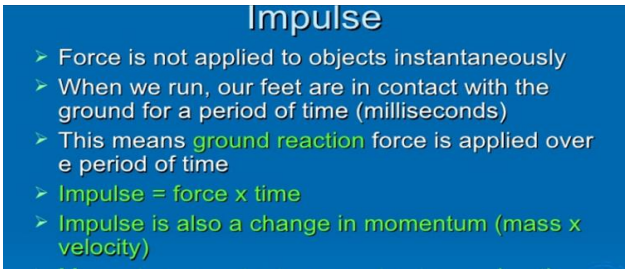
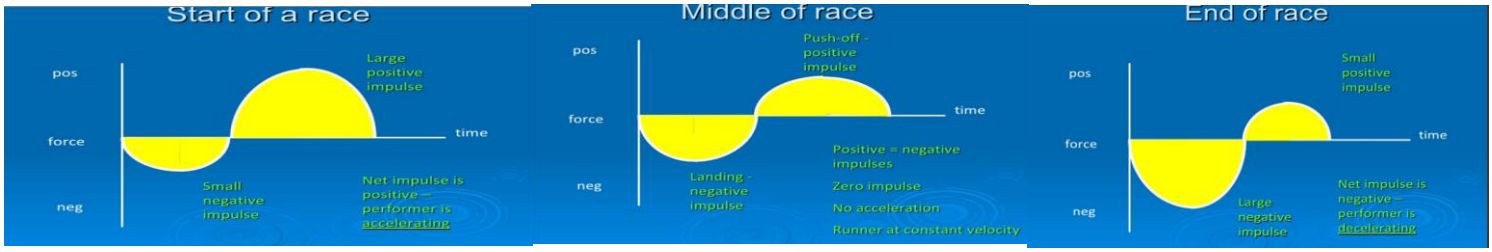
What is biomechanics?

Biomechanics is the sport science field that applies the laws of mechanics and physics to human performance, (in order to gain a greater understanding of performance in athletic events).

Impulse = force (N) x time (seconds)



- The impulse is optimized for any movement in sport.
- Impulse over time will be large but time is relevant.
    - Baseball hitting baseball pat = large impulse / short time
    - Running a marathon = small impulse per step but large impulse over duration of race
- Think of impulse as change in momentum over time and think of force and energy usage.



Combinations of Force and Time Required to Produce 100 units of Impulse

Force	Time	Impulse
100	1	100
50	2	100
25	4	100
10	10	100
4	25	100
2	50	100
1	100	100
0.1	1000	100

Jennifer, who has a mass of 50.0 kg, is riding at 35.0 m/s in her red sports car when she must suddenly slam on the brakes to avoid hitting a deer crossing the road. She strikes the air bag, that brings her body to a stop in 0.500 s. What average force does the seat belt exert on her?

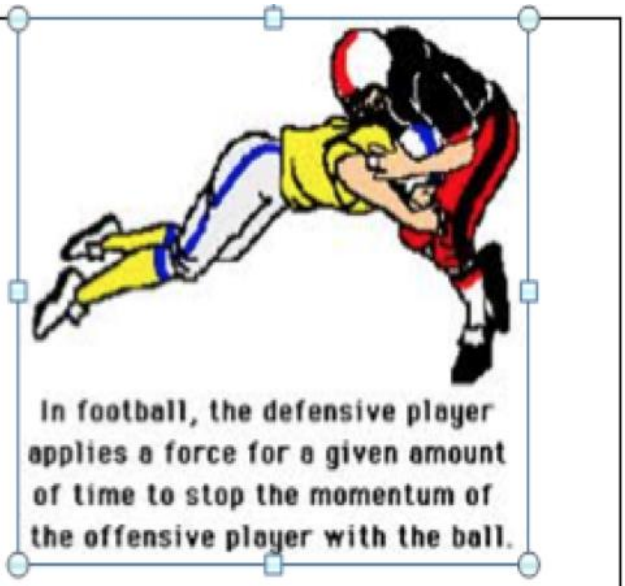
If Jennifer had not been wearing her seat belt and not had an air bag, then the windshield would have stopped her head in 0.002 s. What average force would the windshield have exerted on her?

Bags and padding reduce the force of impact by increasing the time.

Can you think of examples in sport where this is done?

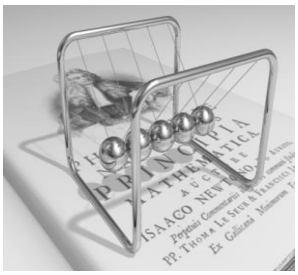
What is the impulse momentum relationship?

The impulse-momentum theorem is logically equivalent to Newton's second law of motion (the force law).



The law of momentum conservation can be stated as follows:

- For a collision occurring between object 1 and object 2 in an isolated system, the total momentum of the two objects before the collision is equal to the total momentum of the two objects after the collision.
- That is, the momentum lost by object 1 is equal to the momentum gained by object 2.



Center of Mass (COM)

1. The mathematical point around which the mass of a body or object is evenly distributed (depends on body density or distribution of body tissues, changes due to age, genders, etc)
2. Point at which the mass and weight of an object are balanced in all directions.
3. It is the axis for all free airbourne rotations

Center of Gravity (COG)

1. The mathematical point of the body or object at which the force of gravity can be considered to be acting.
    - COM & COG are often interchangeable for bodies or objects where the force of gravity does not vary.
    - The two centers are in the same place in bodies of the sporting elements.

REASONS FOR KNOWING THE POSITION OF COM

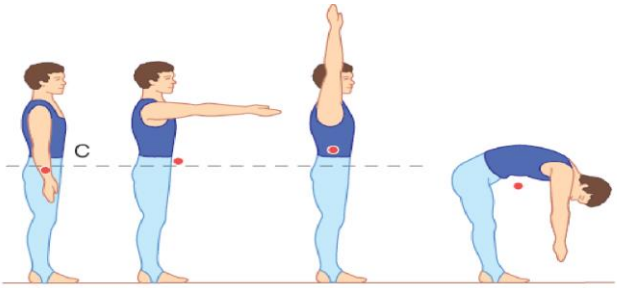
REASON	EXPLANATION	EXAMPLE
It determines the stability of static positions	If the vertical projection of a line downwards from the COM lies within the base of support The position of the body or object is stable and if disturbed by an external force, will return to its original position	• Between the feet when standing • This is the principle behind many balance activities
It is the axis for all free airborne rotations of the body or object		Somersaulting in diving
The COM acts as the reference point when considering whole body or object translation		• Long jump in athletics ○ The trajectory of the COM during ▪ Take off ▪ Flight Landing

MEASURING COM

- Calculations from segmental positions and masses
- Reaction board
- Suspension of an object or model

Fosbury Flop:

1. The athlete bends their body like a banana around the bar and their centre of mass is below and outside the body/may be below the bar
2. The jumper using the Fosbury technique will therefore not have to raise their centre of mass as high as an athlete performing the scissors when clearing the same height.
3. Using the Fosbury technique the jumper will be able to clear a higher bar compared to using the scissors



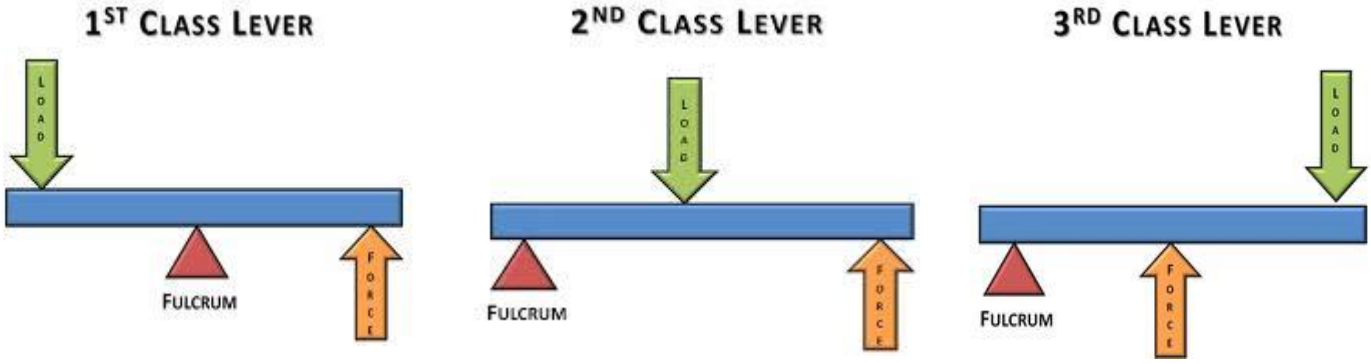
scissors:

1. The upper body is upright and the legs are horizontal to the body – this puts the centre of mass above the legs/hips/bar
2. The distance between the centre of mass of the athlete and the greatest height cleared is generally 25–30cm

Now think of a examples in sport where the center of mass:

- Changes and benefits your performance _____
- You change in order to benefit your performance _____
- Changes and negatively impacts your performance _____
- Can potentially be outside of your body _____

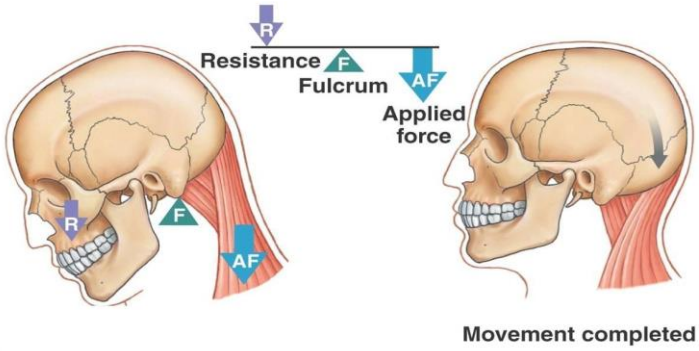
<u>Levers</u>: rigid structures hinged at one point (fulcrum) to which forces are applied to two other points (effort and load)



1. <u>First Class Lever</u>:

The fulcrum lies between the effort and load.

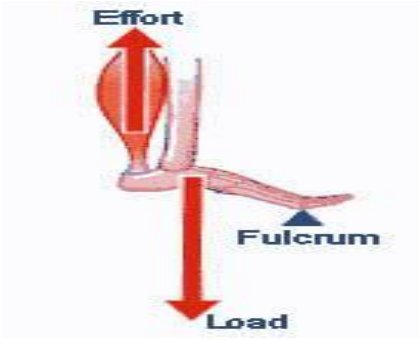
Ex. Neck providing effort force to overcome the resistance force caused by the weight of the head.

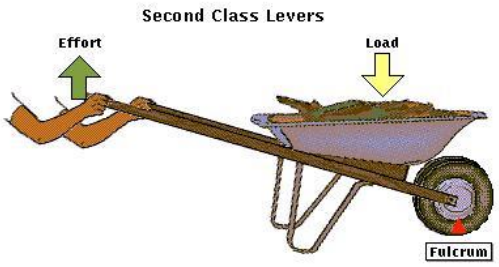


2. <u>Second Class Lever</u>:

The fulcrum lies at one end with the effort at the other and the load in the middle.

Ex. Standing heel raise





3. <u>Third Class Levers</u>:

The effort lies between the load and the fulcrum.

Ex. Biceps curl swinging a bat.