Chapter 2:
Analysing Skill and Technique

Learning Outcomes

After studying Chapter 2, you will be able to:

- Analyse selected skills and techniques from the following perspectives:
  Biomechanical: planes and axes, levers
  Movement: vectors and scalars, Newton's laws of motion
  Quality / effectiveness: economy of movement, creative application of skill.

LO 1.2

Introduction

It takes a lot of time and practice for athletes to reach an elite level in their chosen sport. This time and practice perfects the athletes' techniques so that they can perform their skills effectively and consistently in the most highly pressurised situations. In this chapter you will to learn how to analyse skills and technique from the following perspectives:

- Biomechanical
- Movement
- Quality and effectiveness

A. Biomechanics

Definitions:

Biomechanics is the study of the structure, function and motion of a living body.

Have you ever wondered why athletes regularly try out new equipment that promises to make them move faster? Sports clothing and equipment manufacturers are in a constant battle with each other to develop new running shoes, golf clubs, tennis rackets, racing bikes and swimming suits that offer athletes the chance to beat their competitors and push the boundaries of what humans can do when it comes to sporting achievements. In this section you will learn more about how a good knowledge of biomechanics can enable you to analyse skill and technique effectively.

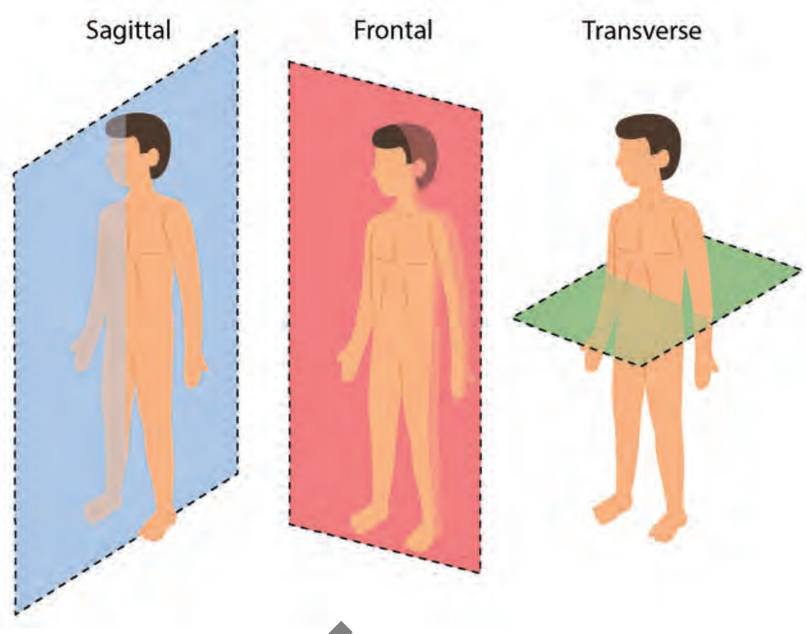
Planes of movement

The human body is capable of a vast array of different movements. There is a range of different sports and physical activities available to us, and each one requires different movements. In this section you will learn about the planes of movement that the body can move through.

Anatomical position diagram

Note: Be aware that this is the anatomical position and is always the starting position for every movement described. The anatomical position is when the body is in a standing position with the arms hanging down by the sides with the palms facing forwards. The face is pointing straight ahead also. Some movements are complex and are multi-planar, but for ease of study, the **main movement** is the one that will be used as an example in this section.

Sagittal plane



The sagittal plane is a vertical plane that divides the body into left and right sections as it passes from front to back (toe side to heel side). Any movement forwards or backwards parallel to this plane, such as forward and backward steps or forward and backward lunges, occur in the sagittal plane. Movements that require flexion and extension such as knee bending during a lunge (flexion) and knee straightening (extension) often occur in the sagittal plane. Running involves both elbow and knee flexion and extension and occurs in the sagittal plane. Can you think of an upper arm exercise that requires flexion and extension and occurs in the sagittal plane?

Analysis:

For visual or digital analysis, it is best to stand to the side of a performer completing an exercise that occurs in the sagittal plane.

Tip to help you remember:

Sagittal starts with the letter **S** and splits your body into the left and right **s**ides

Frontal plane

The frontal plane is a vertical plane that divides the body into a front and back section as it passes from one side to the other side (left shoulder to right shoulder). Any lateral (sideways) movements towards or away from the starting position occur in the frontal plane. Cartwheels and jumping jacks are good examples of movements that occur in the frontal plane.

Analysis:

For visual or digital analysis, it is best to stand directly in front of the performer when they perform an exercise that occurs in the frontal plane.

Tip to help you remember:

Frontal plane starts with the letter **F** and splits your body into a **f**ront half and a back half.

Transverse plane

The transverse plane is a horizontal plane that divides the body into upper and lower sections. Rotational movements occur in the transverse plane. A torso rotation is an example of an exercise that occurs in the transverse plane.

Analysis:

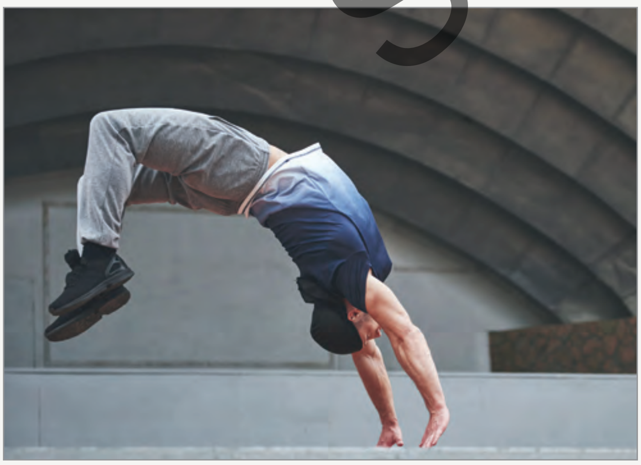
For visual or digital analysis, good practice would be to observe a performer from two angles; directly in front of them and then to one side. For example, the golf swing is one of the most analysed sporting movements. The golfer's torso movement occurs in the transverse plane. Golfers and their coaches will analyse the golf swing from a frontal angle and from an angle to the side opposite to where the ball is travelling.

Practical Activity

- Take time to learn more about the sagittal, frontal and transverse planes. With a partner, using an analysis app of your choice, help each other to analyse one exercise in each plane.
- Discover if there are any obvious differences between one side and the other. Make sure to perform the exercise a few times and to stand in the correct position to analyse the movement.
- Compile a short video detailing your movements and the planes in which they occur.

Tip: Apps like Hudl Technique will allow you to slow or pause the movement and draw lines on your recording allowing you to analyse the movements in detail.

Examine the following images.
Discuss with a partner what planes these exercises occur in.



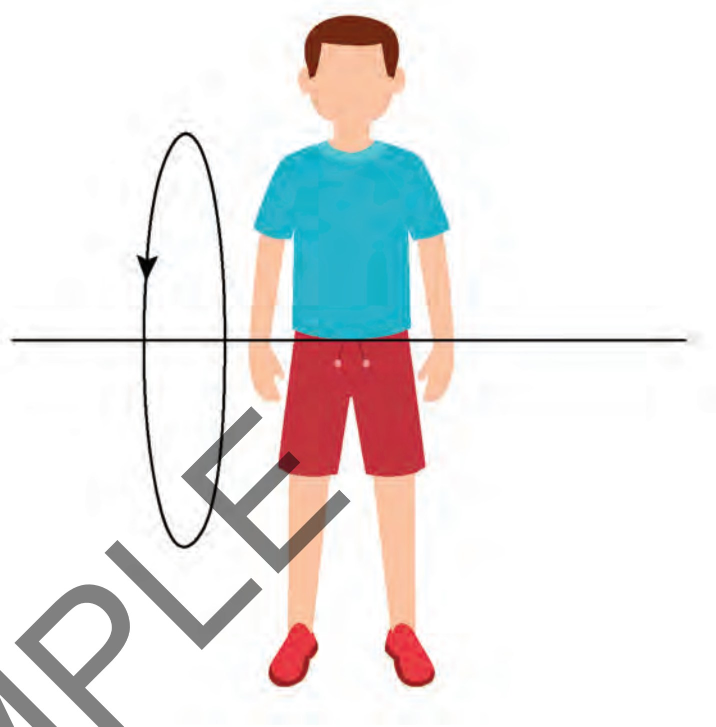
▶ Axes of movement

Definitions:

Axis: a straight line about which a body rotates.

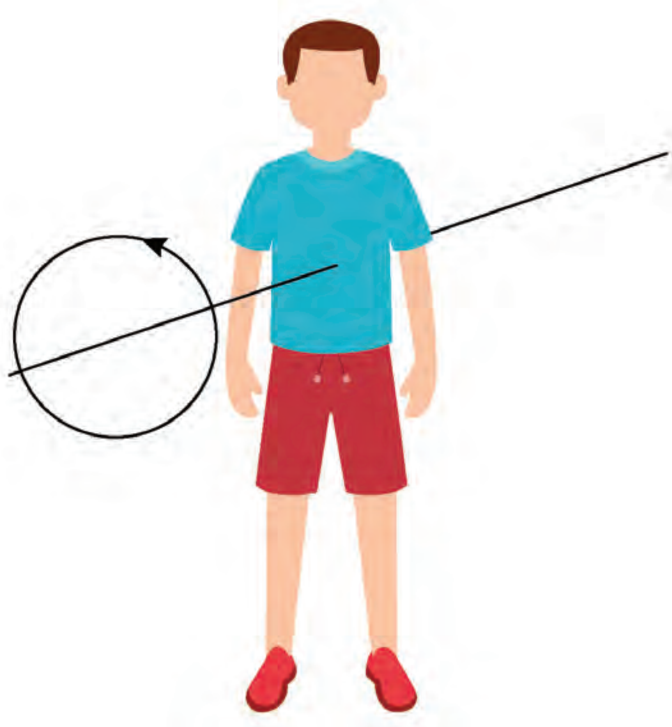
Frontal axis

The frontal axis runs through the body from one side to another. A good example here is a figure of a foosball player. The bar goes through one side of the body at the hip through the other hip. When we see a movement that occurs in the sagittal plane, this is a rotation around the frontal axis. An example of a movement that occurs about the frontal axis and in the sagittal plane is the front flip.



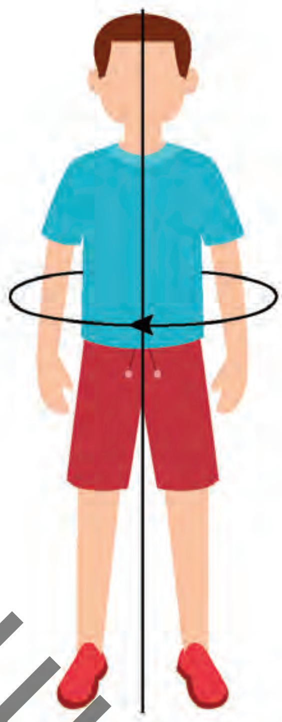
Sagittal axis

The sagittal axis runs through the mid-section of the front of the body through the middle of the back. When we see a movement occur through the frontal plane, this is a rotation around the sagittal axis. An example of a movement that occurs through the sagittal axis and in the frontal plane is a cartwheel.



Vertical axis

The vertical axis runs through the centre of the body through the entire length of the spine and through the head. When we see a movement that occurs through the transverse plane, it rotates around the vertical axis. An example of a movement that occurs about the vertical axis and in the transverse plane is when a figure skater performs a spin.

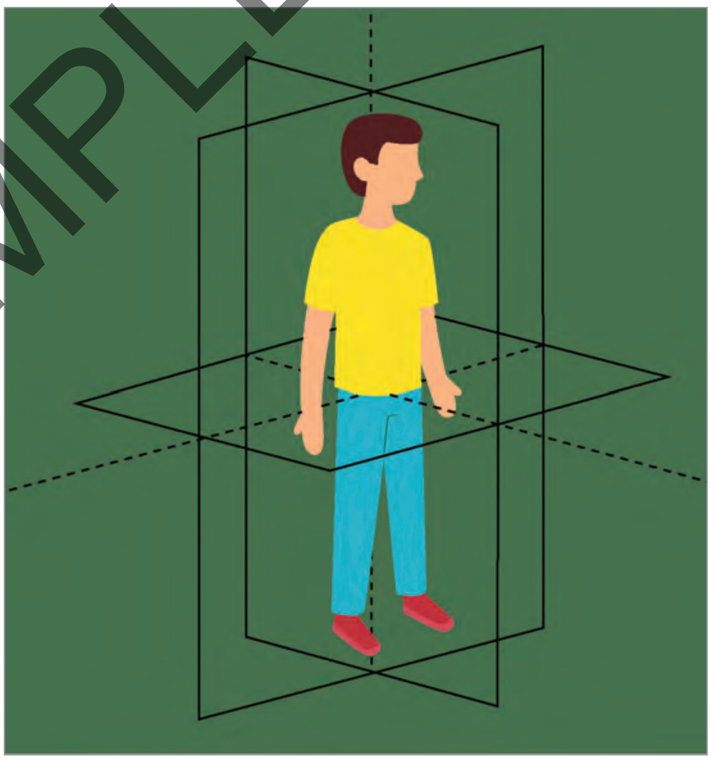


Tip: How to remember which plane and which axis! Each axis runs perpendicular to the plane. You can use the phrase:

Sit-**F**orward **F**or-**S**chool **T**owards-**V**ictory.

Study the image to help your understanding.

Rotates around		
Sagittal plane	->	**F**rontal axis
Frontal plane	->	**S**agittal axis
Transverse plane	->	**V**ertical axis



The diagram above represents the body's planes (rectangles/square) and axes (dotted lines).

Practical Activity

Investigating planes and axes using jelly babies

In this activity, you will need some jelly babies or gummy bears and some toothpicks.

1. Stand a jelly baby upright on a table. Then take a toothpick and place it through the middle (belly button) of the jelly baby and through to the other side. The toothpick is going to act as an axis and can only rotate allowing the jelly baby to rotate around it. In this case the toothpick represents the sagittal axis. Hold the two ends of the toothpick in between your fingers and rotate the tooth pick. What move is the jelly baby doing? This is the frontal plane rotating around the sagittal axis.
2. Next, take out the tooth pick and place it into the jelly baby through the hips like a foosball player. Now twist the tooth pick in your fingers and observe the jelly baby performing! What move is the jelly baby performing? This is the sagittal plane rotating about the frontal axis.
3. Lastly, remove the toothpick and place it through the jelly baby from top to bottom (head to middle of the feet). Twist the toothpick again and observe what the jelly baby is doing. This is the transverse plane rotating around the vertical axis.
4. Take pictures/videos of each axes and plane and compile them into a poster/video which can help you remember the planes and axes of the body.

Levers

Definitions:

Levers: A lever is a rigid body that pivots around a fulcrum. Levers allow physical work to be completed more easily. Levers are made up of three parts: the fulcrum, the effort (force) and the load (resistance).

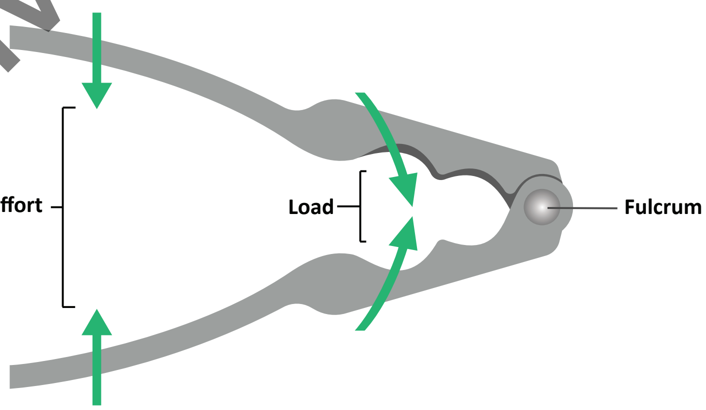
Fulcrum: The part of the lever that pivots. In a wheelbarrow, the wheel is the fulcrum as the rest of the wheelbarrow pivots around it. The body joints are often the fulcrum, i.e. elbow or knee joint.

Load (resistance): This is the object or resistance that opposes movement. For example, in a bicep curl, the dumbbell weight is the load.

Effort: This is the force needed to be applied to move an object. The biceps muscles apply the effort to lift the radius and ulna bones in the lower arm in order to lift the weight while performing a bicep curl.

Lever systems in our bodies allow a range of different movements to be completed. Every time we exercise, our bodies rely on a range of different levers to carry out the required movements. Our lever systems not only allow *us* to move, but allow us to move objects such as when we lift weights, throw or kick a ball. The bodies, muscles, bones and joints all work together in different ways to perform everyday tasks using levers. Having a good knowledge of how the body's levers work can be beneficial when analysing sports skills and techniques.

Components of a lever system:



The different types of levers in the body

There are three main classes of levers present in the body:

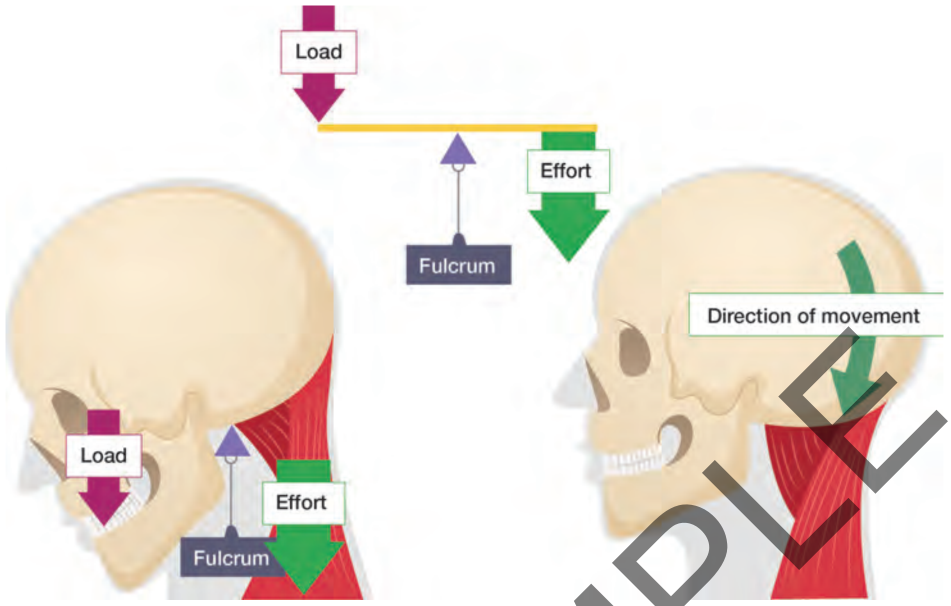
- ⇨ First class levers
- ⇨ Second class levers
- ⇨ Third class levers

Levers are categorised based on where the fulcrum (F), load (L) and effort (E) are situated in a lever.

Tip: An easy way to remember which part is in the middle is to use: 123 = FLE.

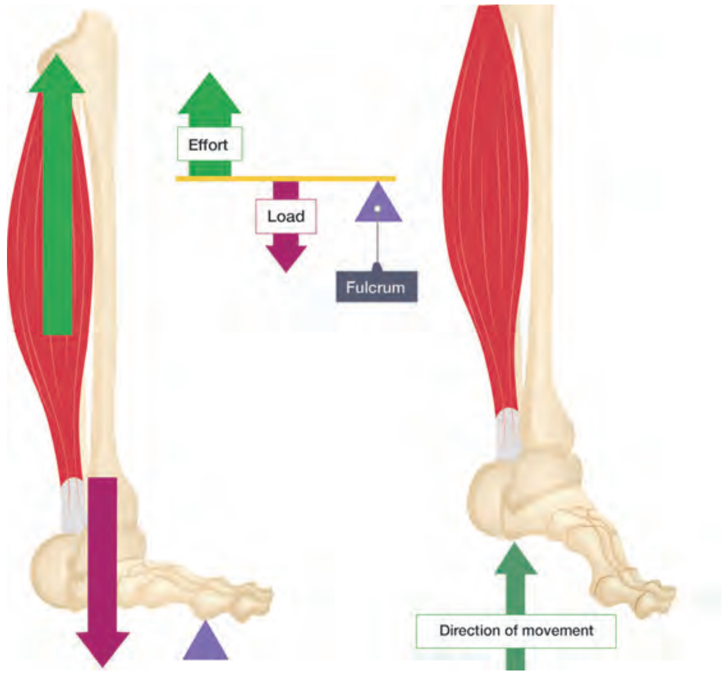
First class levers

In first class levers, the fulcrum is in the middle of the load and the effort. A good example to think of is a seesaw. In the human body, a first class lever is observed in the neck and is used to lift up the head (nose towards the sky) as a high jumper does when clearing the horizontal bar. A football player will also use this lever to head a ball. The load is gravity pushing down on the front part of the head, the fulcrum is the top vertebrae in the cervical spine and the effort is made by the muscles in the back of the neck.



Second class levers

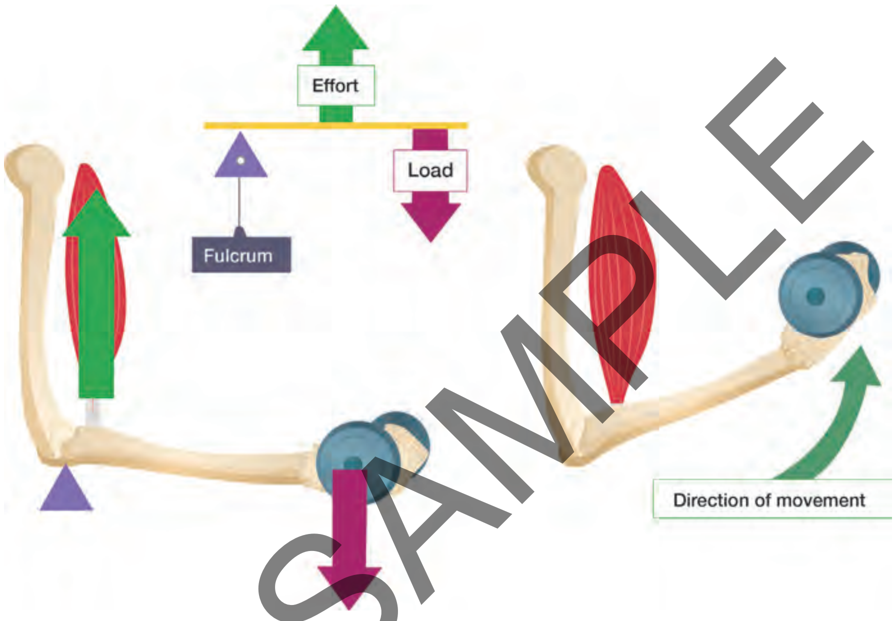
In second class levers, the load is in the middle of the fulcrum and effort. An everyday example of a second class lever is a wheelbarrow. The **load** is the soil or whatever is in the wheelbarrow, the **fulcrum** is the wheel and the **effort** is the force required to lift the handles. An example of a second class lever in the human body occurs when a calf raise is performed. The ball of the foot which stays on the ground is the fulcrum, the load is the body's weight in the middle of the foot and the effort in performing the exercise comes from the contraction of the gastrocnemius muscle (located in the calf area).



Third class levers

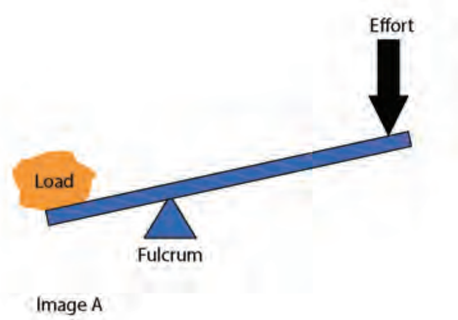
In third class levers, the **effort** is in the middle of the **load** and the **fulcrum**. An everyday example of a third class lever occurs when a fisherman catches a fish. The base of the rod acts as the fulcrum, the effort is made when pulling up the rod and the load is the fish at the end of the hook. In the human body, an example of a third class lever occurs when performing a bicep curl. The elbow joint is the fulcrum, the bicep contraction is the effort and the load is the dumbbell in the hand. Due to the bicep tendons attaching the bicep muscle itself to the radius and ulna (lower arm bones) we can say that the effort occurs at the point of muscle insertion. In the case of a bicep curl the effort lies between the fulcrum (elbow joint) and the load (the weight in the hand).

> NOTE:
> When analysing the levers in the body it is important to understand that the effort is provided by the muscle and moves the bone at the point of insertion. This is where the muscle is attached to a bone via a tendon.



Mechanical advantage of levers in sport

Have you ever wondered if certain athletes are *born* to play a particular sport? Does their body structure give them an advantage allowing them to excel in one particular sport compared to somebody else? As we have learned, we all have levers in our body, but some people have slightly different bone lengths to others, making the levers in their body unique to them. Using an example of a moving a large rock using a plank of wood, take a look at the image below and decide which image will require least effort to move the load.



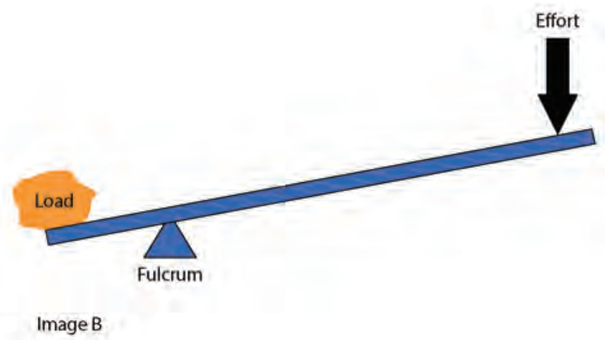
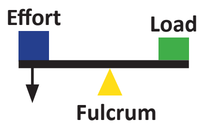


Image B is a longer lever and requires less effort to move the load than image A. As a result, image B can generate force more easily than image A can. This can be related to the human anatomy too. Taking Olympic swimmer Michael Phelps as an example, his wingspan and therefore his arm length is longer than the average person's. Usually a person's wingspan is very close to their height measurement. However, Phelps' wingspan is three inches more than his height. This means that he can generate more force with less effort as he glides through the water. This has helped Phelps to collect 23 Olympic gold medals in his career. Some tennis players have a similar advantage when it comes to generating force in their serve. Many taller tennis players with extremely high serve speeds have emerged in recent times. John Isner and Venus Williams are two of the taller players (6'10" and 6'1") to have played professional tennis in recent times and are known to have extremely fast serve speeds coming in at 253km/h and 208km/h respectively.

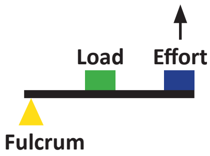
Talking Point
Discuss how the athletes pictured may have an advantage due to the size of their levers.

Summary of the classification of levers

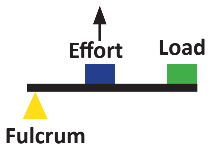
Class 1 – The **fulcrum** lies between the **effort** and the **load**.
Class 2 – The **fulcrum** is at one end, the **effort** at the other end and the **load** lies between the effort and the fulcrum.
Class 3 – The **fulcrum** is at one end, the **load** at the other end and the **effort** lies between the load and the fulcrum.



Class 1 Lever



Class 2 Lever



Class 3 Lever

B. Movement: vectors and scalars

▶ Vectors

Definitions:

Vectors are quantities that have both magnitude and direction.
Examples of vectors are:

- Velocity
- Displacement
- Acceleration
- Force
- Momentum

Velocity is the speed of an object in a given direction.

Displacement is the action of an object moving from its starting position to another position.

Acceleration is the rate of change of a body's velocity.

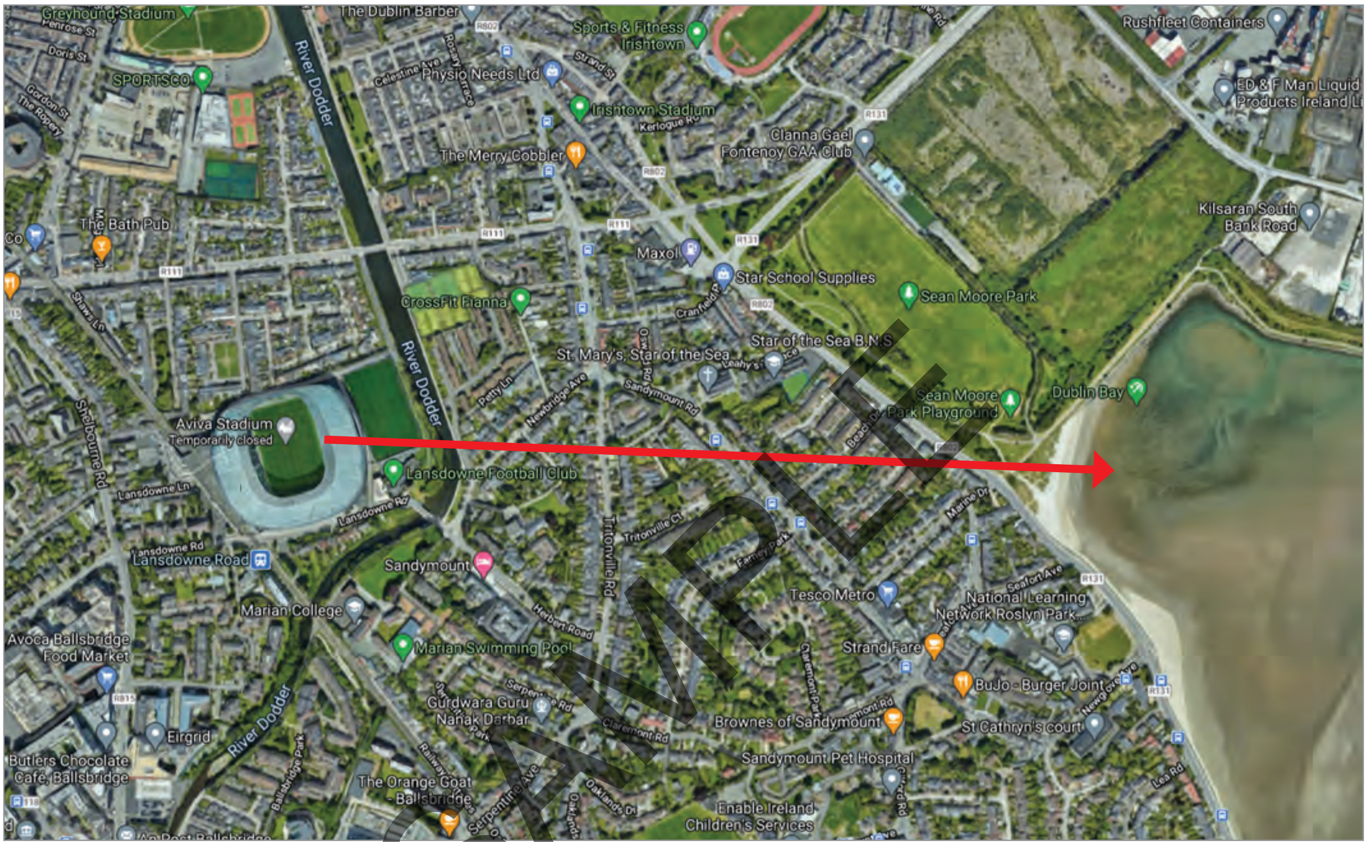
Force is any interaction that has the ability to change the motion of an object.

Momentum can be defined as mass in motion. All objects have mass, so if an object is in motion then it has momentum.

Everyday examples of vectors

Example:
A runner sets off at a speed of 7m/s. Their velocity is 7m/s east. Velocity is a vector as it contains both magnitude (7m/s) and direction (east).
If a runner runs around a track at a constant speed their velocity is not constant as they are running facing different directions as they complete each lap.
Vectors can often be represented by arrows. In the case of displacement (also a vector), the arrow's length represents the magnitude of the vector and the way its pointing representing the direction.

Example:
After attending an Ireland game, you are standing outside the Aviva stadium and decide to go for some seaside fresh air and you visit Sandymount Strand 1km away. The red arrow represents the magnitude of the vector and the way that its pointing indicates the direction (east). This is your displacement from your starting position, and as it had both a magnitude (length) and direction (east) it is said to be a vector.



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▶ Scalars

Definitions:

Scalars are a physical quantity that include magnitude only. A scalar has no direction.

Magnitude is another way of saying size and therefore can be measured using a numerical value. Taking Usain Bolt's 100m world record as an example, Bolt was travelling at a speed of 44.72 km/h, therefore 44.72 is the magnitude of the speed and because speed does not have a direction, we consider it to be a scalar quantity. Other examples of scalar quantities are:

- ⇨ Length
- ⇨ Area
- ⇨ Energy
- ⇨ Time
- ⇨ Mass
- ⇨ Volume
- ⇨ Temperature

Length: The distance between two points (measured in cm or m). The length of a basketball court is 28m.

Area: The space taken up on a surface or a flat shape (measured in cm^2, m^2). The area of a basketball court is $420m^2$.

Energy: Energy is the ability to do work. This means that an object has energy if it has the ability to move another object (measured in joules [j]). A kicked soccer ball has energy.

Time: Time represents how long something takes to happen. It can be measured in many units (seconds, minutes, hours, days, weeks).

Mass: Mass represents the amount of matter in an object. It is measured in grams [g] and kilograms [kg].

Volume: The amount of space an object takes up measured in cm^3.

Temperature: How hot or cold an object is. Temperature is measured in degrees Celsius.

Speed: Speed is the maximal rate at which a person can cover a distance or perform a movement in a period of time. Speed can be calculated using the following formula:

Speed = Distance/Time

For example, an athlete who runs 100m in 12 seconds has an average speed of 8.33 metres per second (m/s).

All of the above quantities can be measured in a numerical value. For example, cm, metres, joules, kg, Celsius etc. The results of many athletics events are provided in a scalar quantity. For example, a discus throw is measured by its length and track events are measured by their time. Studying the following example will help you to understand scalars.

Example of scalar quantity:

The length of the Croke park pitch is 145m. This is an example of a scalar quantity as it has magnitude but direction is not important. Elite GAA players will run at a speed of roughly 9m/s. This is also an example of a scalar as there is no direction involved.

▶ Newton's laws of motion

Isaac Newton (1643-1727) was a physicist who devised three laws of motion, published in 1687. By studying Newton's laws of motion, athletes and coaches can gain a greater understanding of human biomechanics and how the human body's motion can be influenced by external factors. By understanding these laws, coaches and athletes can better understand the needs of their sport and put in place a specific training programme designed to enhance the athlete's performance. Newton's three laws of motion are:

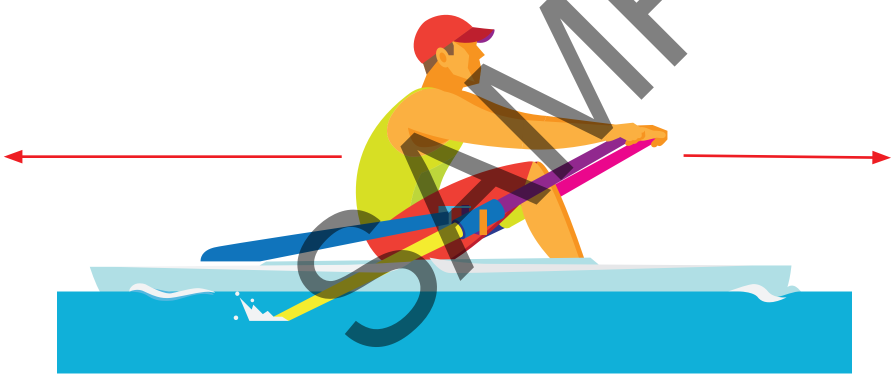
1. The law of inertia
2. The law of acceleration
3. The law of reaction

Newton's first law of motion: The law of inertia

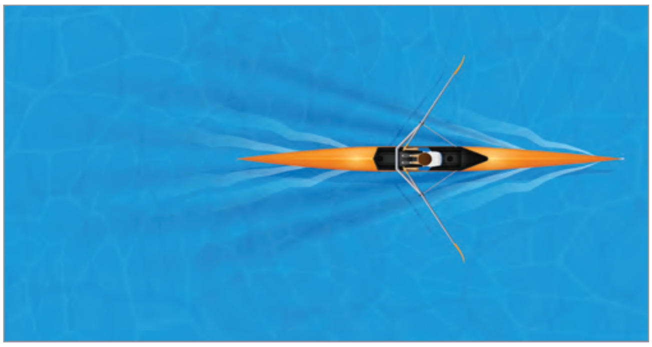
Newton's **first law of motion** states that objects that are stationary with **balanced forces** acting on them will stay at rest. A moving object that has equal forces acting on it will stay in constant motion. Some examples of external forces that act on people when they move are:

- gravity
- friction

For example, at the start of a rowing race, a rower needs to create a situation where there is more force going in the direction that they want to go (arrow on the left of the diagram) than the opposing force going in the opposite direction (arrow on the right of the diagram). In order to start the race, the rower must use their power to fight against the friction created by the water against the oars and to generate enough force to get the boat up to a fast speed as soon as possible.



Talking Point
From studying levers earlier in this chapter, would rowers with longer arms be at an advantage or a disadvantage to an opponent with shorter arms?



Newton's first law suggests that an object at rest wants to stay at rest and an object in motion wants to stay in motion. Take the example of a rugby ball on a kicking tee. The earth's gravity is acting down on the ball, but the force coming upwards from the tee to the ball is equal to the force applied from the earth's gravity. Therefore, the ball stays stationary. When an external force is applied, (i.e. from a kicker's boot) there are unbalanced forces acting against each other. This means that when there is more force coming from the kick than there is working back into the foot of the kicker from the ball, the ball takes off in the direction that the kicker's foot is moving towards.

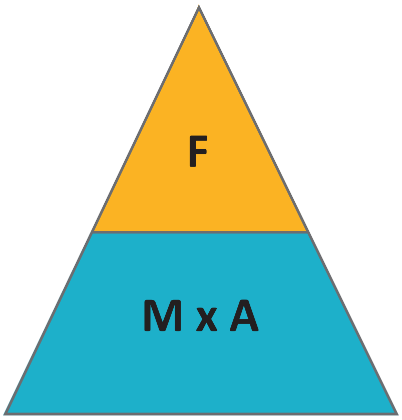
Similarly to how force is needed to start motion, force is needed to stop motion. A moving object will want to stay moving until a force such as friction acts upon it to slow it down. Taking a drive in golf as an example, once the ball goes airborne as a result of greater force applied by the club, it comes into contact with friction from the air and then the grass which slows it down and eventually stops the ball. Another example is a putt. Once the ball leaves the putter face, it comes across friction from the grass and wind which eventually will slow the ball down and stop it.

Talking Point
Another example of Newton's first law in action in sports can be in NFL or rugby. Take the tackle as an example. If a player who has the ball and is moving at a slow pace gets tackled by a defensive player who is heavier and moving at a faster pace, what do you think will happen?

Web time
Watch the following video on how Newton's first law of motion can be applied to sports. Discuss your answers to the questions below in pairs.
[Science of NFL Football]
Search Terms: Newton's First Law of Motion - Science of NFL Football

Questions:
1. Running backs (ball carriers) aim to get down the field to the touchdown area as fast as possible. Use your knowledge of Newton's first law to explain what the defenders must do to stop them.
2. An unbalanced force occurs during a tackle, causing the recipients' speed or direction to __________?
3. What characteristic in NFL players make them more difficult to stop?

Newton's second law of motion: The law of acceleration



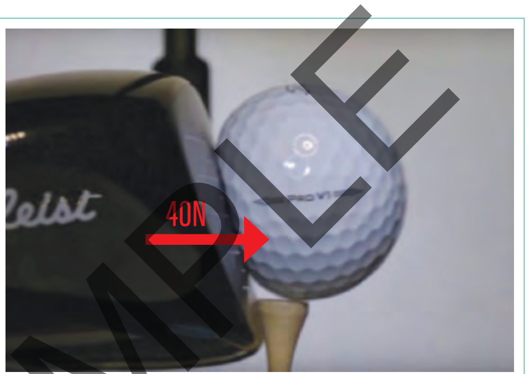
Newton's **second law of motion** outlines how an object with a mass that is accelerating is proportional to the resultant forces acting on it. The formula below allows us to calculate the acceleration of an object where F = force (measured in newtons), M = mass (measured in kg) and A is acceleration (measured in metres per second squared m/s^2).

F = MA (Force = Mass x Acceleration)

The example below will help you to understand Newton's second law of motion and how it relates to sport.

Example of Newton's second law of motion in sport:
Both golfers below are using the same ball and driver. Using Newton's second law of motion we can find out which golfer accelerates the ball better.

The mass of the golf ball is 0.04593kg.

	
The golfer above (a) imparts a force of 20N on the golf ball	The golfer above (b) imparts a force of 40N on the golf ball

Using Newton's second law of motion we can calculate which player accelerates the ball the most.

(a) F =MA (Force = Mass x Acceleration).
Force = 20N
Mass = 0.04593kg
So using the formula:
20N = 0.04593kg x acceleration
Acceleration = Force/mass
Acceleration = 20/0.04593
Acceleration = 435.45 m/s^2

(b) F =MA (Force = Mass x Aceleration).
Force = 40N
Mass = 0.04593kg
So using the formula:
40N = 0.04593kg x acceleration
Acceleration = Force/mass
Acceleration = 40/0.04593
Acceleration = 870.89 m/s^2

Answer: Golfer (b) accelerates the ball more than golfer (a).

Web time
Newton's first and second law of motion in golf. Watch the video and answer the questions. Science of Golf: Newton's First and Second Laws
Search Terms: Science of Golf: Newton's First and Second Laws

1. Acceleration is directly proportional to the ___________ you apply to an object?
2. If the golf ball was slightly smaller in size, would this lead to greater acceleration or a reduction in acceleration compared to a regular golf ball?

Newton's second law of motion introduces the topic of acceleration. It discusses how unbalanced forces cause a change in velocity (speed in a direction). Acceleration of a body will be directly proportional to the force applied to it. This relates to how a large force striking a small mass (a full swing driver shot striking a golf ball) will lead to a big increase in acceleration. However, the same force striking a larger mass (a full swing driver shot striking a sliotar or bowling ball) will result in a slower acceleration. Therefore, a smaller object has more potential to have a rapid increase in acceleration than a larger object.

Newton's third law of motion: The law of reaction

Newton's **third law of motion** states that for every action there is an equal and opposite reaction.

An example of this is bouncing a tennis ball before a serve. When you throw the ball downwards and it hits the ground, this force is equalled by the force coming up from the ground through the tennis ball, causing it to bounce up. If you bounce the ball harder into the ground, then the ball will bounce up in proportion to the force it hit the ground with. Another example is when a kayaker puts their paddle into the water and drags it backwards. At the same time, the water pushes back on the paddle equal in magnitude but opposite in direction. This leads to the kayaker moving forwards.

Lebron James famously uses Newton's third law of motion while performing a self-assist in basketball games when a clear shot to the basket is not available. He performs this by shooting the ball against the backboard with enough force so that the force hitting the backboard is equalled by the backboard's force against the ball causing it to bounce back off it. By this time, he changes his position and catches the rebound in a better position to shoot.

Research and discuss times that athletes in any of your chosen physical activity areas have used one of Newton's laws of motion to their advantage. Design a poster of your example(s) either digitally, using a resource such as PicCollage, or designed by you. Include images and text. The poster should explain what the law of motion is and have a clear example of it.

C. Quality and effectiveness of movement

12 February 2020; Diani Walker of Great Britain, left, and Gina Akpe Moses of Ireland compete in their heat of the Westmeath County Council Women's 60m event.

Sport is highly competitive by nature. As a result, athletes are in a continuous search to find marginal gains over their opponents. These gains can be attained in numerous ways such as:

- Improving skills and techniques.
- Using improved equipment.
- Being more efficient or faster in a particular movement.
- Improving specific aspects of fitness.

In this section, you will learn how elite athletes complete the movements required for their sport in ways that are both extremely effective and of high quality.

▶ Movement economy

Definitions:

Movement economy describes how a motion or activity is completed in an energy saving or efficient way.

Athletes are not only battling it out against the clock or against the opposition, they are also battling external factors that have the ability to slow them on their path to victory. These factors include: friction, inertia and gravity.

Friction

Friction is the resistance to motion of two moving objects or surfaces that come into contact. In sport, examples of friction can come from a variety of different sources. One example is the friction from the wind against a golf ball slowing it down and causing it to fall from the sky. Once the ball lands, the friction from the grass then slows and eventually stops the ball moving any further.

Swimmers also face friction from the water with many swimmers carefully choosing their swim hat and removing any excess body hair to reduce drag. Cyclists also carefully choose their equipment with many racing bikes becoming lighter and thinner. In addition, the availability of teardrop shaped helmets reduces the wind resistance and allows the cyclist to cut through the air more efficiently. Long-distance athletes need to take measures to avoid friction on the inside of their shoes causing blisters. They regularly need to change their running shoe due to the friction caused when the shoe comes into contact with the running surface.

Inertia

Definitions:

Inertia is a body's total resistance to changing its state of motion.

You experience inertia if you are on a bus, train or on the Luas and it stops. You may move forward a little after the vehicle stops before you contract your muscles allowing you to stop. This is inertia. The heavier the item, the greater the force is needed to get it moving or stop it, therefore the greater its inertia. Think of a car with the handbrake off. On a flat surface it will stay still unless a large force begins to move it. Once it starts moving, it will keep moving unless a large force stops it. Consider athletes such as rugby players, many of them have a high body mass especially in their lower body. This makes them hard to move!

Gravity

The earth's gravity is a downward force attracting objects towards its centre. High jumpers and basketball players develop huge leg power to fight against the force of gravity.

Cian Healy Irish rugby player has a high amount of his body mass concentrated in his legs lowering his centre of gravity making him hard to move.

How athletes can increase their economy of movement

Being energy efficient

Many sports have different strategies and formations with the aim of gaining an advantage over the opposition. In athletics, energy saving strategies are evident across its many disciplines. For a long-distance runner such as a marathon runner, it would not be a good idea for them to start their race with an all-out sprint with all of their energy. This would waste valuable energy reserves and require recovery time when they quickly tire. By that stage other competitors will have caught up and raced past. Very often an athlete in a track event will hold back and stay in the pack or towards the rear of the pack. They will then finish with a sudden 'kick' of speed to overtake the athletes who have decided to start the race as front-runners, which can be energy sapping. The sport of CrossFit has become hugely popular across the world in the last ten years and tests an athlete's overall fitness. Many events or 'workouts' require different forms of fitness ranging from aerobic, anaerobic and gymnastics skills with strategies being central to how an athlete completes each workout. The following is an example of one CrossFit games event known as 'Mary'.

Aoife McDermott is helped by her teammates to win a lineout. Aoife has represented Ireland at basketball too.

- **AMRAP (as many rounds and repetitions as possible) in 20 minutes**
- **5 Handstand push-ups**
- **10 Pistol squats (alternating legs)**
- **15 Pull-ups**

If athletes in the CrossFit games aim to continuously complete exercise after exercise, they will tire and eventually become exhausted and won't be able to complete as many repetitions as their opponents. So some will choose to rest at certain intervals during the event in order to save enough energy and recover for a final push towards the end.

Effective technique

Sport by its nature is very diverse and requires a range of different movements. Athletes aim to make every movement, muscle contraction and skill execution count so that they can achieve their goal in the most efficient way possible. Taking an Olympic 400 metre hurdler as an example. This event is known to be one of the most demanding events there is due to the distance and technique involved. An athlete must negotiate ten hurdles on their way around the track. The technique of clearing a hurdle requires a high level of skill and technique to perform correctly. In addition, the final 100m of the race is when the athlete severely tires and will find it more difficult to execute their technique correctly. As a result, the previous 300 metres need to be completed in the most energy efficient way. For this to happen, each of the athlete's steps need to be performed with an effective running technique. This means that their arms and legs need to be in the correct positions and their step pattern needs to be in the correct place as a zig-zag step pattern will lead to the athlete losing time across the duration of the race. This can be extremely difficult under fatigue. A hurdler will take time during training sessions to practise taking the appropriate number of steps between each hurdle as extra steps may lead to time being lost.

Web time

Video A Watch the video and answer the questions in pairs.
[Almost Impossible to Run 100 Meters In 9 Seconds]

Search Terms: Why it's almost impossible to run 100 meters in 9 seconds | WIRED

Questions:

1. Robinson drags his foot on the ground coming out of the blocks. What does this allow him to do?
2. According to Peter Wayne, what is the key to elite sprinting?
3. What is Usain Bolt's top speed?
4. Why do sprinters compete in tight clothing?
5. Why do sprinters slow down in the last 30 metres of a race?
6. With how many times his bodyweight does Robinson apply force to the ground?
7. What two elements of his technique allow Robinson to maximise the force that he applies to the ground?
8. To run a 100-metre race in 9 seconds, how much force would athletes need to put into the ground?

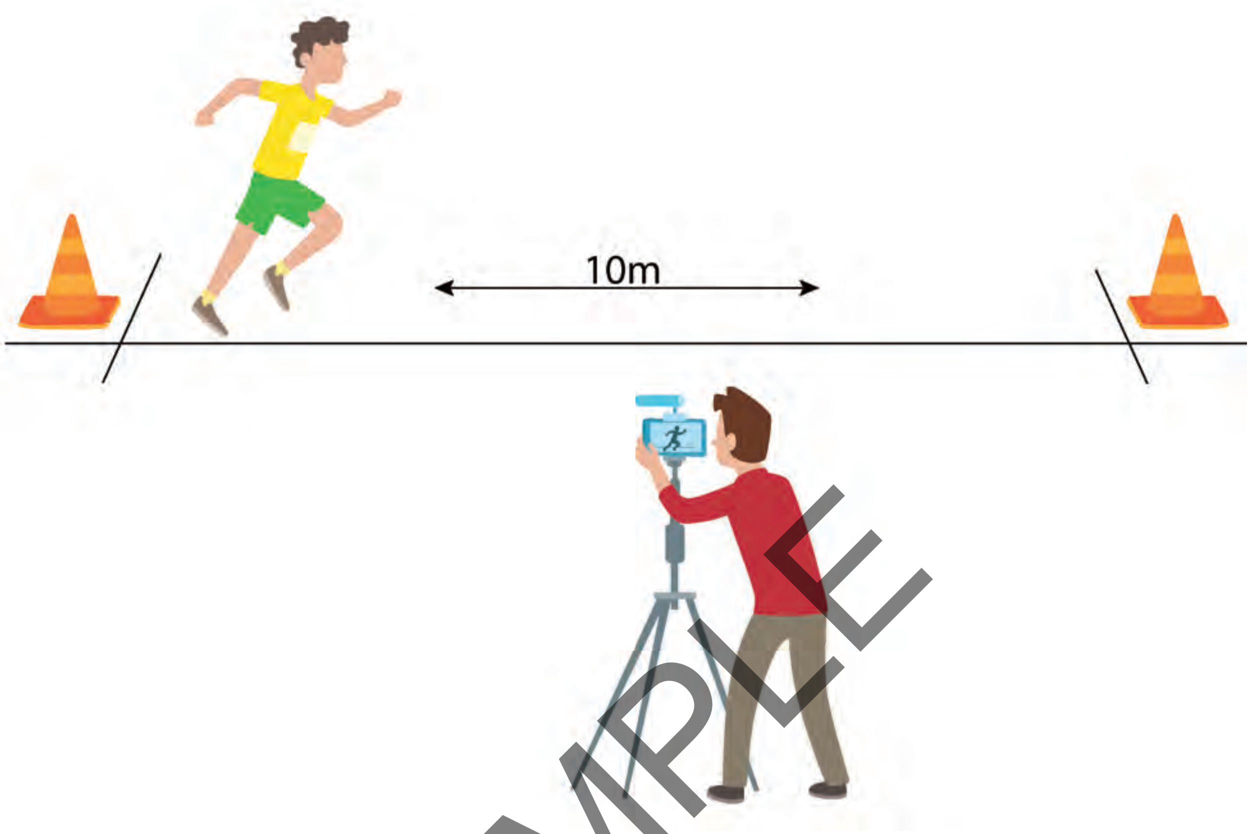
Video B Watch the video and answer the questions in pairs.
[How to sprint with Michael Johnson]

Search Terms: How to sprint with Michael Johnson. Faster. Higher. Stronger.

Questions:

1. According to Johnson, what creates speed?
2. Why did Johnson sprint with a more upright posture?
3. Having the correct physique is important in sprinting. Why is having good upper body strength important for sprinters, according to Johnson?

Practical Activity



Biomechanics and effectiveness of movement in sprinting:
With a partner, find an area clear of any obstacles and a safe distance away from other students in your class. Set up a distance of 10 metres by marking it out with cones. This will allow you to be closer to the camera and therefore analyse the movement better. One person is going to be the sprinter and the other is going to video the sprint. Once finished, swap roles. Optional: you can use another person to time the sprint.

Make sure to choose a good angle to record from. Suggestion: move to the side and record from there as in the diagram. Record the sprint and watch it back in slow motion. From watching the videos earlier in this chapter, you will know that some key points to look for in a sprint are:

- the force applied to the ground by the feet
- upper body movement

Once you have analysed your technique, select points to improve on and record another sprint with the new technique.

Compile a short video presentation detailing how you analysed your performance and improved it. Present the video to the class.

Creative application of skill

Have you ever watched a sporting event and witnessed something that really impressed you? Maybe the athlete used their trickery to deceive an opponent? Or maybe the athlete executed a skill that not many other athletes can? In each sport there is a certain number of basic skills involved that everyone who plays that sport must master. Some highly skilled athletes will use their own unique skills to their advantage. This creativity can be high-risk at times and may cause injury if it is not performed correctly or may give the opponent an advantage if it is not successfully executed. Some examples of this-high risk creative play in sports are:

- the drop shot in tennis
- the no-look pass in rugby
- handling skills in basketball (around the back or through the legs dribble)
- the overhead kick or Panenka penalty in football
- the flop shot in golf

Ronaldo overhead kick for Madrid v Juventus

Talking Point

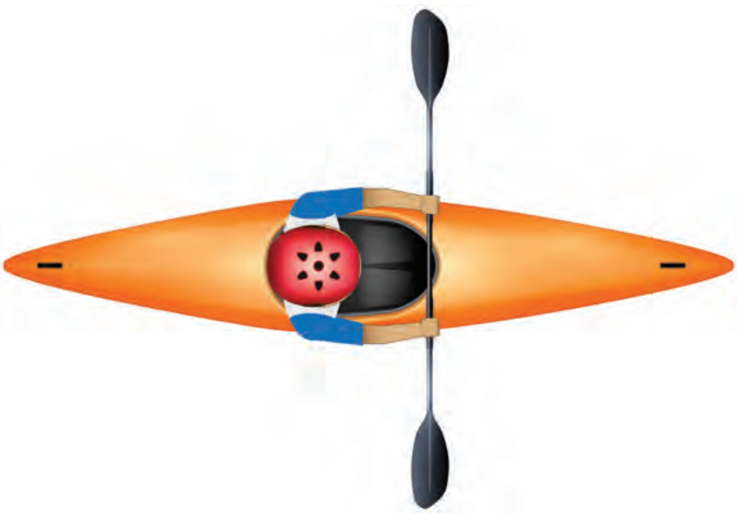
Have you witnessed any examples of creative skill in any of your chosen physical activity areas? Take time to research examples of creativity in your chosen physical activity areas. Discuss your findings with your classmates explaining why each example can be:

- high-risk
- advantageous to the performer

End of chapter questions:

1. What is meant by biomechanics?
2. Through what plane and axis is sprinting performed?
3. Provide one example of a movement that occurs in the frontal plane.
4. Provide an example of a movement that occurs through the transverse plane and vertical axis.
5. Study the diagram and answer the questions below.

   (a) Identify the plane and axis through which the back handspring occurs.
   (b) If this gymnast finished with a pirouette, what plane and axis would they be moving through?
6. In relation to levers, define the terms:
   (a) fulcrum
   (b) load
   (c) effort
7. (a) Draw a diagram of a first class lever labelling the fulcrum, load and effort. Clue: 123=FLE
   (b) Provide an example of where a first class lever can be found in the human body.
8. A mechanical advantage of a second class lever system is used in which one of the following situations?
   (a) A squat (b) a bicep curl (c) a calf raise.
9. (a) Draw a diagram of a third class lever labelling the fulcrum, load and effort.
   (b) Provide an example of where a third class lever can be found in the human body.
10. Describe a situation in a sport of your choice where having short or long levers can be an advantage to the performer.
11. What is the difference between a vector and a scalar? Provide an example of each in your answer.
12. Define speed.
13. If an athlete runs 400m in 58 seconds, what is their speed in metres per second?
14. Here a kayaker is about to take off from a stationary position. Outline how Newton's first and second laws of motion apply here.



15. Provide an application of Newton's third law of motion in a sport of your choice.
16. What is movement economy?
17. Describe how an athlete in a sport of your choice can increase their movement economy.
18. A skateboarder is travelling at a high speed when all of a sudden the front wheels hit a kerb. Using your knowledge of Newton's first law of motion, explain why the skateboarder will continue to move forwards when the skateboard stops suddenly.
19. Discuss how, in a sport of your choice, an athlete can be energy efficient.
20. You are the coach of the ice hockey player in white, below. The player is struggling with not enough power on his shots. Use your knowledge of levers to describe how he can apply more power to his strike.

Go to mentorbooks.ie/resources/onyourmarks for more videos, resources and end of topic Quizlet quizzes.