

Diet and Nutrition and Their Effect on Physical Activity and Performance

3.1.4.1

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Vitamins

Vitamins are also micronutrients that are required in small amounts. There are four main vitamins that have exercise-related functions:

Vitamin C

- Improves immune function which allows athletes to avoid infections and illnesses and maintains and repairs the health of bones and connective tissues
- Found in green vegetables and citrus fruits

Vitamin D

- Improves bone health by assisting the absorption of calcium which is required for bone remodelling
- Supports protein synthesis and increases ATP stores – providing more energy
- Found in fatty fish and dairy products such as milk and cheese

Vitamin B-12

- Aids the production of red blood cells which improves oxygen transport
- Can increase metabolism and, therefore, maintain lean body mass
- Increases energy production
- Found in fish, meat and eggs



Vitamin B-complex

- Used in the production of energy by assisting the breakdown of food
- Found in multivitamin tablets, fortified breads, tuna, berries and vegetables

Proteins

- Minor source of energy
- Role in tissue repair, muscle protein synthesis and recovery
- Allow muscle to repair and adapt to training loads
- Should be consumed immediately after a training session in order to aid recovery of muscle cells
- Sources:** meat, eggs, milk



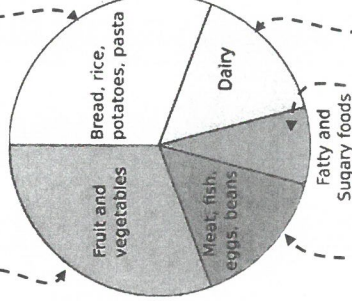
Water

- Hydrates the athlete, preventing dehydration, and replaces fluids lost by sweating
- Required in order to avoid dizziness, increased body temperature, increased heart rate and headaches
- Therefore, water should be consumed as we exercise to maintain hydration:
 - Pre-exercise:** 0.5L 3 hours before exercise and 0.25L 30 mins before exercise
 - During exercise:** water should be consumed during breaks in play
 - Post-exercise:** 0.5L gradually over 30 mins
- Water can be obtained from all sources of fluid, including tap water, bottled water and sports drinks. Drinks such as tea and coffee are diuretics so don't have as strong a hydrating effect, as they cause the need to urinate. Additionally, sugary fizzy drinks also have their negative health effects.



Diet and nutrition

A healthy balanced diet consists of seven components, which when eaten in an optimal proportion can help improve sporting performance.



Minerals

Minerals are micronutrients, required in small amounts. There are three main minerals that have an exercise-related function:

- Calcium:** required for bone regeneration and for muscular contractions and can be found in dairy products such as yoghurt and milk
- Iron:** required for effective transportation of oxygen through the production of haemoglobin and found in red meat, brown rice and fish
- Sodium:** required for maintaining electrolyte balance and found in olives, eggs, table salt, and sports drinks

Carbohydrates

- Main energy source
- Broken down into glucose and absorbed into the blood stream
- Stored as glycogen in the body which can be released into the blood stream when required
- Fuels aerobic exercise such as long-distance running and anaerobic exercise such as sprinting
- There are simple and complex carbohydrates
- Simple carbohydrates release energy quickly but cannot sustain exercise for long periods – they are found in processed sugary foods such as chocolate bars as well as fruit
- Complex carbohydrates release energy slowly and, therefore, sustain endurance-type activities – they are found in foods such as bread, pasta and rice



Fats

- Main source of energy during low-intensity exercise
- Stored in adipose tissue within the body
- There are two main types of fats:
 - Saturated fats** which provide the body with cholesterol and are associated with increase in weight and cardiovascular disease
 - Trans-fats** are natural or man-made saturated fats which are combined with food products to increase their life span. They provide energy but can increase levels of low-density lipoproteins.



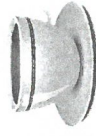
- Saturated sources:** butter, cream, pork / trans-fats, margarine, ice cream, crisps
- Unsaturated fats** contain less cholesterol and are, therefore, considered better for cardiovascular health
- Unsaturated sources:** olive oil, salmon, avocados

There are two types of cholesterol.

- Low-density lipoproteins** transfer cholesterol to the tissues of the body but some can build up on the walls of the arteries and increase the risk of cardiovascular disease
- High-density lipoproteins** transfer cholesterol in the blood to the liver to be broken down and removed from the body. They reduce the risk of cardiovascular disease

Caffeine

Reduces perceived effort, encourages glycogen sparing, improves muscular contraction and increases awareness and alertness. It is useful for endurance athletes who benefit from the increased fat metabolism during exercise that occurs after consuming caffeine.



Risks: Irritability, irregular heart rate

Bicarbonate

Helps to buffer lactic acid in the blood and, therefore, reduces the fatiguing effect of lactic acid during anaerobic exercise.

Risks: Nausea, unsettled stomach

Nutritional aids

Glycogen loading
Athletes can deplete their glycogen stores by consuming a diet high in protein and performing high levels of exercise a week before a competition. They can then consume a diet high in carbohydrates for three days as this leads to super-compensation of glycogen and increases the glycogen stores available during an endurance event.

Risks: Feeling bloated, nausea, issues with digestion

Creatine

Increases power and strength by providing creatine to fuel the ATP-PC system which allows athletes to exercise anaerobically for longer using this system. It also aids recovery by restoring the creatine stores of the body.

Risks: Kidney damage, excess water retention

Preparation and Training Methods in Relation to Improving and Maintaining Physical Activity and Performance

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Data terms

There are four types of data that can be collected from fitness testing. These are qualitative, quantitative, objective and subjective and they are explained below:

Qualitative data is a measurement based on observational data.

Quantitative data is a measurement that involves numerical data.

Subjective data is any data which is taken from observations and involves some form of personal opinion.

Objective data is any data which can be measured directly without personal opinion.

Data integrity can be maintained by ensuring the following are met and also by calibrating equipment regularly:

Validity – the degree to which a test measures what it is intended to



Reliability – the degree to which the results of a test can be repeated



Warming up and cooling down!

Prior to any level of sporting participation it is very important to complete an effective warm-up as this will:

- increase the temperature of the muscles and tendons, which increases flexibility
- increase the speed and strength of muscular contractions
- raise the heart rate, which helps to increase the speed of blood flow to the exercising muscles
- raise the breathing rate which helps to increase the transport of oxygen to the exercising muscles

After physical activity it is important to complete an effective cool-down as this can result in the following physiological benefits:

- improves the removal of lactic acid and other waste products of exercise
- helps to reduce the likelihood of the delayed onset of muscle soreness (DOMS)
- aids the prevention of blood pooling
- enables the gentle lowering of heart rate and breathing rate to pre-exercise levels

There are three types of stretching which can be performed during warm-ups and cool-downs:

1. **Ballistic stretching** which involves sudden bouncing movements to stretch a muscle, and is not recommended due to this type of stretching putting the performer at risk of injury.
2. **Dynamic stretching** which involves stretches being performed when moving which is important for sports such as rugby where athletes must stretch when moving, e.g. during a scrum.
3. **Static stretching** which involves a stretch being held in a stationary position which is important for sports such as gymnastics.

Dynamic stretching



Static stretching



Principles of training

Coaches and athletes should use the following principles of training to guide their training plans. These principles will ensure that training is effective and adequate changes can be made when required.

S	Specificity – training should be relevant to the athlete, e.g. a runner's training should mostly involve running	F	Frequency – the number of times you train each week
P	Progressive overload – as an athlete adapts to their training load, the load should be increased in order to stress the body	I	Intensity – the amount of work that is performed in each training session
R	Reversibility – if an athlete has a period without training, they will begin to lose their adaptations to training	T	Time – the amount of time spent training in each session
R	Recovery – it is important to rest and recover in order for adaptations to occur	T	Type – the form of exercise that is performed in each session

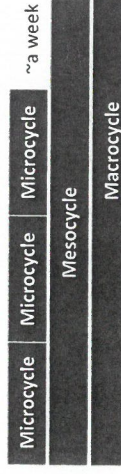
Periodisation of training

Periodisation cycles:

Specific training areas

Consists of a number of microcycles

The training year/goal



Phases of training:

1. **Preparatory phase:** prior to competition, includes fitness training and being ready for competition
2. **Competitive phase:** maintaining physiological and psychological readiness to compete
3. **Transition phase:** in-between the end of the competition and preparatory phase, allowing the athlete to recover

Factors to consider when planning a personal health and fitness programme:

- the client's characteristics
- the client's goals
- the fitness components to target
- FITT
- how to monitor progress
- when to taper
- phases of training

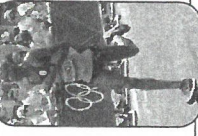
Tapering

Tapering involves reducing the amount of training (but maintaining intensity) 1–3 weeks prior to the competition.

Benefits:

- increases muscle glycogen concentration
- increases muscular endurance and power
- increases VO₂ max

Peaking

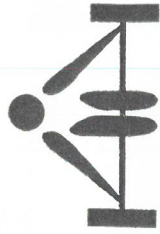


When the adaptations from tapering enable the optimal level of performance. The performer normally aims to peak during the most important competition period of their season.

Training Methods to Improve Physical Activity and Performance

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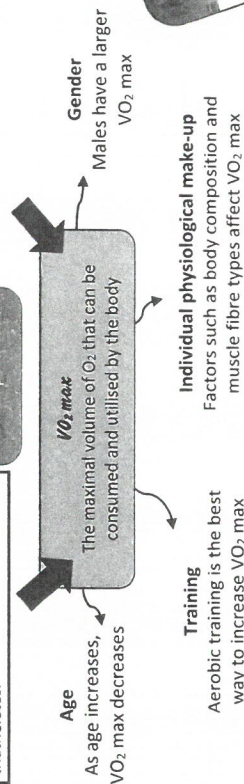
Interval Training	
Anaerobic Power	
What?	- High-intensity work performed - Short duration - Many rest periods
Advantages	- Can be performed with very little equipment - Little time requirements
Disadvantages	- Not an appropriate method for all individuals - Requires high levels of motivation - Can be physically demanding
Useful for	Appropriate for those who are required to perform periods of high-intensity anaerobic work with limited rest or recovery in between, e.g. games players such as rugby and football players.

Proprioceptive Neuromuscular Facilitation	
Flexibility	
What?	The muscle is passively stretched, before isometrically contracted. This then stimulates the Golgi tendon organ to inhibit the stretch reflex, allowing for a greater range of motion for the passive stretch that follows.
Advantages	- Reduces the risk of injury - Increases range of motion
Disadvantages	- Can require an assistant to perform it - Can lead to injury if performed incorrectly - Can be painful
Useful for	Appropriate for any athlete who is required to move their limbs to the full range of motion, e.g. Gymnasts and divers.

Training methods

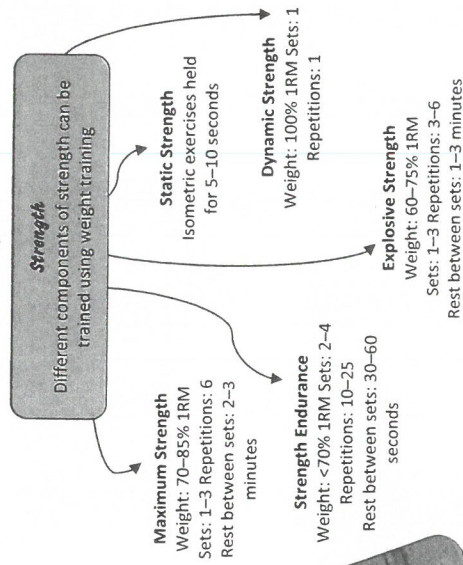
Continuous Training	
Aerobic Endurance	
What?	- Low intensity - Long duration - No rest periods
Advantages	- Requires little equipment - Easy to perform - Requires little assistance
Disadvantages	- Can become boring - Takes up a lot of time - Doesn't improve anaerobic performance
Useful for	Appropriate for those who perform prolonged exercise and require cardiovascular endurance, e.g. triathletes.

Fartlek Training	
Aerobic Endurance	
What?	- Continuous exercise - Performed over different terrains
Advantages	- Can be made appropriate for different sports - Can prevent boredom due to changing terrain - Requires little assistance
Disadvantages	- Can become boring - Hard to track progress - Easy to not put effort in
Useful for	Appropriate for those who perform prolonged exercise and require cardiovascular endurance, e.g. triathletes



Circuit Training	
Muscular Endurance	
What?	- A series of exercises are performed at different stations - Little or no rest between each station - Usually performed with a load of 50% of 1 rep max and 3 sets with a high number of repetitions
Advantages	- It can be made appropriate for all sports by adjusting the exercises performed at each station - The rest-work ratio can easily be adjusted - It is easy to monitor progress - It can incorporate fun exercise which keep the exercisers interested and motivated
Disadvantages	- Time consuming to set up - Requires adequate space, e.g. a sports hall - Requires a lot of equipment
Useful for	Appropriate for those who are required to repeatedly contract their muscles for a prolonged period of time without experiencing reduction in motor control, e.g. boxers and rowers.

Weight Training	
Strength	
What?	- Loads are repeatedly lifted - Can be performed using free weights, resistance machines and body weight - The number of sets and repetitions determines the type of strength being trained - Usually performed with a load of 80-100% of 1 rep max and around 4 sets with a low number of repetitions
Advantages	- Requires little assistance - Can be performed using free weights, resistance machines and body weight - Can be altered to train different muscles - Can be altered to train different components of strength (dynamic, static, explosive, etc.)
Disadvantages	- Correct technique is very important to avoid injury - There are a lot of different techniques to learn - Requires specialist equipment - Usually requires access to a gym
Useful for	Appropriate for any athletes who are required to move loads or exert large forces onto another object, e.g. weight lifters and boxers.



Screening

This involves performing a range of tests on an athlete prior to them taking part in physical activity to determine whether they are at risk of being injured.

Screening can be used to tailor training sessions to avoid certain movements and also to strengthen certain areas of the body.

Acute and Chronic Injuries

- **Acute injury:** A result of a sudden stress to the body
 - **Hard tissue injuries:** injuries to a bone, e.g. fracture of the radius during a rugby tackle or dislocation when the humerus is moved from the shoulder joint
 - **Soft tissue injuries:** injuries to muscles, cartilage, ligaments or tendons, e.g. a strained neck muscle
- **Chronic injury:** A result of continuous stress to the body
 - **Hard tissue:** Injuries to a bone, e.g. a stress fracture of the shin bone
 - **Soft tissue:** A result of 'wear and tear' of soft tissue, e.g. Achilles tendonitis or tennis elbow

Recovery from Exercise

Compression garments

- Tightly fitting clothing which prevents blood from pooling
- Increased oxygen transport around the body improves recovery
- Reduces the effects of DOMS by reducing swelling

Massage / foam rollers

- Pressure applied directly to the muscle
- Improves blood flow to the muscle
- Increased oxygen transport to the muscles improves recovery
- Improves flexibility by stretching connective tissue

Cold therapy

- Muscles are exposed to cold temperatures
- Examples include ice baths and cryotherapy
- Vasoconstriction of blood vessels and removal of lactic acid occur
- Blood flushes the muscles once returned to a normal temperature which improves recovery rate

Sleep

- Receiving enough sleep before competition improves concentration and technique, which reduces the risk of injury
- Sleep regulates the body's immune system, while also helping to strengthen bones and improve muscle mass

Nutrition

- Reducing saturated fat intake and increasing monounsaturated fat intake will have an antiinflammatory effect
- Protein intake can improve muscle recovery as proteins are the building blocks of muscle tissue development

Methods of Preventing Injury

- **Taping and bracing** – protect against injuries such as sprains by stabilising the joint and reducing the risk of soft tissue being damaged.
- **Protective equipment** – equipment, such as pads in cricket, gum shields in rugby and helmets in cycling, can be worn to reduce injuries from compact impacts.

- **Flexibility training** – increasing the range of possible movements at a joint can reduce the risk of injury. This can be done using:
 - Active stretching: holding a stretched position without assistance
 - Passive stretching: using assistance to hold a stretch
 - Static stretching: holding an extended stretch
 - Ballistic stretching: bouncing when in a stretched position in order to push the muscle through a greater range of movement

Caution!

Ballistic stretching can cause muscles to overstretch, causing injuries, so may only be suitable for trained individuals whose muscles may be more used to the tension placed upon them.

Proprioceptive training

- Training of the proprioceptors (which detect changes in tension) found in the muscles, ligaments and joints
- Training which targets proprioceptors can improve signalling to the brain and reduce the risk of injury in the future

Strength training

- Gradually increasing muscle and ligament strength so that the joint is more stable
- Will reduce the risk of future injury

Hyperbaric chambers

- The injured athlete sits in 100 % oxygen which fully saturates the haemoglobin
- This reduces the swelling at the injured site and speeds up recovery

Cryotherapy

- The injured athlete stands in a chamber at extremely low temperature
- The low temperature leads to vasoconstriction at a muscle and reduces swelling
- Once the athlete leaves the chamber, blood flows into the muscle which speeds up recovery

Hydrotherapy

- The injured athlete exercises while in water
- The buoyancy of the water reduces the load on the injured body part and allows range of movement and coordination to be improved

Injury Prevention and Rehabilitation

Warm-up

A warm-up is always essential. Below are the stages of an effective warm-up.

Warm-up activity: 5–10 minutes of light cardiovascular activity – raises body temperature

Static stretching: 5–10 minutes – improves range of movement

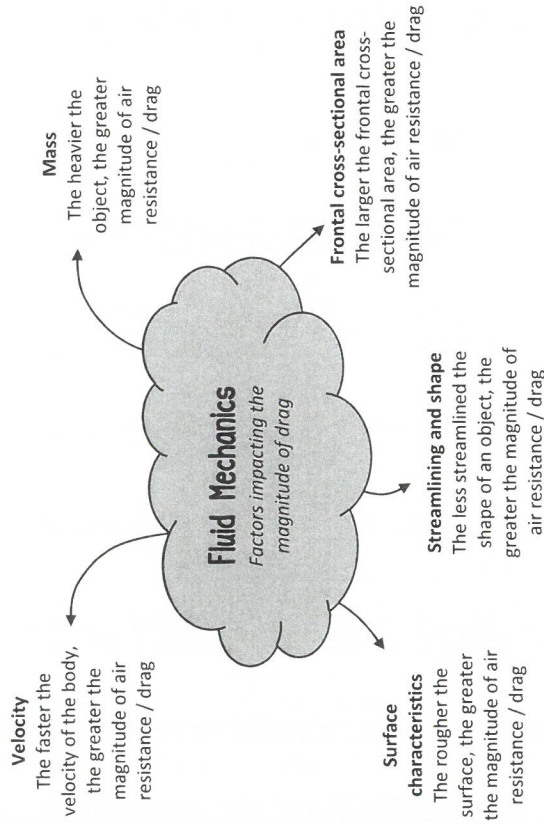
Sport-specific warm-up: replicating the sporting actions in intensity, type, etc.
Dynamic stretching: imitating the relevant sporting actions



Fluid Mechanics and Projectile Motion

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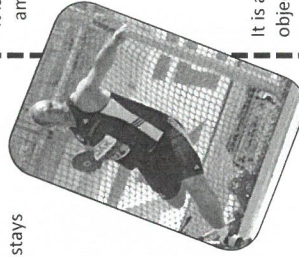
Drag is another word for **air resistance** and is, therefore, a negative force which opposes the movement of an object. There are a number of factors which affect the magnitude of drag:



Upwards Lift Force:

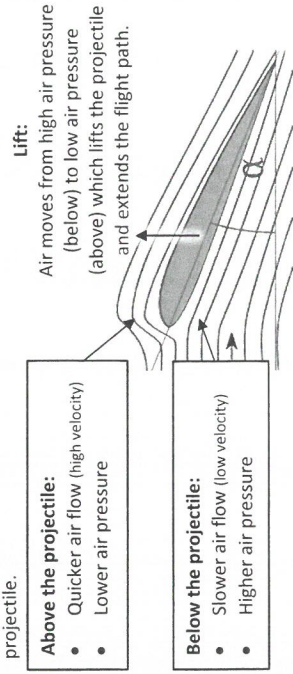
When the projectile's velocity increases, it creates an air pressure gradient that develops additional lift. This lift force is important in some sports to increase the time a projectile stays in the air, increasing horizontal distance covered.

- Upwards lift examples:**
- Discus
 - Javelin
 - Ski jumper



Angle of attack:
Involves the optimal angle to throw a projectile for Bernoulli's principle to improve lift force.

Throwing a discus at the angle shown in the diagram below (17°) increases the speed of the surrounding air, lowering the air pressure below the projectile.



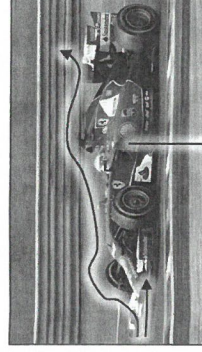
Bernoulli's Principle

It is important in some sports that downforce is generated in order to increase the amount of grip and, therefore, improve the speed that the athletes can travel at, particularly around corners.



- Downwards lift is important in the following examples:**
- F1 racing cars
 - Track cycling
 - Speed skiing

It is achieved by altering the shape of an object so that airflow above the object is slower, e.g. the nose of a racing car is changed to slow airflow velocity over the projectile and increase airflow velocity under the car, creating downforce.



- Above the projectile:**
- Slower air flow (low velocity)
 - Higher air pressure
- Below the projectile:**
- Quicker air flow (high velocity)
 - Lower air pressure

Lift:
Air moves from high air pressure (above) to low air pressure (below) which creates a downwards force on the object.

Projectile Motion

Projectile: An object that is propelled forward through the air by an external force.

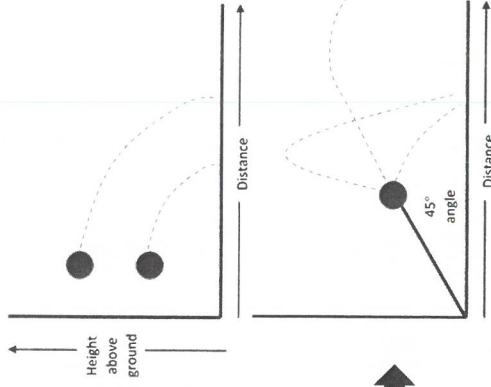
Factors to increase the horizontal displacement:



Height of release
The projectile should be released from as high as possible, as this increases the flight time.

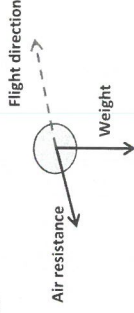
Speed of release
The projectile should be thrown as quickly as possible. This lengthens the positive velocity time of the projectile.

Angle of release
The projectile should be released at an angle of 45° . This allows for an optimal flight height and flight path length.



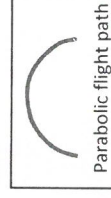
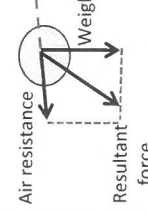
Patterns of Flight Paths

Free-body diagrams demonstrate the impact that air resistance and weight have on a body in flight.



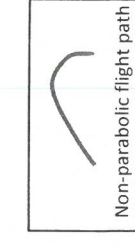
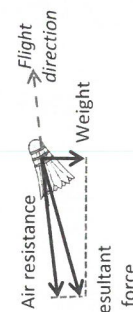
Parallelogram of forces:
The arrows of the resultant forces of weight and air resistance form a parallelogram on the projectile.

Shot-put (parabolic flight path)



Sporting example: Shot-put
Weight provides more resistance than air resistance.

Shuttlecock (non-parabolic flight path)



Sporting example: Badminton shuttlecock
Air resistance is greatest force acting on projectile due to the relatively light mass and high velocity of release.

Linear Motion

Linear Motion: The centre of mass of an object moving along a straight line. Created by **direct force** (the line of force moving through an object's centre of mass).

Quantity	Definition	Calculation	Unit
Distance	The total length of the space between a start point and an end point.	Distance = speed × time	m
Mass	The amount of matter of an object.	Mass = force/acceleration	kg
Weight	The force that gravity applies on an object.	Weight = mass × 9.81 (gravitational acceleration on Earth)	N
Momentum	The amount of motion of an object.	Momentum = mass × velocity	kg m/s
Displacement	The total change in an object's original position.	Displacement = velocity × time	m
Speed	The rate at which an object travels a specified distance.	Speed = distance/time	m/s
Velocity	The rate at which an object undergoes displacement.	Velocity = distance/time	m/s
Acceleration	The positive change in the velocity of an object.	Acceleration = change in velocity/time	m/s ²
Deceleration	The negative change in the velocity of an object.	Deceleration = change in velocity/time	m/s ²

Angular Motion

Angular Motion: The motion of an object around a fixed axis. Created by an **eccentric force** being exerted on an axis or axes of rotation.

Application of Newton's laws to angular motion:

Newton's first law	A rotating object continues to rotate around its axis of rotation at a constant rate of angular momentum unless externally acted upon by a torque.
Newton's second law	The difference in angular momentum and direction of an object is directly proportional to the size and direction of the torque that acts upon it.
Newton's third law	For every torque that is exerted on a second object by a first object, there is an equal and opposite torque exerted on the first object by the second.

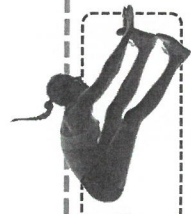
Angular Motion



Quantities

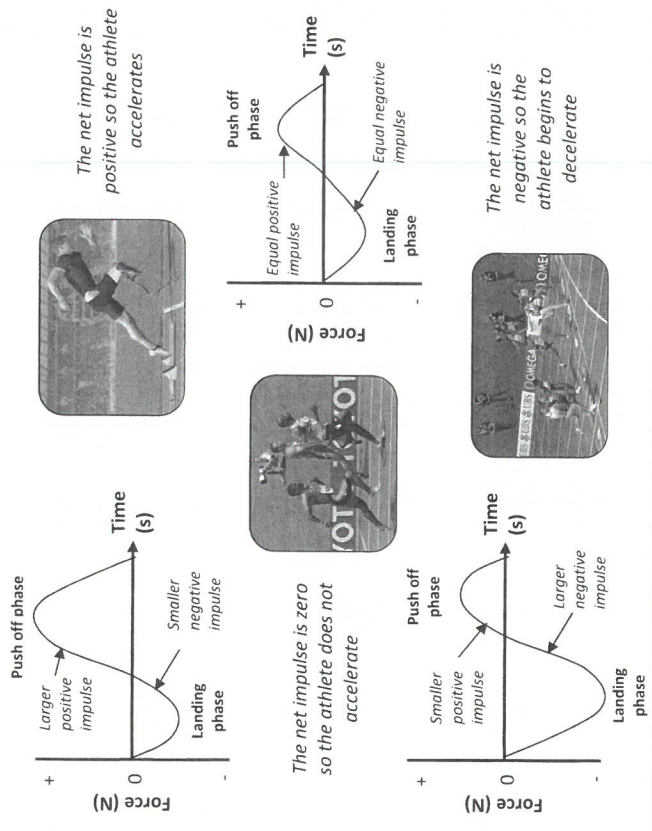
Forces acting on the cyclist during linear motion:

- **Gravity** – A force which attracts the cyclist towards Earth
- **Friction** – Negative force created when one object moves over another, e.g. the tyres over the road
- **Air resistance** – Negative force created by movement against the air. It is affected by the **velocity, mass, cross-sectional area and shape** of the cyclist and bike.
- **Internal muscular force** – Muscular tension which produces a force against resistance and allows the cyclist to move forwards
- **Weight** – The force acting on the cyclist due to gravity and their mass



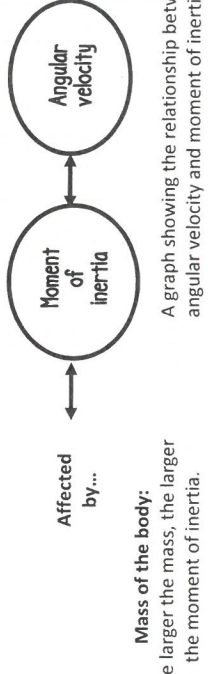
Impulse:

- The relationship between force and time, i.e. impulse = force × time
 - The longer a force is applied for, the greater the impulse
 - The direction and quantity of a force determines acceleration and momentum
- The graphs below show the impulse applied during a 100 m sprint and the impact of this on acceleration.



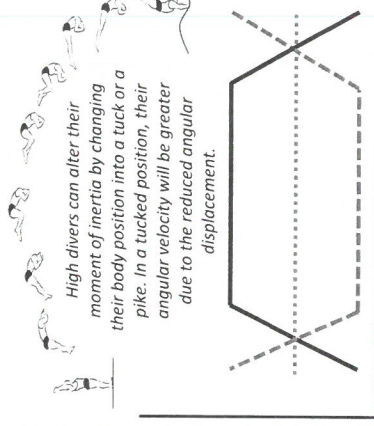
Distribution of the mass from the axis of rotation:

The larger the distance of the mass from the axis of rotation, the larger the moment of inertia.



Conservation of angular momentum

- Angular velocity = angular momentum/moment of inertia
- Inverse relationship: as moment of inertia increases, angular velocity decreases and vice versa
- The angular momentum of an object will remain the same unless acted upon by an external force



Newton's Laws of Motion

First Law: Inertia

An object's state of motion will not change unless acted upon by an external force.

Second Law: Acceleration

An object will accelerate in the same direction as the force exerted on it, and the amount of acceleration is directly proportional to this force.

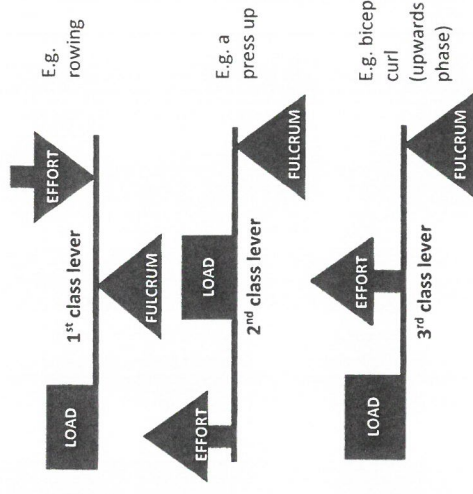
Third Law: Reaction

For every action there is an equal and opposite reaction.

Biomechanical Calculations

Speed (m/s) The time it takes to move a certain distance	=	Distance (m)	/	Time (s)
Distance (m) The length of the path travelled	=	Speed (m/s)	×	Time (s)
Force (N) The 'push' or 'pull' exerted onto an object	=	Mass (kg)	×	Acceleration (m/s ²)

Levers



Load: the weight that needs to be moved (the weight of the moving body part)

Effort: the force needed to move the load (the muscle)

Fulcrum: the location of the movement (the joint)

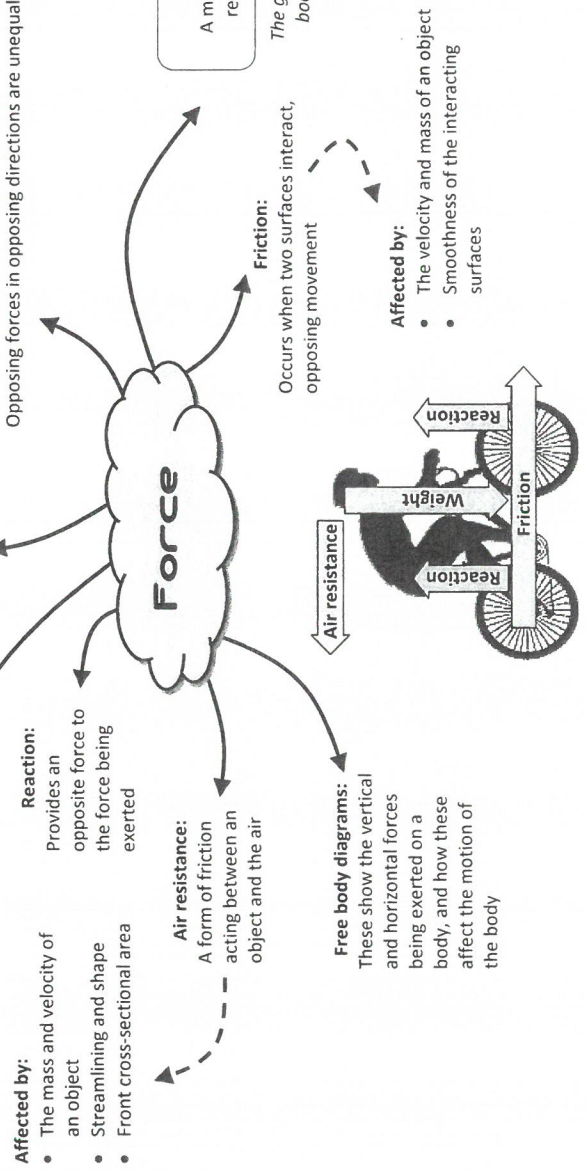
Effort arm: the distance from the fulcrum to the effort

Load arm: the distance from the fulcrum to the load

Mechanical Advantage/Disadvantage

If a load is close to the fulcrum and the effort is further away from the fulcrum (1st & 2nd class lever systems), it is said to have a **mechanical advantage** and you can move large loads.

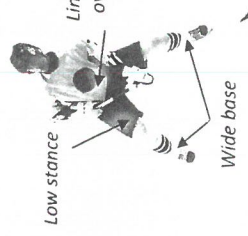
If the effort is larger than the load (3rd class lever system), it is said to have a **mechanical disadvantage** and large loads cannot be moved but smaller loads can be moved at greater speeds.



Position of line of gravity:

The line through which gravity acts is altered by the shape of the body

A line of gravity which is closer to the centre of mass will result in greater stability



Centre of mass:

The point at which the total body mass is concentrated
Raising the centre of mass will reduce the stability

Stability

The object's resistance to changing position

Body mass:

A measure of the body's resistance to change
The greater the mass of a body, the greater the stability

Area of base of support:

The width of the base of support
Having a wide base of support will increase stability