **<u>downward</u>** and a backward direction.
- By Newton's third law, the air resistance pushes back on the bird in the opposite
- . directions—**<u>upward</u>** and forward.
- This force keeps a bird in the air and propels it forward – an **OPPOSITE BUT *<u>EQUAL</u>* FORCE! Action Reaction!!!**

3

Large and Small Objects

- When you run forward, you **push** backward on the ground.
- Your shoe pushes Earth backward, and Earth pushes your shoe **forward.**

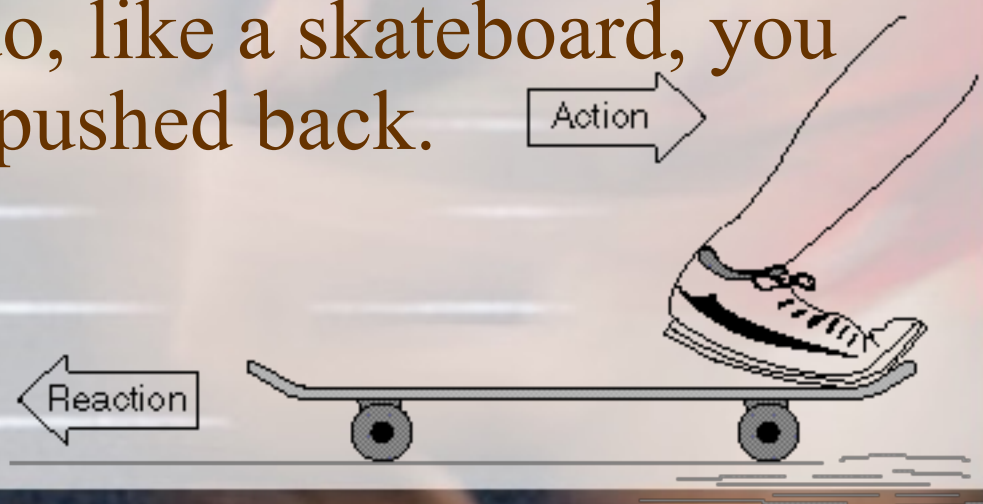


3

Large and Small Objects…why don't I always feel this "push" back?!?

Earth has sooo much mass compared to you, that it does not move **noticeably** when you push it.

- If you step on something that has **less mass** than you do, like a skateboard, you can see it being pushed back.



3

A Rocket Launch

- When the rocket fuel is ignited, a hot gas is produced.
- As the gas molecules collide with the inside engine walls, the walls exert a force that pushes them out of the bottom of the engine.

A Rocket Launch

- This downward push is the action force.
- The reaction force is the upward push on the rocket engine by the gas molecules.
- This is the thrust that propels the rocket upward.

3

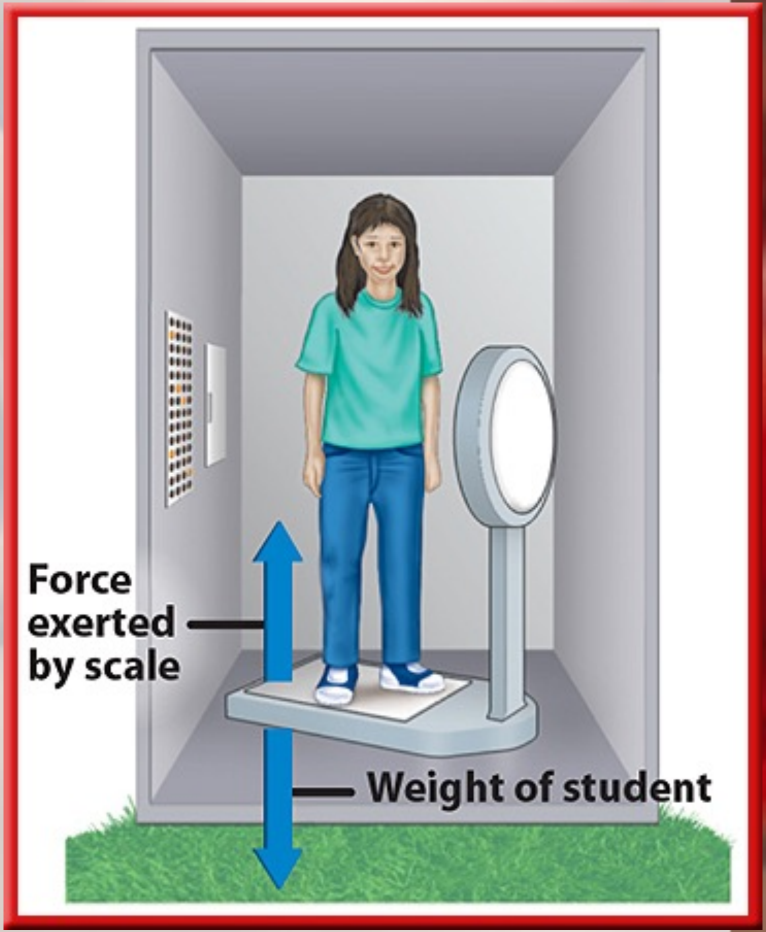
Weightlessness

- You might have seen pictures of astronauts floating inside a space shuttle as it orbits Earth.
- The astronauts are said to be weightless, but do the laws of Forces still apply?

https://www.youtube.com/watch?v=dCF--YOjiOw

Measuring Weight

- When you stand on a scale, your weight pushes down on the scale.
- This causes the scale pointer to point to your weight.

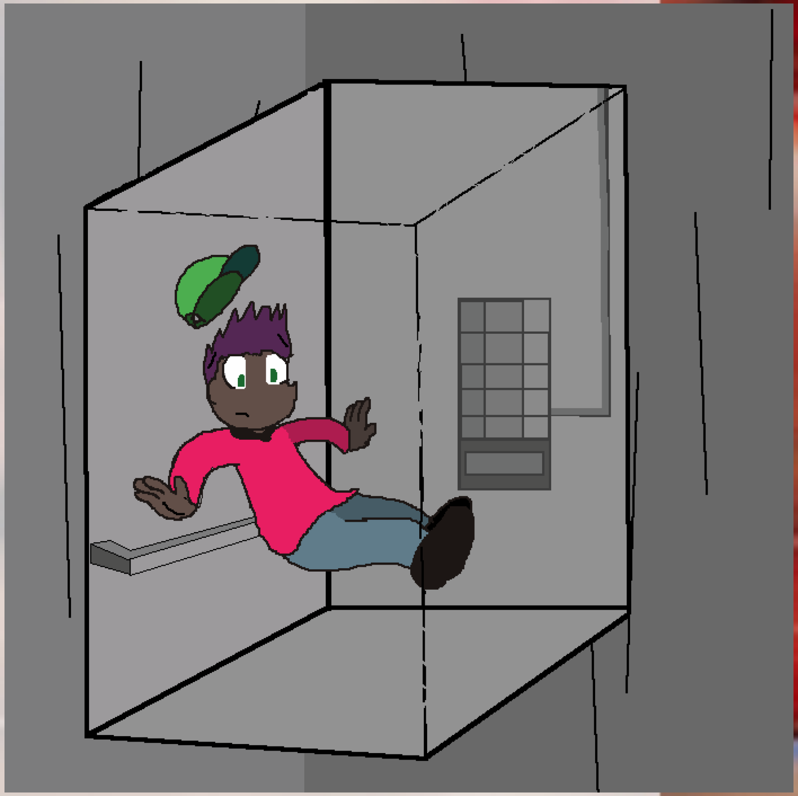


Measuring Weight

- At the same time, by Newton's third law the scale pushes up on you with a force equal to your weight.
- This force balances the downward pull of gravity on you.

Free Fall and Weightlessness

Now suppose you were standing on a scale in a elevator that is falling.

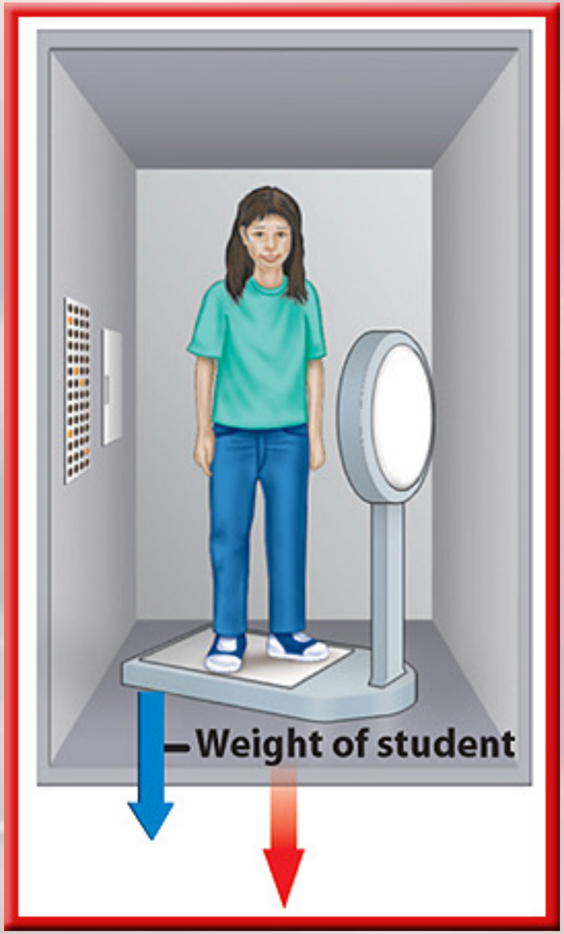


- A falling object is in free fall when the only force acting on the force is gravity.
- You and the scale are both in free fall.

Free Fall and Weightlessness

- Because the only force acting on you is gravity, the scale no longer is pushing up on you.

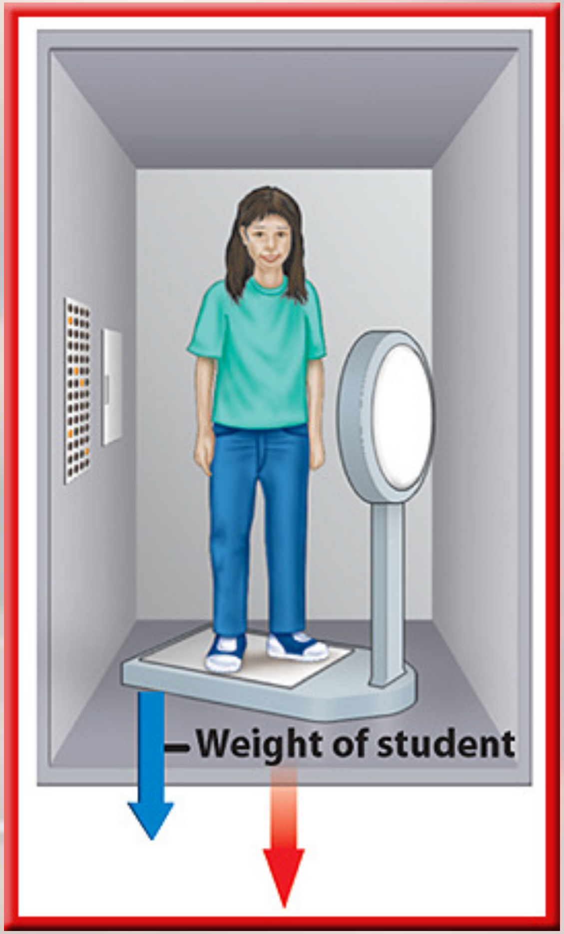
- According to Newton's third law, you no longer push down on the scale.

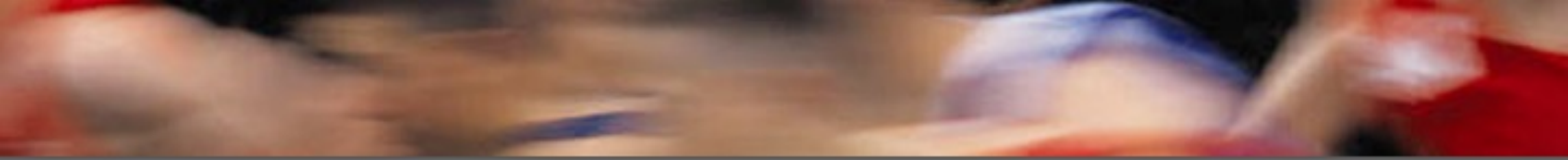


3

Free Fall and Weightlessness

- So the scale pointer stays at zero and you seem to be weightless.
- Weightlessness is the condition that occurs in free fall when the weight of an object seems to be zero.





This is known as the "Action-Reaction" Law

So far Newton has explained…

- Speed…
- Velocity…
- Acceleration…
- Force…
- Newton also went on to explain the ***"quantity of motion"*** called **MOMENTUM!**

Momentum = Mass x Velocity

- Objects with a lot of **momentum,** have a lot of motion.
- They have a high amount of a *push* or *pull* **(force)** going on.
- An objects momentum is dependent upon its mass and its velocity (speed).
- **Momentum = mass x velocity**(units in kg x m/s)

- Objects with a ***greater mass*** have greater momentum. Objects with a **greater velocity** have greater momentum. And vise-versa for both concepts.
- If you know the mass and velocity of two different objects, you can determine their ***momentum*** by using:

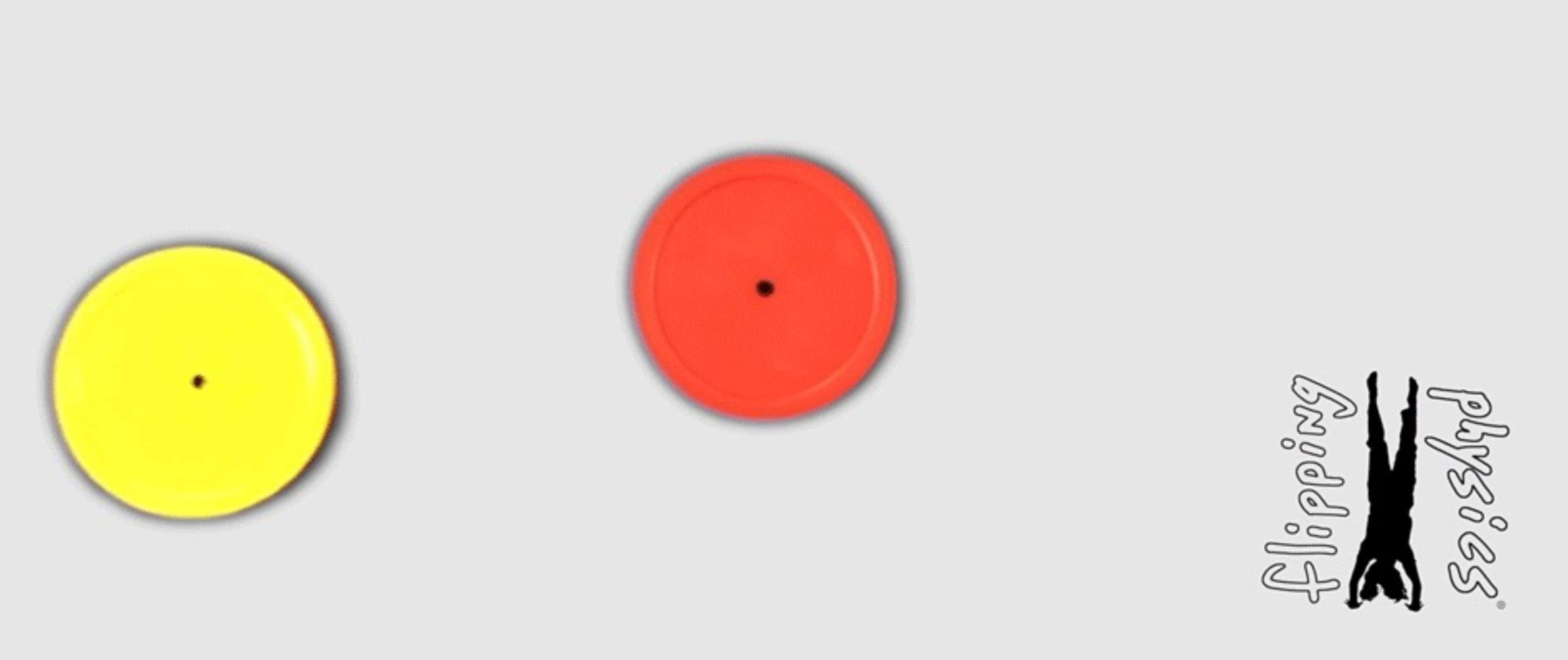
  Momentum = mass x velocity

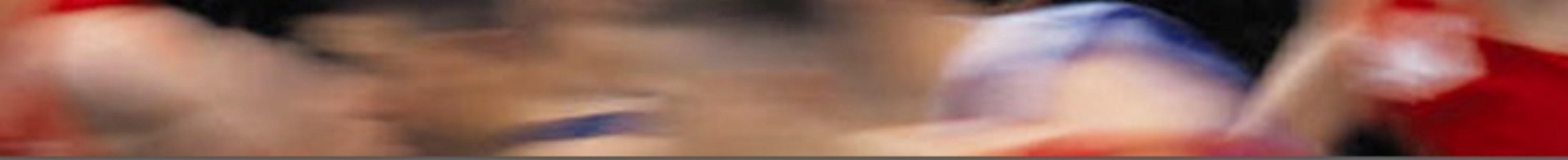
Conservation of Momentum:

- If someone bumps in to you from behind, you gain momentum & move forward.
- When two objects collide, in the absence of friction, momentum is not lost.

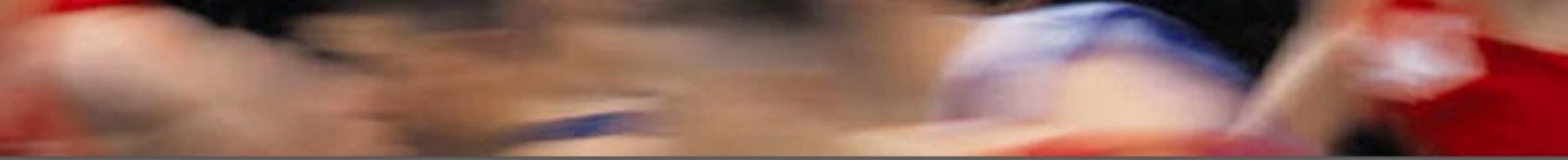
The **Law of Conservation of Momentum** says that momentum does not change when objects interact, it remains the same before and after the interaction.

Law of Conservation of Momentum



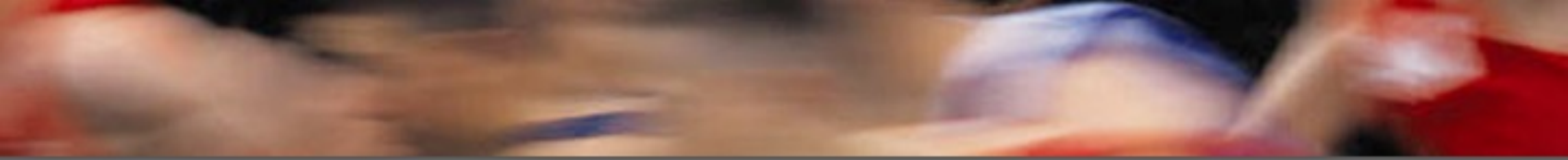


- ***<u>The Law of Conservation of Momentum</u>*** states that the total momentum of any group of objects remains the same unless an outside force acts on the objects!



Guided PrAcTiCe!

- Which has more momentum, a 3 kg sledgehammer (a) swung at 1.5 m/s, or a 4 kg sledgehammer (b) swung at 0.9 m/s?
- (a) 3 kg x 1.5 m/s =   kg x m/s
- (b) 4kg x 0.9 m/s =   kg x m/s
- A has more momentum than the heavier one, because it is swung with a greater velocity – almost twice as fast!



Independent PrAcTiCe!

- 1. A golf ball travels at 16 m/s, while a baseball moves at 7 m/s. The mass of the golf ball is 0.045 kg and the mass of the baseball is 0.14 kg. Which had greater momentum?
- Golf ball = = kg x m/s
- Baseball = = kg x m/s
- 2. What is the momentum of a bird with a mass of 0.018 kg flying at 15 m/s?
- =