**Angular Motion**

Angular motion occurs whenever a force acts outside the centre of mass of a body or object. The off-centre force is called an **eccentric force**- this is needed for rotation to occur.

**Sporting Example**: Gymnast performing a backflip will lean backwards before take off so that the internal force generated by her leg muscles passes outside the centre of mass and initiates rotation.

**Quantities of Angular Motion**

* Angular distance
* Angular displacement
* Angular speed
* Angular velocity
* Angular acceleration

**Axis-**

* Longitudinal axis; top to bottom of body- spinning ice skater
* Transverse axis- side to side- somersaulting high diver
* Fontal axis- front to back- cartwheel

**Torques- movements of force**

These are rotational consequences of a force. The size of the torque depends on the size of the force and the distance that force acts from the axis of rotation.

The bigger the force and further away from the axis of rotation the bigger the torque- think of an ice skater winding up for a big turn- they will turn one leg behind them and arms out to side and apply a big internal force though their leg muscles.

***Torque= size of force x movement arm.***

**Newton’s Laws and Angular Motion!**

**1st Law**

A rotating body will continue to turn about its axis of rotation with constant ***angular momentum*** (a quantity of angular motion or rotation) unless an external force is exerted upon it.

**2nd Law**

Rate of change of angular momentum is proportional to the torque (force) causing it. The change takes place in the direction in which the torque acts.

**3rd Law**

Every torque that is exerted on one body there is an equal and opposite torque exerted by the second body on the first.

**Moment of Inertia**

***Measure of resistance of a body or object to rotate and the desire of the body to continue rotating once it has been set in motion.***

Dependent on….

1. ***Mass of the object***: greater the mass of the object the greater its moment of inertia. Ten pin bowling ball Vs volleyball.
2. ***Distribution of the mass for the axis of rotation***: the further the mass is distributed from the axis of rotation the greater the moment of inertia.

**Trampolinist**

Tucked quicker than a straight somersault. When in a straight position the mass is further away from the axis of rotation. This increases moment of inertia and decreases angular velocity.

Tucked- faster, closer to axis of rotation, increase in angular velocity and decrease in moment of inertia.

***Which axis are they turning about????***

***Relationship between angular velocity and moment of inertia is inversely proportional- one goes up the other goes down.***

Angular momentum must remain constant when a body or object is in flight and can not be changed unless an external force is applied.

***Law of conservation of angular momentum- 1st Law.***

* We know that angular momentum cannot be changed during flight- for example we must ensure that we can get maximum angular momentum when attempting to spin in ice skating.
* Skater will ensure at take off, their arms are out and a leg extended behind them. This generates as bigger torque as possible. The larger the force or further away for the axis of rotation the bigger the torque
* Bigger the torque the bigger the angular momentum.
* Once in flight they pull their arms and legs in as close as possible – this decrease moment of inertia and increases angular velocity speeding up the rotation.
* On landing they spread arms out and increase moment of inertia and decrease angular velocity.

