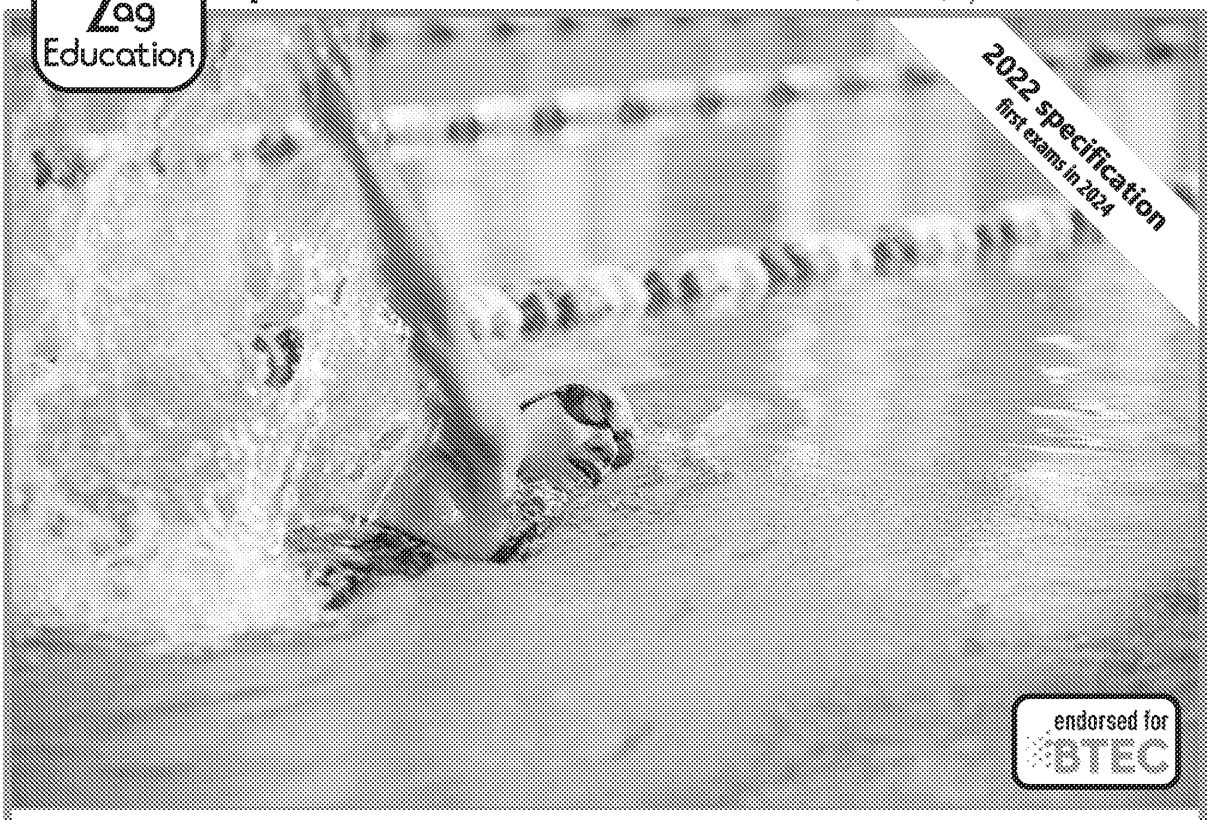
Zig Zag Education

Sport

BTEC Tech Award (L1/2) | 603/7068/3



Course Companion for BTEC Tech Award (L1/2): Sport

Component 3: Developing Fitness to Improve Other Participants' Performance in Sport and Physical Activity

Endorsed Edition v1.1, January 2024

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Course Companion for BTEC Tech Award (L1/2) Sport: Component 3

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In order to ensure that this resource offers high-quality support for the associated Pearson qualification, it has been through a review process by the awarding body. This process confirms that this resource fully covers the teaching and learning content of the specification or part of a specification at which it is aimed. It also confirms that it demonstrates an appropriate balance between the development of subject skills, knowledge and understanding, in addition to preparation for assessment.

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Teacher's Introduction

This course companion is for **Component 3: Developing Fitness to Improve Other Participants' Performance in Sport and Physical Activity**, part of the Pearson BTEC Tech Award Level 1/2 in Sport (First Teaching September 2022). The aim of this resource is to guide students through the core content of the component, providing them with in-depth information that covers each of the specification points. This resource aims to provide students with the knowledge and skills that will help them succeed in the examination for this component.

For clarity and ease of use, the content of this course companion matches the order of the specification.
The content is structured as follows against the element's assessment criteria:

	Chapter/S ics
Learning outcome A: Explore the importance of fitness for sports performance	**A1** The im ce of fitness for successful ess training principles Exercise intensity and how it can be dete
Learning outc e B te fitness testing to me fitness leve	**B1** Importance of fitness testing and require each fitness test **B2** Fitness test methods for components of **B3** Fitness test methods for components of **B4** Interpretation of fitness test results
Learning outcome C: Investigate different fitness training methods	**C1** Requirements for each of the following fi **C2** Fitness training methods for physical con **C3** Fitness training methods for skill-related **C4** Additional requirements for each of the **C5** Provision for taking part in fitness trainin **C6** The effects of long-term fitness training
Learning outcome D: Investigate fitness programming to improve fitness and sports performance	**D1** Personal information to aid training fitne **D2** Fitness programme design **D3** Motivational techniques for fitness prog

Throughout the resource, there are key features to keep an eye out for:

Keywords: used to draw students' attention to various keywords throughout the component.

Did you know?
Provides further information and additional content to inspire and engage students.

Applied activities encourage application of knowledge to the case studies or to real-world scenarios in the sport sector.

Research activities and stretch and cha

Some of the activities can be completed using either computers, mobile phones or tablet can be completed outside the classroom as homework.

There are also two sets of **questions** – *checking y in ding* and *taking it further* – (with answers included). These should h ld recap their knowledge and then appl respectively, throughout the co imp n.

Where norm ata s , we have created data sets that are reasonable estimations of exis realistic and sed to gauge how fitness test results are rated in comparison for age- and g ***coursework e , students should compare to real normative data obtained from reliable***

Endorsement edition, update v1.1, January 2024:

- Updated aerobic training zone to 60-80% and anaerobic training zone to 80-100% on p. 15 and corrected
- Removed 'Isometric' as a keyword on p. 19.
- Fixed broken link on p. 21 and provided a more appropriate link on p. 47.
- Removed high level research activity on p. 50.

Learning Outcome A: Explore the impo for sports performance

Overview

In this section you will learn about the types of sports – and the playing positions within these sports – that require the different components of physical and skill-related fitness.

You will develop an understanding around the principles of training and their application in training programmes to improve the different components of fitness.

By covering the principles of tra... also learn abou... ise... the different tech... used to measure it, and the ways i... be used to elicit certain fitness improvements.

Learning outcomes

After studying this chapter you should be able to:

A1: Understand sports requiring components of fitn... used in different positions in team sports.

- ❑ Identify the types of sports requiring different ...
- ❑ Explain how different positions in the same t... components of fitn...s
- ❑ Assess th... tan...e of components of fitne...

A2: ...erstand the different principles of training an...

- ❑ Identify the different FITT principles and addi...
- ❑ Explain how the different principles can be ap...
- ❑ Analyse how the principles might be applied ...

A3: Understand the principle of exercise intensity a...

- ❑ Identify the different methods and calculatio...
- ❑ Explain how intensity is used to establish targ...
- ❑ Analyse the use of exercise intensity in trainin...

Key terms

Adaptation	the changes that occur to the body as a result of working ... training loads
Aerobic training zone	the 60–80% of maximum heart rate that a performer wor... body's ability to use oxygen during activity)
Anaerobic training zone	the 80–90% of maximum heart rate that a performer wor... body's ability to work at a high intensity and resist fatigu...
Fitness	the ability to meet the demands of the environment
Frequency	how often training is performed
Individual differences	the unique needs and circumstances of each performer w... and activities they perform
Intensity	how hard training is performed
Progressive overload	the gradual increase in the demands of training in order ... adapt over time
RPE (acronym)	rating of perceived exertion; a scale developed by Borg t... 6 (no exertion) to 20 (maximal exertion)
Repetition maximum	the maximum load that can be ...e... in a given number o...
Rest and recovery	the time period b... w...en t...ing sessions which is used ... and ada...
Reversibility	...os... ...itness gains if training stops for an extended ... ...elines over time
Specificity	the relevance of training methods and activities to the fit... the sport
Steady-state exercise	occurs when the oxygen demand of the muscles is met b... cardiorespiratory system
Time	the duration of a training session
Training thresholds	target heart rate zones that the performer stays within fo...
Type	the training methods that a performer chooses to use in ... component of fitness
Variation	altering the types of training performed, in order to prev... motivation to train

Chapter A1:
The importance of fitnes
for successful participation in

There are many different interpretations of successful participation in sport. Some performers may deem success to be personal achievements, such as winning the majority of tackles in football or achieving a personal best time in swimming, whereas others may associate suc Regardless of the different interpretations, in order to experience a participation, the performer must have [illegible] els of fitness.

Fitness demand

There are many different components of fitness that fall under two broad categori skill-related components. Let's start off by reminding ourselves from Component related component meanings before delving into the types of sports that require spe

Physical components

Aerobic endurance is the ability of the heart and lungs to deliver oxygen to the body can continue to exercise for a prolonged period of time without tiring.

Muscular endurance is the ability of a muscle to repeatedly contract at a light t

Muscular strength is the ability of the muscle to apply a maximum force to overc

Speed is the ability to move the whole body or a specific body part as quickly a

Flexibility is the range of movement available at a join to allow a proper techni

Body composition is the relative percentage of fat mass to fat-free (water, mus

Skill-related components

Power is the product of strength and speed.

Agility is the ability to change direction quickly without losing control.

Reaction time is the time taken to initiate a response to a stimulus.

Balance is the ability to maintain centre of mass over the body's base of suppor

Coordination is the ability to use two or more body parts, both smoothly and wi

Types of sports requiring specific components of fi

Most sports will require a combination of different physical and skill-related comp combinations vary between sports.

Aerobic endurance

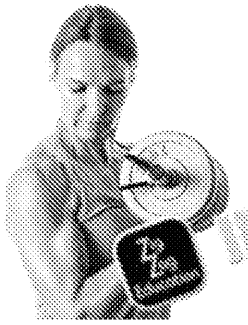
As implied in the name, aerobic endurance is [illegible] endurance events which rely on having a well-developed c[illegible] system to supply the working muscles with oxygen-rich b[illegible] during low-to-medium-intensity exercise. It is important in sports [illegible] lasting more than 30 minutes to ensure that performanc[illegible] kept at a high level and the performer does not fatigue.

Applied:
Similar to the sports that require aerobic endurance, individual sports such as roc muscular endurance to continually contract the muscles at a light to moderate inte distance of the event without fatiguing or experiencing cramp. For example in cy body need to resist fatigue under constant pedalling tension.

Team sports such as cricket and rugby also require muscular endurance, where th over and over, e.g. the muscle groups of the upper body when bowling or tackli Muscular endurance can help maintain posture and stability, improving the capa techniques optimally throughout the whole event.

Muscular endurance

As muscular endurance requires the muscle to contract for an extended period of time, it is important for events where a muscle group is repeatedly contracted at a light to moderate intensity for a duration greater than 30 minutes. As such, it is often required alongside aerobic endurance, as the cardiorespiratory system provides the oxygen and nutrients required for the musculoskeletal system to maintain movement. Without the ability of the muscles to contract repeatedly they would eventually tire and fatigue. Muscular endurance allows athletes to compete at a higher capacity and for longe



Muscular strength

Strength is an important physical component of fitness re
Force is applied to overcome a resistance, which may be i
weight), another person (opposition) or an object. Greater
to be exerted to overcome the resistance, leading to it be
more efficient performance.

Muscular strength may also be linked to power (covered l
exert force with speed.

Applied:
Individual sports such as weightlifting require strength to overcome the weight. Th
greater the weight they can lift. Often weightlifting competitions require the athl
a maximum weight.

Throwing events such as the javelin and shot-put require strength, along with spee
and explosive movements. The greater the strength of the athlete, the more force
meaning they can throw it further.

Team sports such as rugby also require strength for key components of the game
the opposition, such as when scrummaging, rucking or mauling.

Case study

World's Strongest Man is an international competition that is held annually to ass
strength across various challenges to overcome resistances, such as the Atlas Ston
competitors lift five heavy round stones that increase in weight up onto a platfor

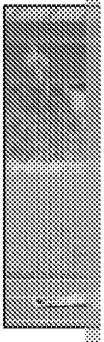
Applied activity
Outline a training session that uses free weights and fixed resistance machines for muscular strength.

How would you adapt this to train muscular endu an s?

Research activity
Research the curre
Other than the on
sports would they

Speed

Speed is required to outrun an opponent over short distances that take a matter of seconds. It is also important at the end of middle- or long-distance events such as the 1500 m where many athletes give their all in a sprint finish.

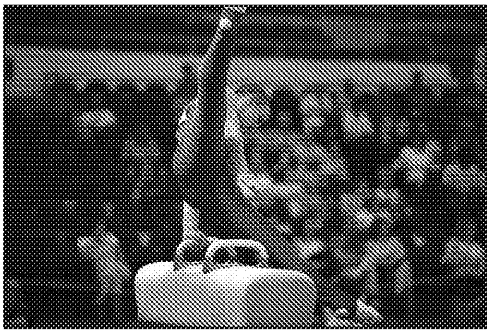


Speed can also refer to the movement of different body parts, such as the arms when throwing punches in boxing or the legs of a swimmer doing front crawl. When this speed of movement is combined with strength, it results in powerful movements.

Applied:
Speed is the main indicator of s... performance in sprint events where perf... quickly they are able t... set distance. This not only applies to sprint e... also key t... cycling, 50 m swim events and 400 m rowing. Althoug... time and ...ation are also important, they only set a good base, and athlete... speed thr... the remainder of the race to have any chance of achieving suc...

Speed is also important in many situations that arise in team sports. A single matc... line in rugby could be the difference between winning and losing a game. A play... be able to outrun opponents and score a try, or catch up with an opponent and m...

As mentioned, speed is important when moving different body parts quickly. In th... of movement will allow an athlete to dodge their opponent's punches, as well as ... before their opponent gets a chance to offer their own reply.



Flexibility

Having good flexibility is important fo... injury prevention, so is key to a range ...

For performance, flexibility allows perf... motion with different movements. Thi... with technique and improves the aesth...

A greater flexibility of joints means tha... motion that they are able to move thr... reducing the risk of injury in sports as muscles are less likely to overstretch. Flexib... when performing sports skills, further contributing to the reduced risk of injury.

Applied:
Individual sports such as gymnastics re... ...xibility for a range of movements. In gymnastics, for e... ...split jump requires good hip flexibility in order for h... ...be parallel to the ground.

Other in... sp...ts such as martial arts also require good flexibility of joints t... ...rm different actions, such as the crescent kick, which uses the ball-and-socket joint at the hip to produce a conical motion of the leg. This will allow the performer to kick to the opponent's head and score valuable points.

A good example of the importance of flexibility in team sports is cricket bowling, where players require overarm rotation for their deliveries. Good flexibility will produce a more efficient bowling action that has the desired impact, whether that be spin or speed.

Body composition

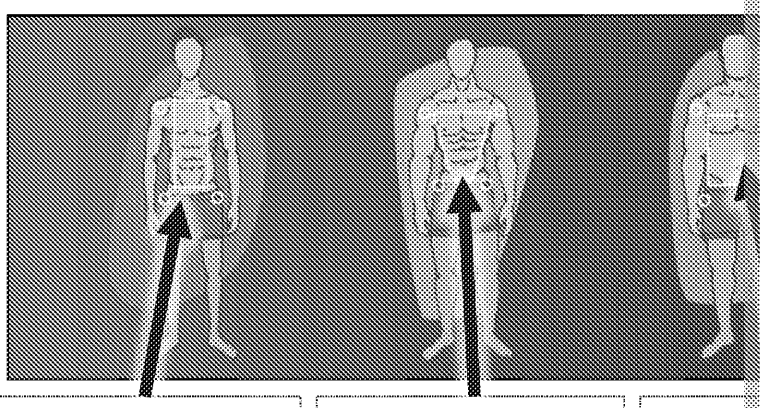
Different body compositions are relevant to different sporting activities and performers. For example, some sports require a performer to have a large muscle mass to maximise contractile mass for power during the event. Other sports may require a low body fat in order to maximise the performer's flexibility and reduce any 'dead weight' that would limit them in movements or require more effort to move. On the other hand, some sports may benefit from having a large fat and muscle mass to increase the weight the performer is able to impose on their opponent.

Applied:

- **Low fat mass**: jumpers and d… fat mass to en… body weight o… little effort.
- **High muscle m…** and other pow… muscle mass fo… benefits, but p… remain lean, t…
- **High muscle m…** sportspersons … players (forwa… greater mass (… be from fat to… greater resista… provides more…

Did you know?

A person's body compo…t… …have as much to do with …tic… …es with lifestyle factors su… …et and physical activity levels.



Low fat mass for efficiency and ability to overcome body weight easily	**High muscle mass** for increased strength and power	**High muscle** resi…

Power

Power is the combination of strength and speed, so is important in activities where both of these components are needed to perform explosive movements, such as jumping, kicking or throwing actions.

Powerful movements use a lot of energy, so performers o… …eed a short period of time to recover before they can p… …another movement with the same explosiveness. Th… …with a lot of sporting events where power is th… …mponent needed for success, a performer us… …multiple attempts which are each separated b… …t, … athletics events such as high jump and javelin.

Applied:

Individual sports that require power include events such as the shot-put. The shot … in the men's event and 4 kg (8.8 lb) in the women's event, which shows the level o… distance. The combination of strength and speed in the throw allows for an explo… distance achieved in the throw.

Other sporting actions where power is key include kicking and jumping. These are… team sports, such as reaching the posts in a rugby conversion or jumping for a sla…

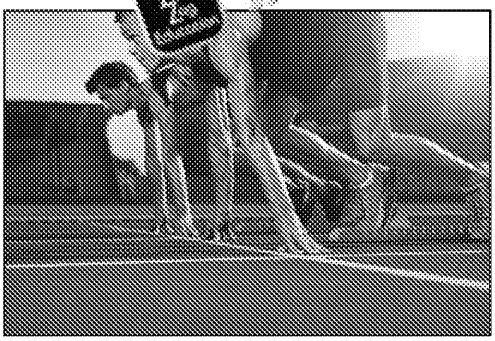
Agility

A performer requires agility in order to change direction quickly, so it is important evade an opponent (e.g. in most team sports) or respond to the movements of an

Agility involves elements of speed, balance and coordination to change direction control. To do this, the performer must rely on fast feet and keep their centre of g all while keeping their head up for spatial awareness of other participants.

Applied:
Individual sports such as tennis require agility for a player to move quickly from other in order to return the shots played by their opponent. Agility helps a playe quickly, allowing them to create a stronger base from which to hit the ball.

Agility is an essential component in team sports such as football, basketball and required to evade their opponents and keep possession for their team. For exam to sidestep opponents and make an offensive line break to gain field position for



Reaction time

Having a good reaction time is impor externally paced, meaning that respon external to the performer. The act of (known as a stimulus) initiates the resp quicker they are able to respond, the the greater chance of success they wil

This stimulus may be the actions of an from an official (e.g. the starting gun i

Applied:
Reaction time plays a major part in the success of short duration, timed events su the performer must explode out of the blocks to the sound of the starting gun.

It is also important in team sports such as football where a goalkeeper may nee outfield player must respond to a loose ball and gain possession for their team.

Balance

Balance is important in dynamic activities that require the control of the distribution of weight or in static activities where the performer must remain upright and steady.

This is achieved by keeping the centre of mass within the base of support (i.e. the contact points of the body to the ground). The performer will often put their hands out to the side to help adjust their balance so that they remain in control of their position.

Applied:
Balance is used in individual sports such as gymnastics, where performers are deducted points for stepping out of a stance when they dismount from a jump.

Balance is also a key component in team sports such as netball, as performers are required to reach and catch a ball and then remain in their landing position within their designed area.

Did

The ta
you ar
maint
becau
lower
contrib

Coordination

Coordination requires the efficient use of two or more body parts at the same tim
eye coordination with the use of equipment, e.g. a racquet in tennis or a baton in

Many sporting movements involve the actions of multiple limbs at the same time,
coordination. This allows movements to be smooth and aesthetically pleasing, whi
movements. An example of this is the movement of the arms and the legs during

Applied:
Individual sports such as tennis, where during the serve the performer must throw
one hand while preparing for the shot by drawing back the racquet with the othe
bring the racquet towards the ball to hit it at its highest point. All of these subrou
hand–eye coordination.

Team sports such as basketball, where pe... required to track and mar
same time as keeping their eye on ... with the ball.

How co... of fitness are used when playing in team... rts

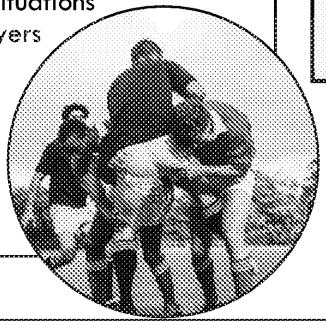
Different team sports often have different positions that will require different fitne
attackers and defenders will require different fitness components to complete the
role. Defenders are more likely to make more tackles and may, therefore, require
needed to get up the field quickly, e.g. in a counterattack, so may have a greater r

Take a look at how backs and forwards differ in rugby...

Case study

Rugby is a sport where the different positional requirements of players across the pitch mean that the specific components of fitness needed to be successful vary from player to player. Both codes, league and union, are made up of forwards and backs. The forwards are typically the larger, more powerful players who are used predominantly in the contact area, such as the scrum, in rucks and mauls, for clearing out opponents, and to break through the defensive line of the opposition. The backs are typically the slimmer, more agile players who cover the most ground and use speed and agility to beat or chase opponents.

Because of these different roles, the components of fitness important for success are different between forwards and backs. Forwards rely more on strength and power, whereas backs rely more on speed and agility. Forwards also typically have a composition consisting of a high ... muscle mass for a large body mass, ... backs typically have a high musc... as ... levels of body fat so that they are ... move around the pitch more easily. Nevertheless, there are crossovers in the components of fitness required as there are situations that come about where some players must cover or fulfil the roles of others. Also, all rugby players require aerobic endurance to last for large stints of the match and coordination to take control of the ball.



Applied activity

1. Copy and com... Discuss with a ... fitness compon... 10 is needed ... compare to y...

Fitness component
Aerobic endurance
Muscular endurance
Muscular strength
Speed
Flexibility
Power
Agility
Reaction time
Balance
Coordination

2. Discuss anothe... fitness require... on the differe... performers in ...

Chapter A1: Revision Questi

Checking understanding questions

1. Name the component of fitness that is needed in activities where a quick de response to a stimulus is needed.

2. State the **two** components of fitness that are needed in sports or events las than 30 minutes.

3. Which two components of fitness combine to form power?

4. Explain the body composition needed by a sp[illegible] optimal performance

5. Identify **one** sport that requ[illegible] levels of each of the fitness componen
   a) Power
   b) Mu[illegible]
   c) Fi[illegible]
   d) Co[illegible]nation

Taking it further questions

1. Give **one** example of where agility is required in sport.

2. State **two** components of fitness that are important for success in gymnasti examples of how they are important.

3. Assess the importance of high levels of aerobic endurance and speed in foot

4. Assess the importance of high levels of power and coordination when servi

Chapter A2:
Fitness training principle

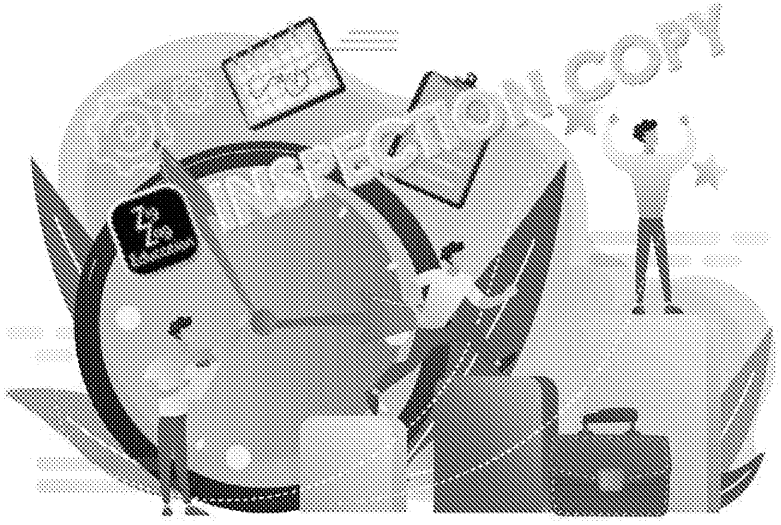
When designing a fitness training programme, it is important that each training se
training that help to improve the effectiveness of training, giving the performer th
fitness and achieving their goals. The principles of training are split into basic FITT
session, and additional principles which can help with the effectiveness of training

Basic principles of training (FITT)

The acronym FITT stands for frequency, intensity, time and typ . It is important to
principle means and how it can be applied to training an nes.

FITT principle		
Frequenc	***'How often'*** The number of training sessions completed over a period of time, usually measured per week.	Scheduling two the first three w increasing it to t remaining three
Intensity	***'How hard'*** The level of effort that a person puts into training.	Exercising at a g heart rate to ach 80–90% for ana
Time	***'How long'*** The duration of a training session.	Performing four 15 minutes on e hour-long traini
Type	***'Which method'*** The training method that a performer chooses to use in order to improve a specific component of fitness.	Programming co training sessions endurance.

Applied activity
Describe anothe
basic FITT princi



Additional principles of training

There are several additional principles of training which can help support the basi effectiveness of training. These principles should be applied throughout the desig ensure the performer is getting the most out of their training.

Progressive overload

'The gradual increase in the demands of training in order to stress the body, causi

Progressive overload can be applied by increasing the frequency, intensity or time this is gradual in order to avoid any sharp increases in training demands which inc

For example, a road cyclist who usually goes for one 2-hour bike ride per week at an average of 60% HR max, might:

- Increase the number of bike rides to two a week, but programme a shorter ride alongside the 90-minute ride (frequency)
- Increase the intensity of the bike ride to an average of around 65% HR max (intensity)
- Increase the duration of the 90-minute ride by around 10 minutes (time)

These changes can then be gradually increased with each training week in order t

Did you know?

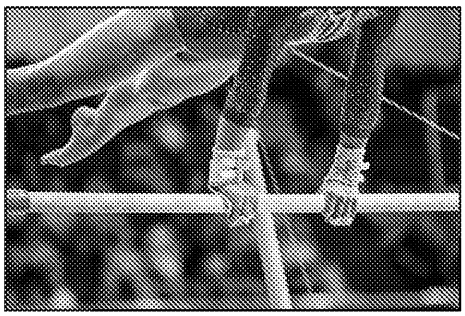
It is suggested that you should keep progressive overload – increases in intensity, duration and/or frequency – to less than 10% each week.

Applied activity

Note down how often, how train per week and then ou progressive overload to yo

Specificity

'The relevance of training methods and activities to the fitness and/or skill needs o



It is important that the training program fitness that are required in the sport that There are certain methods of training tha specific components of fitness, so it is im programme is designed around these m

For example, increasing balance, flexibili important for gymnastics, and therefore training methods designed to improve th

When making training specific to the sport you should consider...

- the movement patterns and skills required for the sport
- the muscles used to perform the movement patterns and skills
- the energy systems used – aerobic or anaerobic
- the duration of the activity (e.g. a 90-minute football match)

... and how training can be designed to replicate these conditions to ensure trainin

Case study

The specificity of training can be seen in rugby through behind-the-scenes footag training camps for competitions like the Six Nations. Stations are set up to replica rugby, such as the use of tackle bags, static scrums, one-on-one wrestling and shut the components of fitness needed for rugby, such as strength and aerobic endura

Individual differences

'The unique needs and circumstances of each performer which influence the types ... they perform.'

Each individual is different in their needs, likes and dislikes, and how they respond to training. Therefore, it is important that each training programme is individualised to meet the specific performer's needs. This may include:

- Fitness levels, e.g. someone who has limited previous experience of sports participation might need to start off at a lower level.
- Medical history, e.g. someone with joint issues may require low-impact activities in their training programme.
- Sporting goals, e.g. some performers may need to focus more on the weaker aspects of their performance.

Giving a generic programme to each individual looking to improve muscular stren... effective for everyone. For example, someone may have had a previous injury whi... performing a particular exercise. Therefore, an alternative exercise will need to be ...

Case study

A strength and conditioning (S&C) coach is responsible for maximising ... of sports performers. In rugby, one role of the S&C coach will be to design gym ... players to perform as part of their training. In preparation for each Six Nations ... weeks' worth of training with the national squad before the first round of fixture... weeks in camp preparing for each game. S&C coaches will spend the time leadi... monitoring players for their clubs and designing a training programme for them ... training camp. There will be an open dialogue between the clubs and the nation... training status of each player and any individual needs that need adding to the ... programme will be different, focusing on the needs of the player as well as the ... within the team.

Adaptation

'The changes that occur to the body as a result of working under increased trainin...

Applying the principle of progressive overload places a greater stress on the body ... The subsequent rest period is where the body recovers and, in turn, adapts. These ... translate to improvements in fitness. Adaptations will vary depending on the type ...

For example, the adaptations to the muscular system from muscular endurance tra... adaptations from muscular strength training. Muscular strength training will resul... (hypertrophy) and greater strength of connective tissues, whereas muscular endur... greater capillary density (capillarisation) around the muscle tissues and increased ...

Applied activity

Discuss the possible long-term adaptations of the body that might occur to see from the following training methods:

1. High-intensity interval training for speed
2. Static stretching for flexibility

*The effects of long-te... more detail in **Chapt...***

Reversibility

'The loss of fitness gains if training stops for an extended period or the intensity of

Training may stop or decline in intensity for many reasons:

- The performer might be injured.
- The performer might not be able to train as much as usual due to other life commitments.
- The season may have finished.

The decreasing demand on the body means that instead of adapting, it regresses. Any fitness gains made from training are lost.

Research activity

To gain further insight into the physiology behind reversibility of fitness, conduct some independent research to see whether you can answer the following questions:

1. How long do you need to be inactive before you start to lose aerobic fitness or strength?
2. Will muscle memory help to regain lost fitness faster when you return?

Variation

'Altering the types of training performed, in order to prevent boredom and maintain

There are often several different methods of training that can be used to improve a single fitness component. Moreover, there are numerous other ways that training can be varied to keep it entertaining and maintain motivation.

For example, performing the same resistance training exercise with each training session will almost certainly result in the performer getting bored and losing motivation. Instead, the performer should create a plan where they look to vary the exercises they do, in order to avoid the repetitive nature of training.

Applied activity

Resistance training is one of the best training methods for adding variety, as there For example, there is a diverse range of equipment that can be used for a range

Identify **three other** ways to add variety to a resistance training session besides equipment and exercises.

Rest and recovery

'The time period between training sessions which is used by the body to recover an

The performer should always allow time to rest and recover between training sessions. This is the optimal time the body needs to adapt from training. As fitness improves, the performer will be able to recover more quickly from training. However, the performer should always listen to their own body, and if they feel fatigued, tender or have a slight niggle with a muscle, they should allow sufficient time off to ensure they are fully recovered.

Did yo

Sleep is a
recovery.
of sleep, i

- **Light**
  and
- **Deep**
  reste
- **Rapi**
  the b

Recovery is also an important principle during training sessions. Nearly all training methods will require recovery periods between bouts of activity to allow the body to prepare itself for the next. It is important that the duration of this bout is appropriate to maintain quality of training, at the same time as challenging the body to sustain th the duration of a session. For example, rest periods between sets of resistance ex allow the muscle to recover, but short enough that muscles stay warm.

Chapter A3:
Exercise intensity and how it can be

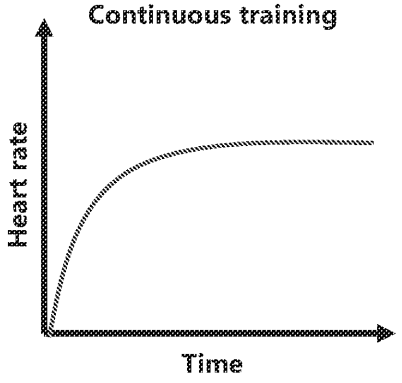
The basic FITT principle of intensity can be measured in numerous ways. How 'ha matter of the performer saying that their effort level for a particular session was 9 performer could measure the intensity of a session is by recording their heart rate rate the higher the intensity. Heart rate provides a more objective assessment of individual's perceived exertion (i.e. the effort an individual thinks they are putting interpretation. Let's take a look at both.

Heart rate

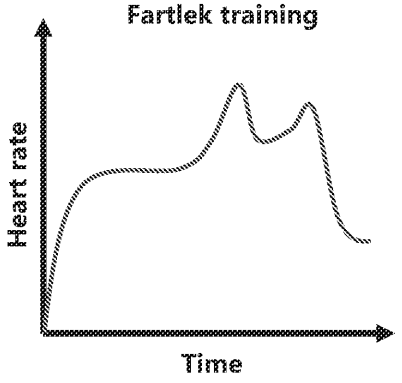
Heart rate (HR) is the number of times the heart beats per minute and it reflects h individual's cardiorespiratory system working to deliver oxygen to the working m

Heart rate can simply be measured manually by counting the pulse of either the c artery in the neck or the radial artery in the wrist. It can also be measured automa using technology such as a heart rate monitor, which we will touch on later.

Heart rate is commonly measured during training methods such as continuous tra interval training and fartlek training. The graphs below show example heart rate t during each training method.



Heart rate increases as the performer reaches steady-state and plateaus for the remainder of the session.



Heart rate peaks and troughs throughout the session as the performer changes speed and/or terrain and thus intensity.

Heart rate is used in these training sessions to calculate training thresholds. These rate training zones which the performer stays within for specific fitness benefits.

Did you know?

Heart rate can be used to monitor fitness improvements. A decrease in resting heart rate over time is often a marker of improved fitness, as is a lower exercising heart rate for a given exercise intensity (e.g. speed).

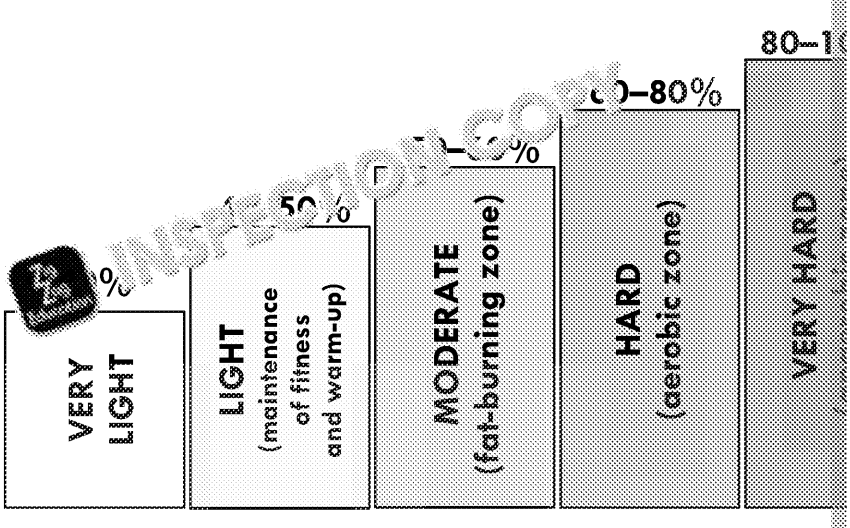
Steady-state the oxygen by oxygen cardiorespi

Target zones and training thresholds

Target heart rate training zones are calculated using an individual's estimated max
HR max can be calculated through the following equation:

HR max = 220 – age (in years)
e.g. an individual aged 40 would have an HR max of 220 – 4

The two main training zones used in fitness training are the aerobic training zone

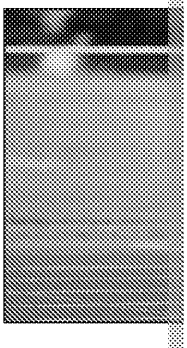


Aerobic training zone *(60–80% HR max)*

The performer should aim to stay within this training zone if they want to improve their aerobic performance. This is exercise where oxygen delivery to the working muscle is able to meet the muscle's demands for oxygen. Most continuous and fartlek training s will be completed in this targ zone.

Using ... above, the individual aged 40 s... for a target heart rate zone of 180 × 0.6 to 180 × 0.80 = ***108–144 bpm***

Anaerobic train



This zone is u performance muscle's demand of the body t duration for exe Most interva completed in

Using the exam 40 should aim 180 × 0.80 to

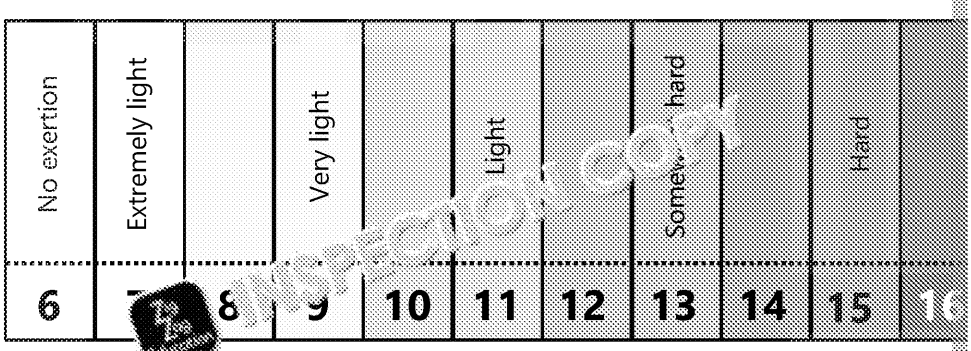
Applied activity
Calculate your own maximum heart rate and target heart rate zones using the e

Borg's rating of perceived exertion (RPE)

RPE is displayed on a scale of 6–20, ranging from exercise where there is no physi
out maximal exertion (rated 20). The scale is designed to correspond to heart rat
expect to be at if they gave a certain rating, where heart rate is RPE multiplied by

HR = RPE × 10

*e.g. a performer who gives an **RPE of 15** should be roughly working at*



There are some limitations of using RPE to measure exercise intensity. As performers are assessing themselves they could slack and be dishonest, suggesting they are working at a higher rating than they are. Performers also need to know what the ratings mean as this is subjective. One performer's 'somewhat hard' might be another performer's 'hard'.

Did y

The Borg sc
psychologist
It was first r
monitoring e

Repetition maximum (RM)

RM is the term used to describe maximum load that can be lifted with a given nu
maximum load that can be lifted in a single repetition) gives a measure of someo
15RM (the maximum load that can be lifted in 15 repetitions) gives a measure of s

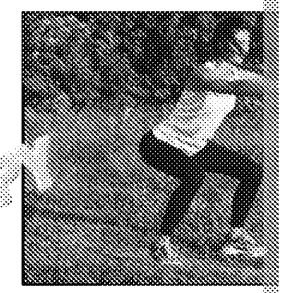
A person's 1RM is measured to prescribe training for both these components of fi
increasing the weight with a given exercise until the maximum weight that can be
reached, and then using this value to prescribe the load and number of reps acco

Muscular strength training

Aim to perform **4–8 reps** at a load **above 70% 1RM**.

*e.g. an individual with a 1RM of 120 kg should aim to perform 4–8 reps at a load 120 × 0.7 = **> 84 kg***

Muscular enduran



Aim to perform **12-** load **below 70**

e.g. an individual w 50 kg should aim to reps at a load 50 ×

Research activity

Research the different ways that 1RM can be calculated besides the traditional m
with a specific exercise.

Technology to measure exercise intensity

As mentioned previously, heart rate can be calculated by palpating the pulse at the wrist (radial artery), but for continuous monitoring during exercise, technology is to to take a quick check of their heart rate without having to stop exercising. It often

There are a number of different devices that can be used to monitor heart rate and during exercise.

- A **heart rate monitor** is attached to a strap and worn around the chest. It uses electrical activity of the heart, which feeds this information to a connected watch below). As they use electrical signals, heart rate monitors are deemed the most
- Some items of gym equipment, such as treadmills and exercise bikes, have be pick up heart rate information from the chest-based monitor and display this. pick up heart rate through the skin when the handles are held, using a similar monitor.
- **Smartwatches** often have built-in heart rate monitors that use LEDs to detect blood flow through the radial artery in the wrist. Many report other useful measures of exercise intensity, such as running pace, to further help regulate exercise. They can give very accurate readings but may also report inaccuracies due to sweat, or if they move around due to being too loose.
- **Apps** can be downloaded onto mobile phones and used alongside smartwatches and heart rate monitors to store fitness data for greater analysis. Many compatible apps exist for heart rate monitor and smartwatch manufacturers such as Polar and Garmin. These allow the performer to review training sessions and identify where exercise intensity might have increased or decreased without knowing!
- There are also apps that pick up pulse rate directly using the phone. These use a method similar to smartwatches where the finger is placed over the torch on the phone and the light is used to detect blood flow through the finger.

Applied activity:
Try out each of the devices listed above to measure your own heart rate. You should use each at the same so that it is recording the same heart rate. Monitor your rate for a sample period (e.g. one minute) and then re values in the table below. You could attempt it at rest during exercise to see if any differences are exacerb

Device	Rest (bpm)	Exercise
Heart rate monitor		
Smartwatch		
App on phone (e.g. Instant Heart Rate)		

Chapters A2 and A3: Revision Q

Checking understanding questions

1. Name the FITT principle of training described as 'the number of training ses completed over a period of time, usually per week'.

2. Describe how someone's aerobic training zone is calculated.

3. Name **two** items of technology that can be used to measure exercise intens

4. State the heart rate value you expect someone to be exercising at if they give

5. What percentage of one-rep max (1RM) should be used for training muscul

Taking it further questions

1. Give **t** mples of how the principle of progressive overload can be app improve strength of a rugby player.

2. Explain **one** reason why it is important to apply the principle of rest in a training programme.

3. Calculate the anaerobic training zone for a 400 m sprinter who is 36 years o Show your working.

4. For each of the following additional principles of training, give **one** example can be applied to the training programme of a hockey player:
   - Specificity
   - Individual differences
   - Variation

Learning Outcome B: Investigate fitn determine fitness levels

Overview

In this section you will understand the reasons why performers, trainers and coaches in sport use fitness testing.

You will also gain knowledge of the different aspects required to set up and administer the protocols of a range of fitness tests for the different components of fitness, as well as how to interpret results and compare these to normative data.

You will learn what is meant by the reliability, validity and practicality of fitness tests and how each of these can be determined.

Learning outcomes

After studying this chapter you should be able to:

B1: Understand the importance of fitness testing and require of each fitness test.

- ❑ Identify the reasons for fitness testing and evaluate wh valid and practical fitness test
- ❑ Describe the pre-test pro es that must take place
- ❑ Describe stand est thods and how to accurately be abl ore the results to interpret them against
- ❑ Eva e appropriateness of certain fitness tests for diff and/or participants

B2/B3: Understand the different fitness tests used for each co fitness and the practicality and validity of each.

- ❑ Identify the different fitness test for each component o standard test methods for each
- ❑ Explain why some tests are more reliable, valid and/or

B4: Understand how normative data tables are used to interp recommendations to improve performance.

- ❑ Analyse the results of fitness tests using normative pul based on these results

Key terms

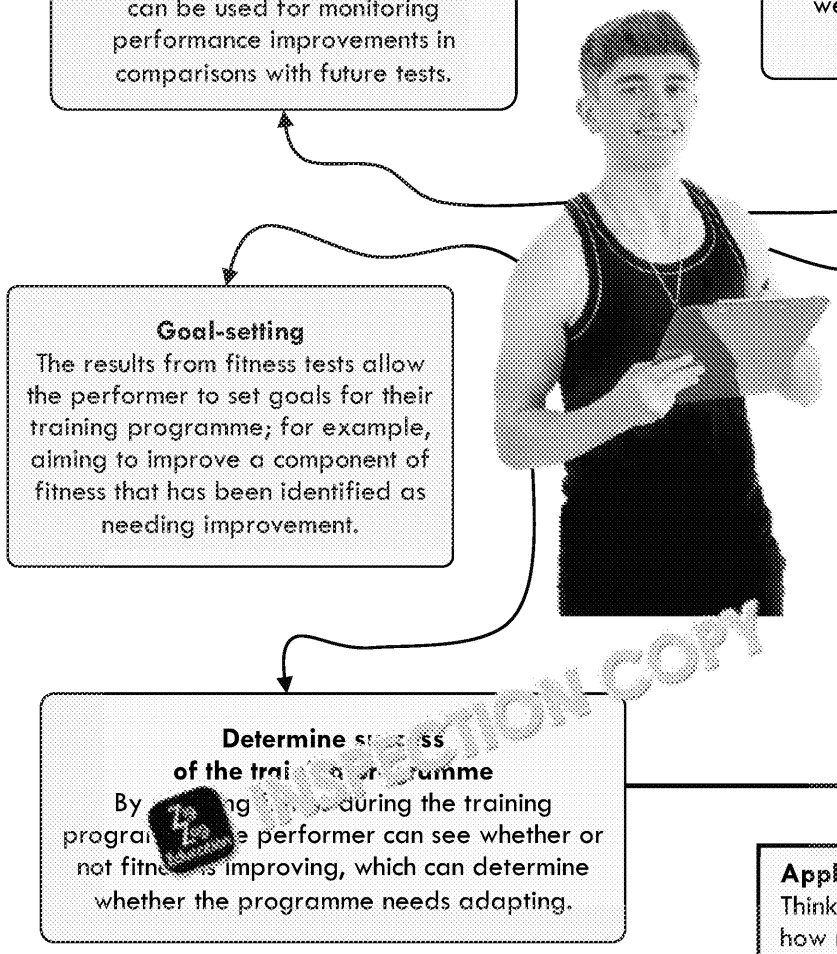
Calibration	the process by which measuring instruments are check to ensure they produce accurate results
Informed consent	a written agreement between the test participant and outlines what the participant can expect from the test
Normative data	a data set which is categorised by age and gender and fitness test norms for that population
PAR-Q	a series of questions designed to identify any previous injuries that may impact an individual's participation in
Practicality	the measure of how feasible a fitness test is
Reliability	the measure of the consistency st results due to th under the exact same c ti
Spotter	a person for support if the performer is u allowing the performer to work to maximum
Validity	e measure of whether the results of a test actually re being measured

Chapter B1:
Importance of fitness testing
requirements for administration of ea

In order to get an idea of an individual's fitness levels, fitness tests are used. Ther
each component of fitness, and for each component there are often multiple tests
that component. These tests differ in their reliability, validity and practicality, as w
purposes, situations and participants. Before we get into what each of these term
understand the reasons why fitness testing is carried out in the first place, and the
set up and administer the protocol of each test.

Reasons for fitness testin

Each individual will have differe reasons for testing their fitness. Some individuals
for why they would wan t test their fitness. Some of the main reasons for fitness t



Baseline data
Testing components of fitness at the beginning of a training programme provides us with baseline data which can be used for monitoring performance improvements in comparisons with future tests.

Design of
The results from
inform the desig
Fitness tests he
weaknesses, w
addresse

Goal-setting
The results from fitness tests allow the performer to set goals for their training programme; for example, aiming to improve a component of fitness that has been identified as needing improvement.

Result
the ma
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Seeing
worki
needed

Determine s ss
of the trai r ramme
By ng during the training
progra e performer can see whether or
not fitne s improving, which can determine
whether the programme needs adapting.

Applied activity
Thinking back to
how might a trai
if the performer
achieving their g

Pre-test procedures

There are a number of different administration requirements of fitness testing that e
participant must carry out before starting the fitness test protocol. Some key pre-te

Calibration of test equipment

Some equipment used in fitness tests may need calibrating before it is used to collect data. This involves checking the settings on equipment to ensure the results they are giving are accurate. For example, the dynamometer used in the grip dynamometer test for muscular strength should be calibrated by applying weights of known masses to the handgrip one at a time. Any differences between the reading on the screen and the mass of the weights should be adjusted in the set

Cali
whic
chec
they

Informed consent forms

It is extremely important for a [illegible] conductor to obtain signed informed consent f
part in fitness tests. T[illegible] written agreement between the test participant and t
the particip[illegible]t t[illegible]r participation is entirely voluntary and that they are free t
time. An ini[illegible] consent form also provides the participant with detailed inform
test will entail so that they are fully aware of what they are consenting to. Exampl
consent form may contain is shown below.

Informed Consent Form
Fitness test: 12-minute Cooper run **Test explanation:** Before agreeing to participate in this test, you should have read the expect from the test, which covers the procedures and the benefits and risks you mig **Confidentiality:** The data obtained from this test and your personal information will r **Questions:** Any questions you may have before agreeing to take part, please forward before giving your signed informed consent. **Agreement:** If you have fully understood the explanation of the test and are happy to the agreement below. 1. I fully understand what to expect from the test and have had the opportunity to a 2. I understand that I am free to withdraw from the test at any given time. 3. I agree to take part in the test. **Name (printed):** _____ **Signature:** _____

Physical Activity Readiness Questionnaire (PAR-Q)

A PAR-Q consists of a series of questions designed to identify any previous or existing health conditions or injuries that may impact an individual's participation in physical activity. Any information that may affect the individual's participation in the fitness test should be raised before continuing. In some instances, the participant may need approval from a doctor before they can take part in the test. The PAR-Q can also determine whether a participant's **physical activity or exercise participation** is at a requisite level for them to safely carry out the fitness test.

Complete[illegible]an [illegible]AR-Q here: **zzed.uk/12122-PARQ**

Research activity
Research information that may be contained in a PAR-Q and create your own!

Did

Any pers
from fitn
General
(GDPR) g

Pre-fitness test check

Immediately before starting a fitness test, the performer will undergo a pre-fitness
safe to go ahead with the fitness test. This will often be a series of questions that
conductor or issued as a questionnaire that may address information such as whe
taking any medication, has suffered from any illnesses in the past week, has picke
reasons why they should not take part in the fitness test. It is then at the discretio
whether it is safe for the test to go ahead.

Further requirements for administering fitness tests

All of the above indicate checks and consent that must be obtained from the parti
tests. However, it is important that the test conductor is knowledgeable about the
how to accurately measure and record results and how to use/interpret these aga
tables to assess the participant's fitness levels.

Additional information involved in the administration of fitness tests includes:

- ✓ Knowledge of the [illegible] standard test methods and use of equipment
- ✓ Knowl[illegible]f s[illegible] appropriate tests for participants and their situations
- ✓ Accura[illegible]surement and recording of results
- ✓ Basic processing of test results and interpretation using published data table

Reliability of tests

A reliable test is one that can be repeated in the exact same conditions and bring about the same results. There are a number of different factors that can affect the reliability of a test:

Reliability is the m
of test results due t
repeated under th

- **Calibration of equipment** – if equipment is not calibrated before use then it
  It is important that equipment is checked and in proper working order before carrying out a fitness test.
- **Motivation of the participant** – if a fitness test requires large motivation levels from the participant, the results are more likely to be inconsistent. This is because performers are not always going to have the same motivation levels when performing a test. For example, the participant may be more motivated if performing the test at a different time in the day or if they have a previous result they need to beat.
- **Conditions of the testing environment** – the conditions for fitness testing s
  ensure reliable results. A fitness test conducted outdoors is more likely to be
  than a fitness test conducted indoors. For example:
  - Wind speed can impact tests for speed.
  - Wet conditions can impact tests for agility.
  - Temperature can increase the intensity of fitn[illegible]s[illegible] for aerobic endur
- Furthermore, the temperature and conditi[illegible]ns wit[illegible]the environment can als
  for example, completing a multist[illegible]n[illegible]s test may be a lot more challeng
  the sports hall.
- **Experience of the test conductor** – an experienced test conductor will ha[illegible]ec[illegible]the test several times before and, therefore, will have a [illegible]orking knowledge of the standard test methods. This helps to make results more reliable and ensure that the correct procedures are used.
- **Compliance with standardised test procedures** – the test conductor will also have to make sure that the performer follows the correct instructions/procedures at all times during the test, and to void any test results that were recorded with a breach of the procedures. This will ensure that all comparisons made with results are reliable.

Validity of results

A valid test is one that measures what it sets out to measure. It is where the test results are a true reflection of the fitness component being measured. For example, the 12-minute Cooper run is a maximal fitness test used to measure aerobic endurance. Aerobic endurance, remember, is the ability of the h working muscles with oxygen for an extended duration. Therefore, it is more valid the Harvard step test, which do not directly measure aerobic endurance but use a

Validity is the me of a test actually being measured.

Practicality of tests

A practical test is one that is efficient and can be carried out with relative ease. Th make a test practical. These include:

- **Low cost** – some equipment can be quite co: ly, ing the test less practica
- **Little time** – the time it takes to
  a) set up the test
  b) perform the t
  c) a he sults
  ... will i e the practicality of the test. The less time it takes to complete a test, the more practical it is.
- **Can collect data from numerous participants at once** – being able to run a test and collect the data from multiple participants at the same time will make a test highly practical. This is because it saves time on repeating the test for each participant, especially if the test takes a long time.

Case study

BMI is a highly **practi** composition due to th analysing data. All t **height** and body ma differentiate betwee a highly muscular ind BMI as an individual means it has poor **va** due to weight.

Read more about wh **zzed.uk/12122-bmi**

Chapter B2:
Fitness test methods
for components of physical f

Knowledge of the published standard test methods and use of equipment for eac
number of reasons. Firstly, it allows the right tests to be selected which will produ
a specific sport or activity. It also allows the test conductor to improve the reliabil
the standardised test procedures. Finally, it helps the person conducting the test
practical tests for certain categories of participants. Covered below are the differe
component of physical fitness.

A warm-up is recommended prior to **all** tests. This will help to reduce the r
tests, and also increase the validity of results by providing a more accurate mea

Aerobic endurance

There are various fitness tests for aerobic endurance, improving their suitability to
them to be completed by a range of participants.

Multistage fitness test

Also known as the **bleep test**, this is a maximal test that increases in speed and re
performer to change direction every 20 metres. This test can be adapted for peop
disabilities, especially wheelchair users, as it removes the need to step – a require
the Harvard step test (see next page).

The main procedures for this test are:

1. A 20 m track is marked out with a cone placed at either end.
2. The participant starts behind the cone at one end of the track.
3. The assistant starts the test recording track through an audio player, which si
   the 20 m track that the participant must run.
4. As the test progresses, the time between each beep decreases and, in turn, th
   running speed.
5. The participant should continue for as long as they can keep up with the timi
6. Once the participant fails to meet three consecutive beeps, the assistant shou
7. The stage and shuttle number that the participant was last able to complete i

The equipment needed for this test includes:

- ✓ Cones
- ✓ Measuring tape/wheel
- ✓ Audio player and test recording track
- ✓ Running track

Did y

The yo-y
prominen
Bangsbo,

The yo-yo test is similar to the bleep test in that it requires the performer to
track to the other in time with 'beeps' from an audio track. There are numerous
different levels of fitness.

- **Level 1 Beginner** test consists of slower speeds than the bleep test.
- **Level 2 Advanced** test consists of greater increments of speed than the
- **Intermittent** variants of the test, which are the most popular, include a
  after every 40 m. An additional 5 m is marked out behind the start cone
  during this 10 s.

5 m recovery distance for the intermittent yo-yo test

20 m running distance for the bleep a

Harvard step test

A submaximal test where the performer must repeatedly step up onto and down t
This test would be best suited for individuals who have a limited cardiovascular en

The main procedures are:

1. The participant begins the test by facing the stepping bench.
2. The test conductor should start a metronome via an audio player at 30 beats per minute.
3. On each beat, the participant should step up onto a bench and back down again, alternating the leading leg each time.
4. They should continue doing this for 5 minutes, at which point the assistant should notify them to stop.
5. The participant should measure their pulse ra[illegible] minute mark after e consecutive minutes. This can be do[illegible]ng the last 15 seconds of ev it by four.
6. The test score can b[illegible] by the equation:

$$\frac{30{,}000}{\text{(pulse after 1 min + pulse after 2 mins + pulse after 3}}$$

The equipment needed for this test includes:

- ✓ Audio player and recording track
- ✓ Bench or step
- ✓ Stopwatch

Did you k

The Harvard step tes
Harvard University in
test for soldiers in the

Cooper 12-minute test

Another maximal test where the performer must run or swim as far as possible wit

The main procedures are:

1. The participant warms up in preparation for the 12-minute Cooper test they are about to perform (run or swim).
2. On the command 'go', the assistant starts the stopwatch and the participant begins the test.
3. The participant must run or swim (depending on the test) as far as possible within 12 minutes.
4. Once the 12-minute time period is up, the participant must stop where they a
5. The distance they have travelled is recorded in metres and used as the test sc

The equipment needed for this test includes:

- ✓ Running track / swimming pool
- ✓ Stopwatch

Applied activity

Which of the fo[illegible]s would be considered most valid for a 1500 m
Justify yo[illegible]e [illegible] test.

Cardiovascular endurance tests are suited to endurance performers. The beep an
team sport athletes who require cardiovascular endurance but need to have good
whereas the Cooper 12-minute test is wholly specific to long-distance runners and

Maximal tests require lots of motivation so the results from the bleep, yo-yo and C
more unreliable than the Harvard step test. Nevertheless, the results are more like
test uses a calculation to predict cardiovascular endurance. All tests might be con
numerous participants at once and require minimal equipment.

Normative data can be found for the different fitness tests for aerobic endurance
against population norms, allowing participants to rate their fitness levels.

Normative data for the Cooper 12-minute run for m[illegible] females aged 14

Rating	M[illegible]	
Excellent	[illegible]700 m	
Good	2550–2700 m	2
Average	2350–2549 m	1
	2050–2349 m	1
	< 2050 m	

Source: Estimated and adapted from Cooper (1968)

Normative data for the Harvard step test for 14–16-year-olds, based on the s

Rating	Excellent	Above average	Average	Below
Male	> 99.0	76.0–99.0	61.5–75.9	49.0
Female	> 79.0	72.0–79.0	58.0–71.9	45.0

Source: Estimated and adapted from Beashel and Taylor (1997)

**Normative data for the bleep test for 15–17-year-olds. Performers are rated
number (S) they were able to reach:**

Rating	Excellent	Above average	Average	Below
Male	L12 S9	L11 S4	L8 S11	L7
Female	L10 S10	L9 S2	L6 S8	L5

Source: Estimated and adapted from Bizley et al. (2010)

Applied activity
See if you can use the above normative data tables to assign a rating to ea
performers below:

Name	Age	Gender	[illegible]st	Sc
Gina	14	Female	[illegible] step test	61.5
John	16	[illegible]ale	12-minute Cooper run	2200
Amad	[illegible]	Male	Harvard step test	83.2
[illegible]	15	Female	Multistage fitness test	L11 S
[illegible]oppy	14	Female	12-minute Cooper run	2000
Ian	17	Male	Multistage fitness test	L7 S5

Muscular endurance

There are a number of different tests for muscular endurance which involve differe
endurance of specific muscles.

One-minute press-up or sit-up test

A test where the participant must perform as many press-ups or sit-ups as they ca
generally easier to perform so may be used by a wider range of participants.

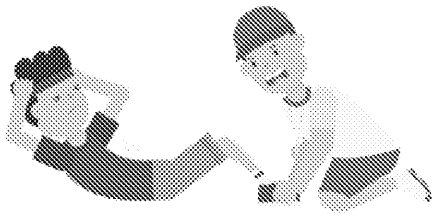
The main procedures are:

1. The participant lies on an exercise mat, with their legs bent (sit-up), or props
   and feet (see images).
2. On the command 'go', the assistant starts the stop[illegible] and the participant
   their elbows to their knees) or a press-up (by lowering their chest to the floor
3. They then return to their initial position – each counts as one full repetition (re
4. Their aim is to perform as many reps as possible within one minute.
5. The test score is the number of reps they are able to perform.

The equipment needed for these tests includes:

- ✓ Exercise mat
- ✓ Stopwatch

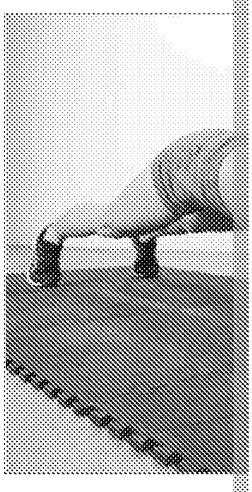
The press-up test targets the pectorals and triceps, whereas the sit-up test targets the abdominals.



The timed plank test is another test that can measure muscular endurance. This tests the isometric ability of several muscles, including the quadriceps, abdominals and deltoids.

Instead of using the number of reps performed in a minute as the measure, this test is measured as the amount of **time** the participant is able to hold the plank position for. The same equipment is required.

The proper plank position is shown in the image to the right, where the body is propped up parallel to the ground. This position should be maintained in order to obtain a valid measurement of muscular endurance.



Isometric muscle co
muscle contracts b

Tests for muscular endura[illegible]ed to events that involve repeated muscle ac
30 minutes, s[illegible]as [illegible] basketball where the upper body muscles are consta

The one-mi[illegible]sts are highly practical as they are quick and easy to perform. H
questioned as performing a maximum number of reps in one minute relies on stre
All muscular endurance tests can be considered reliable, though, as they do not re
motivation, no equipment needs to be calibrated, the environment is always the s
conductor is not essential.

Applied activity
Have a go at performing the one-minute sit-up test and/or the plank test, and co
data on the next page to see how you rate! You should be rested between each
muscles (the abdominals).

Normative data for the one-minute sit-up test for males and females aged 1

Rating	Males	Fema
Excellent	> 27	> 2
Above average	25–27	20–
Average	19–24	14–
Below average	15–18	8–1
Poor	< 15	< 8

Source: *Estimated and adapted from Davis et al. (2000)*

Normative data for the plank test for males and females aged 16–18:

Excellent	Very good	Above average	Average	Below aver
> 5 mins	3–5 mins	2–3 mins	1.5–2 mins	45 secs – 1.5

Source: Estimated and adapted from Strand et al. (2014)

Flexibility

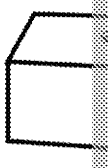
Just as the different muscular endurance tests measure the endurance of specific m
flexibility tests that measure the flexibility of specific muscles.

Sit and reach test

The most commonly used flexibility test. This measures the flexibility of the hams
having the performer reach out over a box.

The main procedures are:

1. The participant performs a warm-up to increase flexibility and reduce the risk of injury.
2. They then sit with their feet pressed up against the si
reach box with legs straight and flat on the fl
in the image to the right).
3. The participant should the
far as possible ov
make
4. The ass
participant is able to reach by reading the built-in ruler on top of the sit and reach box. This is used as the test score.



Normative
for the sit a

Rating
Excellent
Good
Average
Fair
Poor

Source: Estima

The equipment needed for this test includes:

- ✓ Sit and reach box (with built-in ruler)
- ✓ Exercise mat (optional)

The shoulder flexibility test may refer to one of many different tests that measure the flexibility of the muscles around the shoulder, such as the deltoids and the rotator cuffs. The most common test is the overhead reach, also known as the back scratch test. This involves the participant reaching over their head with one arm, at the same time as reaching around with the other arm and attempting to make contact between the fingers of both hands.

A rating is given based on how close the fingers are to each other:

- Greater than 5 cm apart – 'Poor'
- Less than 5 cm apart but not touching – 'Fair'
- Touching – 'Good'

The calf muscle
facing a wall with o
then leaning forwa
knee. This is repeat
their foot further ba
attempt, until they
with their knee. The
the wall (in centime

The flexibility of the
gastrocnemius) is in
exercises requiring
ankle, such as takin
performing a squat

Ratings for the shoulder flexibil

Rating	Descriptor
G	Fingers are able to touch each other
	Fingers are less than 5 cm (2 in) apart
Poor	Fingers are greater than 5 cm (2 in) apart

Flexibility tests are suited to sports such as gymnastics which require a large range
joints. All of the flexibility tests covered above can be considered valid as they ass
muscles. However, in order to bring about reliable results the performer must be
take a short amount of time and can be performed in a range of environments, th

Speed

There are two tests commonly used to measure speed, with the only difference be
starting point.

30-metre sprint test

This test involves a standing start, so can give a measure of acceleration and spee

The main procedures are:

1. The participant should warm up while the assistant marks out a 30-metre tra
2. The participant starts from a stationary position between the start cones.
3. On the command 'go', the assistant should start the stopwatch and the partic
   sprint the 30 metres right through to the end cone.
4. As the participant passes the end cone, the assistant stops the stopwatch and
   which is used as the test score.

30-metre flying sprint test

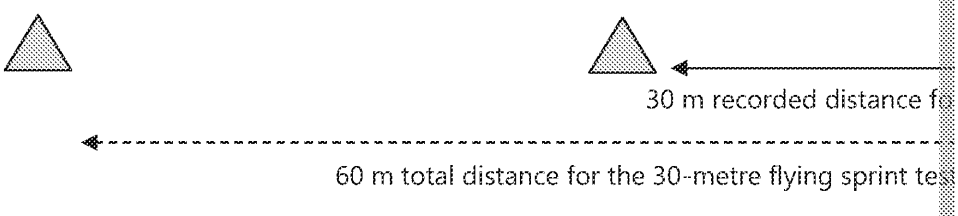
This test gives a pure measure of speed, as the performer should already be near
time starts.

The main procedures are:

1. The participant warms up while the assistant marks out 60 metres with cones
   halfway point.
2. On the command 'go', the participant accelerates and builds up running spee
   30 metres.
3. As the participant passes the halfway point, the assistant starts the stopwatch
4. The assistant stops the stopwatch as the participant passes the end cone and
   that the time taken to cover the final 30 metres is used as the test score.

The equipment needed for these tests includes:

- ✓ Cones
- ✓ Measuring tape/wheel
- ✓ Stopwatch
- ✓ Running track



Applied activity
How would you expect your test score to differ for the two speed tests?

Research activity
Timing gates can improve the measurements. Research how t are more accurate than a stop

The speed tests above are suitable for athletes who require speed for their sport, but For example, the 30-metre flying sprint is regularly used by 100 m sprinters look metre sprint test may be used by performers looking to test their acceleration as we

Both tests a for the different types of speed that they measure (accelerative a each test ma nd on the test conditions. For example, wind speed can have a each test is completed. Both tests are, however, highly practical as they are quick, e

Normative data for the 30-metre sprint test and flying sprint test for 14–16-y

Rating	Males	
Excellent	< 4.2 seconds	
Good	4.2–4.4 seconds	
Average	4.5–4.6 seconds	
Fair	4.7–4.8 seconds	
Poor	> 4.8 seconds	

Source: *Estimated and adapted from Davis (2000)*

Muscular strength

There are two commonly used fitness tests for muscular strength, which allow the groups to be determined.

One-rep max (1RM) test

This test measures the maximum weight that can be lifted in one repetition. It is i participants performing this are well-trained as poor technique can increase the ri

The main procedures are:

1. The participant should warm up using the muscle group they are choosing to commonly a back squat for lower body strength or a bench press for upper b
2. For the back squat, the participant should stand with their feet shoulder widt with an unweighted bar resting on their back.
3. To perform the squat, the participant should [illegible] until their thighs are parallel to the floor, keeping their fe[illegible] planted and their back straight (
4. They should perform a single [illegible] gradually increase the weight loade
5. They should do this [illegible] of a spotter until they reach the maximal we
6. The total weight (plus bar) is recorded in kilograms and used as the te

The equipment needed for this test includes:

- ✓ Barbell
- ✓ Bench/squat rack
- ✓ Weighted plates

Spotter – a person who is there for support complete a rep, allowing the performer to

Research activity

Rating of strength using 1RM uses the load li Take a look at the ratings for adults on the T **zzed.uk/12122-bench**

Grip dynamometer test

This test measures grip strength using a bespoke measurement device called a dy wider range of participants as it does not rely on technique.

Main procedures:

1. The participant adjusts the handgrip so that it sits comfortably between the first crease of the index finger and the palm of the hand.
2. They should then stand holding the dynamometer down beside them but with the arm slightly away from the body so that it is not touching.
3. When ready, they should squeeze the handgrip as hard as possible for up to five seconds.
4. The test score is displayed upon the screen in kilogram watts (KgW).

Equipment and facilities needed:

- ✓ Handgrip dynamometer

The 1RM test is suited for performers who rely on [illegible] strength, such as weig grip dynamometer is more suited to a wi[illegible]e performers as it gives an ind than strength of specific muscle g[illegible] this reason, the 1RM test is considere dynamometer test is muc[illegible]tical as it takes a short amount of time to co test, which re[illegible]es [illegible]mer to rest between sets. The grip dynamometer te reliable too[illegible] 1RM test is likely to be more affected by motivation and the su conductor a[illegible]hat constitutes a valid rep.

Normative data for the grip dynamometer test for 14–16-year-olds:

Rating	Males	Females
Excellent	> 50	> 32
Good	48–50	29–32
Average	43–47	24–28
Fair	37–42	18–23
Poor	< 37	< 18

Source: *Estimated and adapted from Davis (2000)*

A W ex da su

Body composition

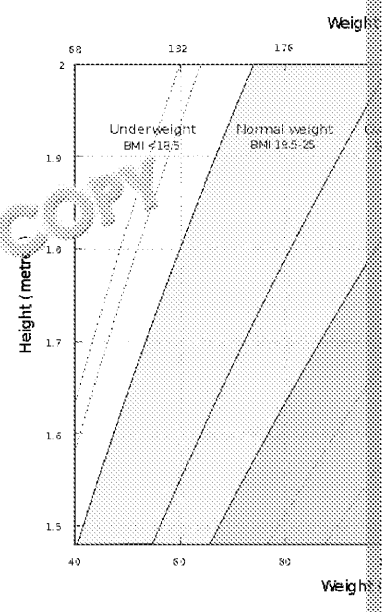
There are numerous tests for measuring body composition, with some giving mor
others. The procedures for three of the most practical tests for estimating body c

Body mass index (BMI)

This is a simple estimation of body composition which uses an individual's weight

The main procedures are:

1. The participant's height is measured, preferably using a stadiometer.
2. The participant's weight is measured using accurate floor scales.
3. The participant's weight (in kg) is divided by their height (in metres) squared.
4. The value is used to deter[illegible] the participant's weigh[illegible] as shown in the gra[illegible] th[illegible]



Equipment needed to measure BMI includes:

- ✓ Scales (for weight)
- ✓ Stadiometer or tape measure (for height)
- ✓ Calculator
- ✓ The validity of BMI as an indicator of body composition is scrutinised as it does not distinguish between fat mass and fat-free mass. For example, two people wh 1.8 m tall could both be classified as obese, yet one might have a high lean m fat mass.
- ✓ However, it would be considered the most practical as it can be calculated us equipment. The reliability of this test could be affected by the test conducto measurements including the participant's clothing and footwear, while some which will affect the results.

Applied activity

See if you can use the above graph and calculation for BMI to work out the classification of the following individuals:

Name	Age	Height	Weight	BMI classification
Carl	23	173 cm	66 kg	
Amelia	19	155 cm	52 kg	
Shweta	33	175 cm	78 kg	
Ki	42	184 cm	[illegible]	

Bioelectrical impedance analysis (BIA)

This test uses a piece of specialised equipment which sends an electrical current th

The main procedures are:

1. The participant stands on the BIA machine and places their hands onto conta electrical current through the body.
2. Information relating to the individual's body composition is displayed on the paper. This includes an estimation of body fat percentage, fat mass and fat-f the body, as well as the whole body.

A BIA machine is all that is needed to measure body composition through this me can be expensive and are often only available in clinic[illegible]s or for a cost in some health and fitness facilities, making it [illegible]practical method of measuring body composition.

Some conductors get th[illegible]rticipants to avoid consuming fluids in the few hours leadi[illegible]o [illegible], as every 500 mL consumed results in a 2% increase in the estim[illegible]body fat percentage. This will provide more valid results of body composition, but if this approach is used by some and not others, results will be unreliable.

Waist-to-hip ratio (WHR)

This test uses a measurement of an individual's waist circumference relative to the better indicator of central obesity around the abdominal area (i.e. above the waist

The main procedures are:

1. The participant stands upright.
2. The narrowest part of the waist is identified and its circumference is measured using a tape measure.
3. The widest part of the hips is identified and the same technique is used to measure its circumference.
4. Waist circumference is divided by hip circumference and the value is used to determine health risk, below:

Health risk	Women	Men
Low	0.80 or lower	0.95 or lower
Moderate	0.81–0.85	0.96–1.0
High	0.86 or higher	1.0 or higher

Did yo

Central obes
individual w
'apple-shap
cardiovascu
'pear-shape
accumulate

Research a
Research th
measureme
as DEXA a

Equipment needed for the WHR meas[illegible]er [illegible]cludes:

- ✓ Tape measure
- ✓ Calculator

The measure[illegible] for the WHR can take time so it might be considered less prac simple equipment, it is more practical than BIA.

An inexperienced test conductor is likely to take waist and hip measurements at th affect the validity of the WHR measurement and the reliability of repeat results.

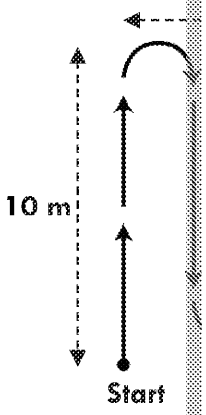
Chapter B3: Fitness test methods for components of skill-related

Agility

There are two key tests designed to measure agility, each using a different course a

Illinois agility run test

This test uses a course which involves running in a forwards direction throughout.



Main procedures:

1. The participant warms up while the assistant marks out a 10 m × 5 m course, as shown in the diagram to the right.
2. On the command 'go', the participant should aim to complete the course in the direction shown, as quickly as possible.
3. The assistant uses a stopwatch to time how long they take in seconds and this is used as the test score.

Normative data for the Illinois agility run test for 14–16-year-olds:

Rating	Males	Females
Excellent	< 15.2 s	< 17.0 s
Above average	15.2–16.1 s	17.0–17.9 s
Average	16.2–18.1 s	18.0–21.7 s
Below average	18.2–19.3 s	21.8–23.0 s
Poor	> 19.3 s	> 23.0 s

Source: *Estimated and adapted from Davis (2000)*

T test

This test uses a course which involves moving in a forwards, sideways and backwards direction.

Main procedures:

1. The participant starts at the bottom cone. On the command 'go', they run as quickly as possible to the opposite cone and touch it with their right hand.
2. From here, they shuffle across to the cone on their left and touch it with their left hand.
3. They then shuffle across all the way to the right hand cone and touch it with their right hand.
4. The participant then shuffles left to the centre cone, touching it with their left hand.
5. Finally, they return to the starting cone by running backwards.
6. The time taken to complete the test is used as their test score.

Equipment needed for these tests includes:

- ✓ Cones
- ✓ Stopwatch
- ✓ Non-slip running surface
- ✓ Assistant

Agility tests are suited to participants in sports that require changes of direction, s tennis. Both tests provide valid results as they test the body's ability to change di reliable as they require little motivation and neither test requires an experienced c impacted by environmental conditions. They are also both very practical as they r set up and analyse and can be completed in a short amount of time.

Balance

There are two tests that can be used to measure balance – one that is designed to
is designed to test dynamic balance.

Stork stand test

This test involves the participant adopting a stance and maintaining static balance f

The main procedures are:

1. The participant is given time to practise the stance for the test shown on the
2. The participant then starts the test by adopting the stance, while at the same
   should start the stopwatch.
3. The participant should try to maintain their balance for as long as possible.
4. If the participant loses balance at any point, or the supporting foot leaves their sta
   stops the stopwatch and records the time in minutes and/or seconds. This is us

Equipment needed:

✓ Stopwatch

Normative data for the stork stand test for males and females, aged 14–16:

	Excellent	Above average	Average	Below average	Poor
Males	> 55 s	41–55 s	17–40s	6–16 s	< 6 s
Females	> 30 s	24–30s	9–23s	3–8 s	< 3 s

Source: Estimated and adapted from Schell & Leelarthaepin (1994)

The **Y-balance test** can also give a measure of balance, but compared to t
static balance, this test gives a measure of dynamic balance.

The participant starts by adopting a single-leg stance on a piece of apparatus d
They then reach out as far as possible with the other leg in three differen
posteromedial and posterolateral (at a 45° angle between the back and each
separately and is guided by the apparatus, which uses a slider and an inbuilt
achieved on each. Once the subject has performed the test in each direction, th
that there are six tests in total. Results take into account limb length to give a co

Watch the video using the link below to see how this test is carried out and resu
https://www.youtube.com/watch?v=qFVuS-P2FrI

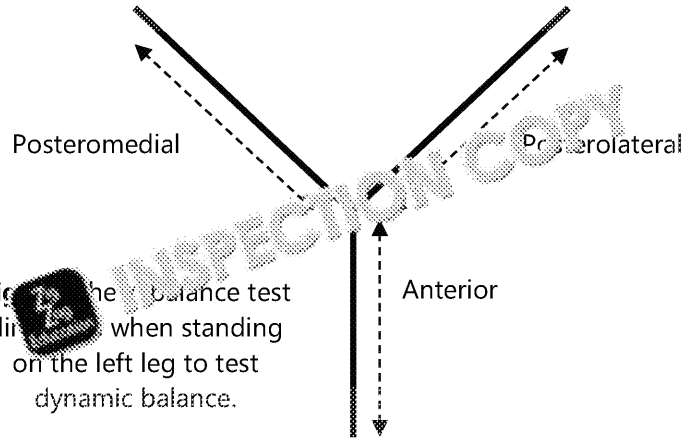


Fig he Y-balance test di when standing on the left leg to test dynamic balance.

Resea
Resea
see a
being

Appli
Which
would
Give
your

Different tests for balance are more suited to specific events due to their measurem
For example, the stork stand test is most suitable for sporting actions that require st
positions in gymnastics, while the Y-balance test is most suitable for sporting activit
as badminton and squash. Each test is highly valid for the type of balance it measur
produce reliable results as it is not affected by any of the factors that would limit the

Coordination

Most fitness tests for coordination test hand–eye coordination. Two common tests

Alternate-hand wall-toss test

This tests hand–eye coordination by getting the participant to throw and catch a b

The main procedures are:

1. The participant stands two metres away from a flat wall with a tennis ball in t
2. On the command 'go', the assistant starts the stopwatch and the participant t with one hand and catch it with the other.
3. They must repeat this as quickly but as accurately as possible for 30 seconds.
4. The number of successful catches is counted by the assistant.
5. When the time is up, the assistant tells the participant to stop.
6. The number of successful catches that is counted by the assistant is used a

Equipment needed for these fitness tests includes:

- ✓ Ruler/measuring tape
- ✓ Tennis ball
- ✓ Stopwatch

The **stick flip test** can also be used to test hand–eye coordination.

There are two parts to this test:

Part A (half-turn)

1. The subject holds two sticks, one in each hand, at waist height and parallel
2. An assistant then places a third stick horizontally across the two held sticks.
3. The participant has five attempts at flipping the stick so that it completes two held sticks.
4. One point is awarded for each successful half-turn flip of the stick.

Part B (full turn)

5. Steps 1–3 are repeated, but this time the participant must execute a compl
6. The tip of the stick being flipped can be painted or taped to determine whe
7. Two points are awarded for each successful full flip of the stick.

The total of the score of both parts is taken and used as the test score.

Research activity

Research the normative data for these fitness tests on the Topend Sports website:
zzed.uk/12122-coordination

These tests are suited to sports requiring hand–eye coordination, such as rugb alternate-hand wall-toss test would be more suitable for ball sports that require th fielding in cricket, whereas the stick flip coordination test is suited to movements t at the same time, such as serving in tennis. Both tests are highly valid as a measu focus on using two or more body parts at once. They are also highly practical as t to set up and measure, and can produce results in a short space of time. Both tes affected by factors such as motivation or an experienced test conductor.

Power

Fitness tests for power mainly measure the power of the lower body muscles, requ
jumping and sprinting activities. Three common tests are described below.

Vertical jump test

The participant jumps as high as possible.

The main procedures are:

1. The participant warms up then chalks their fingers (or holds a piece of chalk).
2. The participant then stands side-on to the wall and reaches up as far as possi
   mark the wall with the chalk.
3. The participant then jumps as high as they can and again marks the wall with
   arm stretched as high as they possible can above them.
4. The assistant records the distance between the fi[illegible]k while standing) an
   second mark (while jumping), in centimet[illegible]s, and this is used as the test scor

Equipment needed for this test incl[illegible]e:

✓ Chalk ✓ [illegible]

Did you know?

The vertical jump test is also k
as the Sargent jump test, nam
after the person who first dev
it over 100 years ago in 192

Standing [illegible] jump (broad jump)

The participa[illegible] jumps as far as possible.

The main procedures are:

1. The participant warms up while the assistant sets out a tape measure from a s
2. The participant places their feet behind the line and, from a static position,
   uses their arms and legs to propel themselves as far forward as possible.
3. They should remain fixed in their landing position as the assistant
   uses the tape measure to assess how far they were able to jump.
4. The distance is recorded and used as the test score.

Equipment needed for this test includes:

✓ Tape measure ✓ Chalk or a cone to indicate starting line

The **Margaria-Kalamen test** can also be used to assess power. It involves the participant sprinting up three steps at a time. As they make contact with the third step (i.e. on the first leap), an assistant starts the stopwatch and stops it as soon as the participant's foot has left the ninth step (i.e. after the third leap). Power is calculated using the following formula:

power (watts) =
(weight (kg) × vertical distance between steps 3 and 9 (m)) × 9.8 / time taken (s)

These all assess the power of the lower body, so are suited to sports and events that involve jumping actions, such as the high jump and long jump. They are highly valid as they rely on pspeed and stren[illegible]g[illegible]nerate power. They are also quite practical as they do not rely on ex[illegible]ive equipment, are easy to set up and can be conducted i[illegible]sh[illegible]pace of time. However, the Margaria-Kalamen test might t[illegible] slig[illegible]y longer due to the need to perform a calculation. All tests f[illegible]ve are reliable as they are unlikely to be affected by [illegible]e f[illegible]s such as the test conduction, the motivation of the performer o[illegible]xperience of the test conductor.

Normative data for the vertical jump test for 14–16-year-olds:

Rating	Males	Females
Excellent	> 58 cm	> 52 cm
Good	47–58 cm	45–52 cm
Average	38–46 cm	34–44 cm
Fair	28–37 cm	25–33 cm
Poor	< 28 cm	< 25 cm

Source: *Estimated and adapted from Davis (2000)*

Applied activity

Attempt the vertical jump test a
to the values in the normative d

Would you expect to receive th
broad jump? Attempt this test a
the normative data at the Tope
zzed.uk/12122-power

Are your ratings the same? If n

Reaction time

The ruler drop test is the recognised fitness test for reaction time, but there are m
reaction time tests that can also be found online.

Ruler drop test

The participant catches a ruler by responding to it being dropped by an assistant.

The main procedures are:

1. The participant sits at a table with their forearm resting on the surface and ar
   open hand hanging over the end.
2. The assistant holds a ruler with the 0 cm mark level with the top of the open
3. In the assistant's own time, they should drop the ru[illegible]out giving any adv
   indication to the participant.
4. The participant must respond as qui[illegible]possible by catching the ruler.
5. The centimetre mark of th[illegible]ruler which is at the top of the hand is use
   the test score.

Equipment a[illegible]lities needed:

- ✓ Ruler
- ✓ Table
- ✓ Assistant

Normative data for the ruler drop test for males and females aged 14–16:

Excellent	Above average	Average	Below average	Poor
< 8.3 cm	8.3–16.7 cm	16.8–21.4 cm	21.5–30.8 cm	> 30.8 cm

Source: Estimated and adapted from Davis (2000)

There are many **online reaction time tests** that have been developed to test reaction time to something that appears on the screen, such as a shape or an object changing colour. The participant must click their mouse or press the space bar on the keyboard in response.

Research activity
Research three different online reaction time tests and test your average reaction time on each.

Applied activity
Would online reaction time t
valid results than the ruler d
Suggest reasons why or why

Tests for reaction time are suited to a number of s[illegible]r[illegible]iring good reactions,
starting gun in the 100 m sprint. They ca[illegible]nsidered valid as they measure th
However, the reliability of online r[illegible]e tests may be affected by trustworth
reliability of the ruler dro[illegible] influenced by the experience of the conduct
participant f[illegible]s a[illegible]equired procedures (for example, the participant must
to catch the

These tests are highly practical as they can be performed in any environment, com
minimal time to set up, carry out and analyse.

Chapter B4:
Interpretation of fitness test

As shown with the normative data tables for fitness tests throughout chapters B2 and B3, interpretations can be drawn about a person's fitness levels by comparing their test scores to these normative tables. Different scores are assigned a rating which describes how well that performer has tested relative to the population.

Norma
that is
and is
fitness

Comparison to normative data

It is important to be able to analyse and evaluate test resu[illegible]ing normative data metre sprint test as an example. The data below s[illegible] normative data for thi

	Males	Females
[illegible]cellent	< 4.0 s	< 4.5 s
Good	4.0–4.4 s	4.5–4.8 s
Average	4.5–4.6 s	4.9–5.0 s
Fair	4.7–5.1 s	5.1–5.4 s
Poor	> 5.1	> 5.5 s

Estimated and adapted from Davis, B et al. (

Test scores can then be used as a direct comparison to the normative data table a performer to find the appropriate column, and then using their score to find the r This allows ratings to be assigned to specific fitness tests to analyse and evaluate results.

Subje
1
2
3
4

The table on the right shows hypothetical results for the 30-mtre sprint test for a group of 14–16-year-olds. Here we can see the rating assigned to each performer.

Analysis and evaluation of test results

This table can then be analysed to draw conclusions on the test. For example:

Subject 4, a male, recorded the quickest time, but Subject 2, a female, received the because males are typically faster than females due to greater muscle mass on ave more power with each stride. Therefore, they need to record a quicker time to ach

Recommendations for improvements

The results from fitness tests can be used to provide recommendations to a perfo on how they can improve that component of fitness in future. This is one of the m reasons for fitness testing, in that the test result can b[illegible]p[illegible]ori[illegible] the training prog to focus on improving that fitness compone[illegible]arc[illegible] selecting the relevant train methods and appropriately applyin[illegible]ri[illegible]ples of training.

Ap[illegible]ac

Th[illegible] below shows example normative data for a female student ag dat[illegible]les in chapters B2 and B3 to record the rating for each fitness te

Test	Score	
Grip dynamometer test	40 kgW	
Illinois agility test	17.1 s	
Vertical jump test	28 cm	
Cooper 12-minute run test	2300 m	

Provide recommendations for improving the student's fitness based on the

Checking understanding questions

1. Outline **three** reasons for fitness testing.

2. Give **two** reasons why it is important to use informed consent forms prior
administering a fitness test.

3. Explain **two** factors that affect the reliability of fitness tests.

4. Define validity.

5. Name **two** fitness tests used to me endurance.

6. For the alternate-ha test:
   a) Ide th ent of fitness measured.
   b) D the protocol.

7. A personal trainer has measured the body composition of their different cli
Complete the table below to identify the BMI status of each client from the

Client	BMI	BMI Status
A	23.8	
B	17.6	
C	33.1	
D	26.4	

Taking it further questions

1. Compare the practicality of the 1RM and grip dynamometer tests for muscu

2. A tennis player has undergone fitness testing to measure their physical and sk
Their results are shown below:
   - Yo-yo test – Excellent
   - Alternate-hand wall-toss test – Above average
   - Illinois agility run test – Below average
   - Vertical jump test – Average

   Using the results, explain one component of fitness that the tennis player sh
to improve their performance in tennis.

Learning Outcome C: Investigate dif training methods

Overview

In this section you will learn about what constitutes a safe and effective training session and the different aspects that allow this to fit into a safe and effective training programme.

You will gain an understanding of the various fitness training methods that can be used for the different physical and skill-related components of fitness, including advantages and disadvantages and the long-term effects on the body systems. You will be able to suggest and justify appropriate training methods for specific sports participants, of a range of ages and abilities.

Finally, you will learn about the different types of public, private and voluntary provision for fitness training and the advantages and disadvantages of each.

Learning outcomes

After studying this chapter you should be able to:

C1: Understand how fitness training can be carried

- ❑ Identify the different components of a war
- ❑ Explain the effects that a warm-up and coo
- ❑ Assess how FITT principles and the addition safe and effecti programme

C2–C5: and st the physical and skill-related ipa of different ages and abilities and th

- ❑ Describe the training methods that can be physical and skill-related related fitness
- ❑ Suggest and justify appropriate training m and of different ages and abilities
- ❑ Assess the advantages and disadvantages
- ❑ Assess the advantages and disadvantages training providers

C6: Understand the effects of different training m helps to improve specific components of fitness.

- ❑ Identify the adaptations on the body syste
- ❑ Explain the impact of the different adaptat

Key terms

Acceleration sprints	a speed training method whereby the performer starts or rolling start and then gradually increases their pace into a maximal sprint
Bradycardia	a resting heart rate below 60 bpm, usually as a result o training
Capillarisation	an increase in the number of capillaries around the alv aerobic endurance training
Cardiac hypertrophy	the increase in the size of the heart that occurs as a re endurance training
Circuit training	a range of different exercises th e completed at dif
Continuous training	sustained exercise for l no an 30 minutes, comple
Fartlek training	varied s or rains to intermittently change the i
Free weights	y ece of weighted gym apparatus not attached to
Interval t	periods of work interspersed by periods of rest
Lactic acid	a by-product of anaerobic exercise, e.g. speed training and fatigue
Ligament	a connective tissue at the joint which joins bone to bo
Mobiliser	a key component of the warm-up which involves exerc range of movement at a joint
Muscle tone	the physical appearance of muscles as a result of being

Key terms

PNF (acronym)	proprioceptive neuromuscular facilitation; PNF is a stretch reflex of the muscle to gradually increase th
Plyometric training	a training method that uses explosive, bounding
Private provision	sports providers run by individuals or groups look
Public provision	sports providers run by a body belonging to local
Pulse raiser	a key component of the warm-up which involves increase heart rate and the flow of oxygen to the
Resistance drills	speed training methods which utilise a range of d (e.g. sleds) or natural resources (e.g. hills) to apply sprinting and accelerating
Resistance machine	gym equipment that usually operates on a cable weighted plates to be loaded on
Respiration	a process that occurs in all living cells in the body organs and tissues to function
SAQ (acronym)	speed, agility and quickness; a training method th multidirectional movements using equipment suc
Static stretching	holding an isometric stretch for up to 30 seconds
Static active stretching	an internal force is applied by the performer activ the muscle themselves
Static passive stretching	the performer uses an external force to stretch th person or an object (e.g. a wall)
Stretch reflex	a protective mechanism of the muscle whereby it detected, preventing the muscle from overstretch
Stroke volume	the amount of blood ejected from the left ventricl
Tendon	a connective tissue at the joint which joins muscle
Voluntary provision	sports provider run by not-for-profit individuals o having a positive impact on society
Weight-bearing exercise	any activity where bodyweight is not supported, s

Chapter C1:
Requirements for each of the fo
fitness training method

Training programmes are designed to improve certain components of fitness by s
and applying the necessary principles, ensuring training is carried out both saf
session should consist of a warm-up before taking part in the main fitness training
afterwards. Let's start off this chapter by taking a look at these requirements for t

Warm-up prior to taking part

All training sessions should involve a warm-up to ins e hat the participant is pre
within the session and is at a reduced ris o y. A warm-up should consist of t

1. Pulse raiser
This incre ea e and breathing increase oxygen supply to the working muscles. It also increases the temperature and pliability of muscles, reducing the risk of injury.

e.g. a light jog, cycle or row to get the blood pumping around the body

2. Mobiliser
This involves exercises that gradually increase the range of movement at the joints. This helps increase production of synovial fluid, which lubricates the joints and improves articulation.

e.g. circling the arms or swinging the legs to improve shoulder and hip mobility

Did you know?

Sport-specific warm-ups involve movements directly related to the participant's s
allow them to practise certain movements to familiarise themselves with the requi

Cool-down after the session

Cooling down after the session may have many benefits for the performer in the r
ensuring that they are as fresh as possible for the next training session. A cool-do
key components:

1. **Light exercise** to gradually lower heart rate and breathi rate to resting leve
intensity of this exercise should be lower than th e ain session to red
demands at the muscle. This allows the b dy to emove lactic acid that has b
muscles during the main activi a t estore any deficits in muscle oxyger
have been incurred at the ame.
2. **Stretches** he s return to their pre-exercise length. This helps to r
and m eness or stiffness in the hours and days following the activity.

Applied activity
Apply the warm-up in a sport of your choice! Design a warm-up to include the d
and activities you would include in preparation for a training method to improv

Throughout the next chapter you will learn to link each training method to each c
apply the basic FITT principles and additional principles of training to each fitness
applying the correct training intensities. You may wish to revisit chapters A2 and

Chapter C2:
Fitness training method
for physical components of f

There are certain training methods suited to improving specific components of fit
that the right training methods are selected for the performer and their sport. To
training method, it is also important that each session applies the basic (FITT) and
as well as selecting the appropriate intensity to achieve the athlete's goals. This c
fitness training methods that are used for physical components of fitness and late
advantages and disadvantages of each.

Aerobic endurance

There are four recognised train me h s for improving aerobic endurance. Th a c tinuous training, fartlek training, interval trai d t training.

Continuous training

Continuous training involves sustained exercise at a steady pace without rest. Training sessions should last for longer than 30 minutes and be performed at a constant intensity. This intensity should be moderate, between 60% and 85% HR max, so that the performer is working in the aerobic training zone.

As continuous training sessions are performed at a moderate intensity over a long duration, continuous training is best suited to long-distance activities where there are few changes in intensity, such as marathon running.

For example, a long-distance runner may choose to exercise at a 6 min/km pace for 60 minutes, running a distance of 10 km.

Applied
For this e
long-dist
basic FIT
overload

Fartlek training

Fartlek training uses varied speeds
change the intensity of exercise. D
use for fartlek training include road
the intensity of exercise varies, the
aerobic and anaerobic training zon

Fart ra g is suited to perform
a ity varies, such as long-dista
over a variety of inclines, or for tea
involved in walking, jogging, runnin

For examp gby player may alternate between a jog for 2 minutes in the aerobic training zone and a run for 1 minute in the anaerobic training zone.

Did you know?

Fartlek is the Swedish term for 'g
play', and is essentially a mix be
continuous training and interval t

Interval training

Interval training involves periods of work interspersed by periods of rest. The time of work and rest periods are expressed as a work-to-rest ratio. Interval training for aerobic endurance involves long work periods and short rest or recovery periods. As such, there are fewer intervals required for aerobic endurance training. The intensity of training should be greater than that of continuous training as rest periods allow the performer to recover. Therefore, the performer should look towards the top end of the aerobic training zone (around 80%).

Interval training is suited to sports of an intermittent natu[illegible]ich involve breaks

The design of an interval training session [illegible] co[illegible]ist of multiple repetitions (re[illegible] work period and a rest/recovery p[illegible] performer may perform a single set [illegible] Each set may be different [illegible] and usually has its own extended period of res[illegible]

For examp[illegible]ckey player may use the following interval training session pla[illegible]
***Set 1:** 3 reps of 4 minutes' work at 80% HRM, with 1-minute rest and recovery per[illegible]*
***Set 2:** 3 reps of 3 minutes' work at 80% HRM, with 30-second rest periods (a 6:1 w[illegible]*

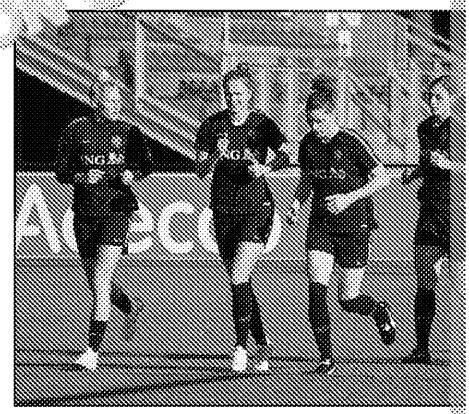
Interval training can also be used for speed (covered later in this chapter), but the[illegible]

- **Work periods** – work periods are performed at a lower intensity for a longer[illegible] for aerobic endurance.
- **Rest periods** – rest periods will be shorter as recovery is quicker. This is beca[illegible] products like lactic acid to be cleared between bouts.
- **Number of reps** – the number of work and rest periods will be fewer for aer[illegible] due to work periods being longer in duration, so lots of reps would result in [illegible] intensity at which interval training is performed.

Case study

Fitness training for team sports such as football has changed dramat[illegible] over the years. Traditional methods to build aerobic endurance used[illegible] around continuous training, where players would be sent to run a giv[illegible] a constant intensity, particularly when rebuilding fitness in preseason[illegible] turn of the twenty-first century when research around football was g[illegible] the field of sport science was becoming a popular discipline, the em[illegible] training became more focused on short, sharp periods of exercise, in[illegible] with periods of rest; characteristic of interval training. This reflects th[illegible] state of the game, where the intensity of play is greater and player[illegible] performing more and more repeated sprints.

Applied activity
Evaluate th[illegible]inu[illegible]ng and [illegible]val training for [illegible]ball. What are the benefits or drawbacks of performing each?



Circuit training

Circuit training involves a range of
different 'stations'. For aerobic end
are completed for a given amount
so that rest periods between each a
complete cycle of stations is classe
repeated depending on the duratio

Circuit training may be used by a ra
between stations can help maintain

*For example, an endurance performer such as a triat[illegible]n may have a 60-minut
spend 15 minutes on each of the exercise bik[illegible]t ea[illegible]l, rowing machine and s*

Circuit training can be m[illegible] to target other components of fitness. For ex

- Differe[illegible]rci[illegible]d be performed at each station, such as body resista[illegible]ats or dumb-bell rows for muscular endura[illegible]training.
- The duration of work and rest/recovery periods could change to manipulate the work-to-rest ratio.
- The number of exercise stations or the amount of complete circuits could be changed.

App
Disc
used
com

Flexibility

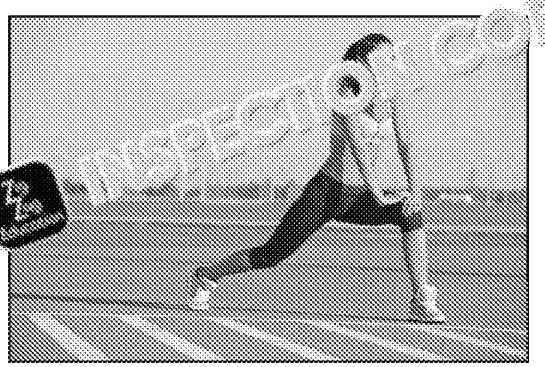
Training for flexibility involves various stretching exercises that can be performed
training is effective at both improving performance and reducing the risk of injury
muscles used in the sporting activity requiring flexibility in order to ensure that tra
specificity. The types of stretches focused on here include static active and passiv
neuromuscular facilitation (PNF).

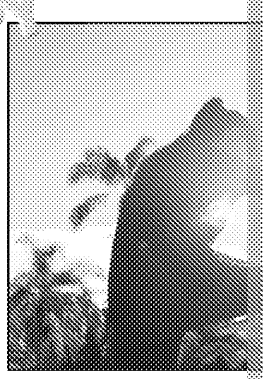
Static stretching

Static stretching is split into active and passive forms. Both types involve holding
30 seconds before moving on to the next body part used in the sporting activity.
rounds to safely increase the length of the muscle each time.

Static active stretching
An internal force is applied by the performer actively stretching and lengthening the muscle themselves.

Static passi
The performer use
stretch the musc
person or an o





Applied activity
List **three** different types of stretches for both method
of static stretching and then try them out yourself!

Proprioceptive neuromuscular facilitation (PNF)

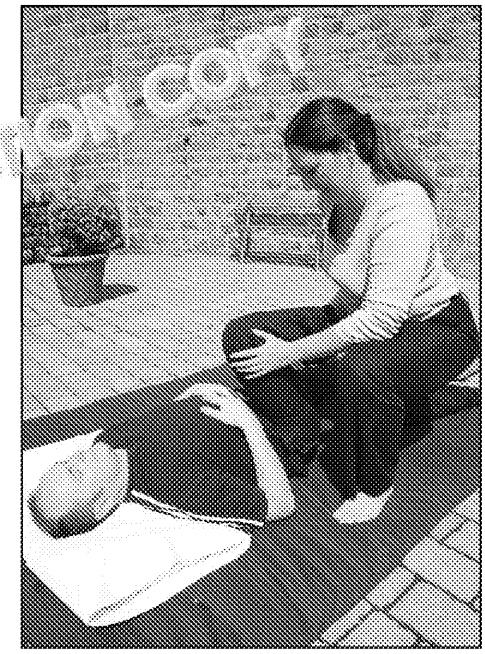
PNF is a technique that inhibits the stretch reflex of the muscle to gradually increa range. It requires the help of a partner or an external resistance, and consists of th

Stage 1
The muscle is passively stretched using the assistance of a partner or an object (e.g. an elastic resistance band) and is held for a few seconds.

Stage 2
The performer isometrically contracts the muscle being stretched by pushing [illegible] the part[illegible] ob[illegible] without mov[illegible] occurring.

Stage 3
The performer relaxes the muscle and then stretches it again with the help of the partner or object. This stretch overrides the stretch reflex and the muscle is able to extend beyond its initial stretch.

Stretch reflex – a protective mechanism of the muscle whereby it contracts when a stretch is detected, preventing the muscle from overstretching.



Muscular endurance and muscular strength trainin

Free weights and fixed resistance machines are both methods of training for impr
muscular strength. The main difference between the two is the principles behind

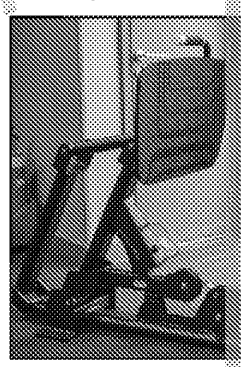
Free weights

Any piece of weighted gym apparatus not attached to other equipment. These are useful as they are easily portable and can be used for a wide range of exercises. They also take up less space so are more widespread in a gym, meaning the performer is less likely to be waiting around for equipment to be free.

Examples include dumb-bells, barbells, kettle bells, medicine balls and resistance bands.

Fixed resist

These usually oper
system or allow weig
on. A lot of fixed r
specific to a partic
cable systems allo
and have multiple
range of exerci



*Examples includ
down and han
Dual cable syste*

TRAINING FOR MUSCULAR STRENGTH

- High loads (> 70% 1RM)
- Low number of reps (around 4–8)
- Longer rest periods (around 3 mins)

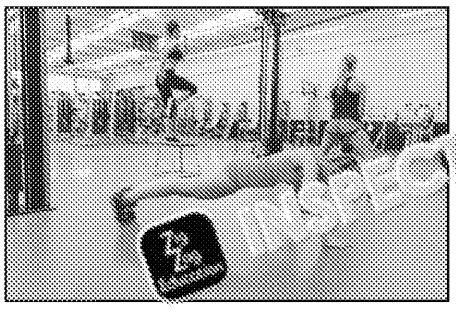
VS

TRAI MUSCULA

- Low loads (<
- High numbe
- Short rest pe

Circuit training *(for muscular endurance)*

Like circuit training for aerobic endurance, circuit training for muscular endurance
exercises at each station.



There are a few key differences:

- **Types of ex s** – circuit training
body es ta e of free weight exerc
nb of reps.
- **Time at each station** – the time at e
determined by the number of reps b
the duration of the activity. This ens
the right number of reps needed to i

The rest periods between stations will still be short in order to improve the muscle
the build-up of waste products.

For example, a rugby player might complete a circuit of weighted press-ups, TRX rows, lunges, kettle bell swings and band-assisted pull-ups, performing 12 reps for each exercise and having 1 minute rest between each circuit, completing three circuits.

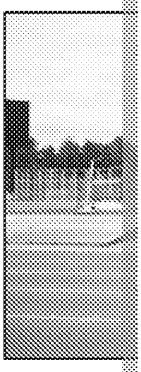
A
Su
pe
ap
ov

Speed training

There are a number of different training methods that can be used to develop spe
sprints, interval training and different resistance drills.

Acceleration sprints

The performer starts from a standing or rolling start and then gradually increases their pace from a jog, to a stride, into a maximal sprint.

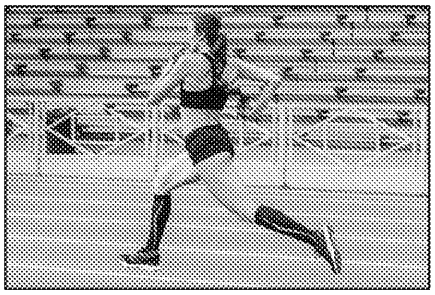


This helps the performer to focus on sprinting technique by starting slowly and then maintaining form into the sprint. It also reduces fatigue during the session as the performer is not performi
maximal acceleration, which can be more energeti
anding.

Standing/rolling start → Jo
Stride → Sprint

Interval t g

Interval train
speed involves the same elements as interval training for aero
work periods interspersed with periods of rest.

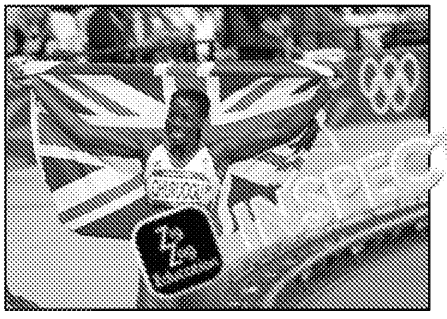


For example, a 200 m runner may perform six 10-second sprints followed by a 2-minute rest – a work-to-rest ratio of 1:16.

However, there are a few key differences:

- **Work periods** – work periods are pe
for a shorter duration when interval t
of work periods will be purely anaero
- **Rest periods** – rest periods will be lo
to recover between each bout. This
build-up of waste products that need
work period.
- **Number of reps** – the number of wo
greater for speed interval training. T
shorter; therefore more reps can be

Applied activity
Have a go at designing your own interv
and outline the differences you would m
it for aerobic endurance.



Research activity
There are different types of interval tra
interval training (HIIT) and sprint interva
them here: ak 12122-interval

Case study

Interval training for speed was common
runner Christine Ohuruogu. This is becau
able to tolerate a large build-up in wa
yet still maintain a high intensity right th

Resistance drills

These utilise a range of different equipment or natural resources to apply an added resistance to sprinting and accelerating, helping to develop sprint speed.

*Examp
bunge*

Hill runs are also an effective way of applying a resistance, and may be more acces
that require equipment and/or help from a partner.

Chapter C3:
Fitness training methods
skill-related components of f

Training methods and exercises also exist for the various skill-related components require creativity in designing for specific sports participants that are of different a

Agility

Speed, agility and quickness (SAQ) training is commonly used to improve agility. This involves short, sharp, multidirectional movements using equipment such as cones, ladders a ies. It works to develop motor skills by training the ne scular system – the connection between the n muscle.

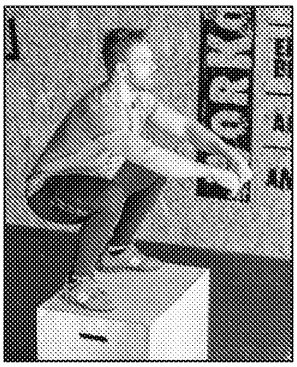
Applied activity
Time to g tiv - design your own SAQ training drill!

Did you know?

SAQ® training is trademark-registered.
You can access equipment and programmes through their website: **zzed.uk/1212**

Power

Plyometric training is used to develop power.



Plyometric exercises consist of three key stages:

Stage 1: Controlled eccentric contraction (where the muscle lengthens).

Stage 2: Amortisation phase where elastic energy is stored, ready to recoil.

Power is the combination of speed and strength. Stren the force needed to overcome a given resistance. Ther selecting the optimum weight to maximise power. This

Examples of plyometric exercises include box jumps, hurdle jumps, medicine ba incline press-ups.

Balance

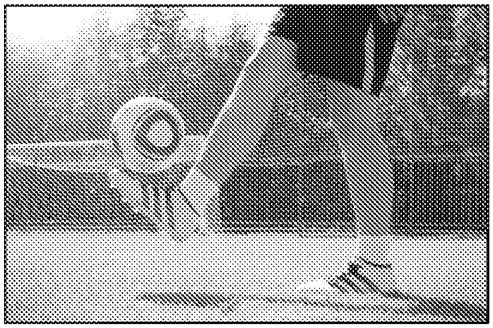
Specific training exercises to develop b nvolve balancing on a reduced-size base of support.

There is var u that can be used and exercises that can be done by a p r to achieve this:

- **Balance boards** provide an unstable surface which challenges the performer to continuously correct their posture and try to maintain their centre of mass over the reduced base of support.
- **Single-leg exercises** provide a stable surface with a reduced base of support, and can be used to perform a range of static and dynamic exercises possible in different directions or hopping side to side and front to back.

Coordination

Specific training exercises to develop coordination involve using two or more bod

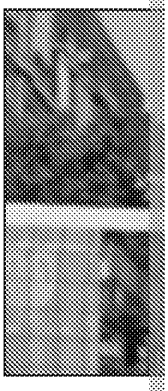


Coordination in sport commonly involv
hands or feet, such as following the ba
highest point, or dribbling with a footb
teammates and opposition players.

Example activities to develop hand–eye
include juggling or rope jumping. Exer
such as performing kick-ups in football
a ball in cricket or alternating hands

Reaction time

Specific training exercises to develop reaction time involve practising rapid responses to an external stimulus. These stimuli may be responding to a noise or signal, such as the blow of the whistle or the drop of an arm, or they could be in response to a moving object, such as a bouncing rugby ball.



Reaction time activities may also integrate an element of decision-making, such as someone shouting the colour of a cone that the performer must touch or run towards. Activities can be made sport-specific, such as reacting to a shot played by smash shots made by an opponent in volleyball.

Applied a
Design you
balance, c
sport of yo
specific to
reaction ti

Chapter C4:
Additional requirements
for each of the fitness training m

Not all fitness training methods are as effective as each other at improving certain
may better reflect the demands of certain sports more than others, or some may b
given component of fitness. There are also other advantages and disadvantages o
including the number of participants that can take part, the ease of setting up, the
injury that each method poses to the performer. These should all be considered w
training methods are most effective, safe and accessible to a specific sports partici
advantages and disadvantages for the main training methods are summarised in t

Training method	Advantages	
Continuous training	• Minimal equipment required • Can be done in simple environments • Can be performed for a variety of modes • Easy to gauge intensity • Easy to progressively overload • Can be performed in a group or on one's own	• Tedious • May result • Requires m long durat • Not sport-s • Little room • Doesn't de fitness com
Fartlek training	• Performer can adjust intensity throughout (e.g. to suit speed or muscular endurance) • Improves aerobic and anaerobic fitness • Develops a range of fitness components • No equipment required • Uses many environments, which helps prevent tedium • Specific to physical demands of intermittent sports such as football and tennis • Can be performed in a group or on one's own	• Not wholly is solely an • Athletes m the sprint • Some terra • Changes in of injury • Most sport • Difficult to varying int
Interval training	• Requires minimal equipment • Can be done in many environments • Work-to-rest ratios can be manipulated to mimic fitness needs • Improves aerobic and anaerobic fitness • Develops a range of fitness components • Easy to apply progressive overload	• Requires e appropriat • Increased • Requires h • Requires ti
Circuit training	• Intensity and duration of each station can be tailored to different fitness needs • Types of exercise can be altered to improve different components of fitness • Range of exercises provides variety, which helps prevent tedium • Exercises can target the whole body or isolate different areas used in the sporting activity • Exercises can be made sport-specific (e.g. use of treadmills for running, exercise bikes for cycling) • Can be performed in large groups • Can be performed using body weight exercises to avoid cost of equipment	• May requi e.g. racks, if weight t • May take a • Requires a the circuit • Not wholly performed • Inappropri cause fatig fatigue-rel • Cost of eq

Training method	Advantages	
Flexibility training	• Simple to perform • Active stretches can be performed on one's own • Suitable for all ability levels • Can be done with little or no equipment • Effective in injury prevention and improving flexibility • Can focus on specific muscle groups	• Tedious • Performer • Risk of goi • Doesn't in • Performer • Passive str external re
Weight training	• A variety of exercises can be performed • A variety of equipment can be used • A number of different metho[illegible] be used • Can target is[illegible]cle groups and perf[illegible]body movements [illegible] apply progressive overload Can manipulate load, sets and reps to target a range of fitness components	• A spotter training cl • Correct te • Increased • May requi membersh • Not sport- • Requires n
Speed training	• Numerous participants can take part in acceleration sprints at any one time • A variety of equipment can be used for resistance drills for variation • A number of different training methods can be used • Resistance drills can be manipulated to enhance speed, e.g. the weight of a sled • Resistance drills can replicate the demands of sports (e.g. leg drive in a rugby tackle)	• There may for numer resistance • Equipment • Replicating requires a an athletic • High risk o • Requires h
SAQ training	• A variety of equipment can be used • Activities can be made sport specific, e.g. zigzag movement in and out of cones can replicate dribbling in ball sports • Can be performed with simple equipment (e.g. cones) • Can replicate demands of a sport, e.g. using a ball with drills • Can be performed in large groups	• May use a to cost (e. • Highly spe actions inv • Risk of inju twisting an • Can be hig
Plyometrics	• Can use sport-specific movements • Uses a range of equipment • Effective for developing power • Training sessions are usually [illegible]	• High risk o • Correct te • Performer • May requi • Only deve
Specific training exercises	• Can be made [illegible]ific, i.e. by incl[illegible]s such as catching, [illegible]g or kicking A range of equipment and exercises can be used for variety • Numerous participants can often take part at once	• Some exer e.g. reactio such as in reacting to • Requires c

Checking understanding questions

1. Continuous training and interval training are used to improve aerobic endur
   a) Identify **two** characteristics of continuous training.
   b) Name **two** other training methods used to improve aerobic endurance
   continuous training and interval training.

2. Describe the difference between active and passive forms of static stretchin

3. Describe the difference between the training princi[illegible]r muscular strengt
   and endurance.

4. Describe how interval traini[illegible]hen training for aerobic endurance a

Taking it f[illegible]e[illegible]stions

1. For a sp[illegible]f your choice, justify **two** examples of free weight exercises th
   be relevant for that sport.

2. Give **two** examples of specific training exercises that could be used to impr
   coordination for tennis.

3. For a sport of your choice, explain the activities that would go into an appro
   warm-up and cool-down.

Chapter C5:
Provision for taking part in fitness tra

Fitness training is provided by three sectors – public, private and voluntary. Thes
disadvantages to performers in sport, relating to types of equipment they offer, th
and additional support offered.

Public provision

The main aim of sports providers in the public sector is to increase participation levels in sport within a local area. Therefore, they are more focused on breaking even on the money invested and on the money they receive. Sport in the public sector is provided for by government funding, which comes from taxes and National Insurance paid by the general public. This is distributed to local government and authorities such as councils, which provide facilities and initiatives to get people involved in sport.

Examples include local leisure centres, public tennis courts, and sports fields for
This allows for participation in a range of training methods, such as continuous
fields and circuit training in leisure centres.

Advantages	Di
• Provides a wide range of sport and physical activities to increase the diversity of opportunities, so that people from all backgrounds and walks of life can get involved • Cost of participation is heavily subsidised as sports providers in the public sector are not looking to make a profit, but must still ensure they cover the costs to run facilities and pay staff	• Facilities and equip cut costs and may • There may be a lac different categorie accessible features • There are limited a users, such as pers and crèches

Did you know?

Greater participation levels in sport improves the health of th
nation. This, in turn, reduces the financial strain on the NHS, ha
positive impact on the economy. Physical inactivity is estimate
the NHS around £1 billion per year. This is one of the main re
government provides funding for public provision of sports!

Private provision

The main aim of sports providers in the private sector is to make a profit. These are often run by a consortium of investors who open more and more facilities in major urban areas around the country as their brand becomes more and more successful and thus profitable. Private sports providers are also run by individuals who are able to invest their own money into a local gym and grow their brand. The private sector also extends to sports clubs whose facilities are exclusive to members who are signed onto a sports club or who pay a membership fee.

Examples include health and fitness centres such as PureGym, Bannatyne, Virgi... This allows the use of equipment in a range of fitnes... methods, such as... training for muscular strength and endurance, and ... metrics for power.

Advantages	Di
• Provid... ilc... vice to cater for the latest trends ... th and fitness, securing popularity • Equipment is top-class and regularly maintained • There is often access to additional services such as personal training, physiotherapy, refreshments and crèche facilities	• Memberships are ... can be very costly, ... may have a lower ... • Access to some fa... members only, an... general public

Case studies

Sports providers in the private sector have built their success on responding quic... fitness trends. For example, centres such as PureGym offer a range of fitness cla... to paying members. PureGym also have their own personal training academy w... becoming a certified PT within 14 weeks. They also guarantee a role in the gym ... allowing people looking to pursue this career path to work their way up to a ma... More information on this course can be found here:
zzed.uk/12122-puregym

Voluntary provision

The main aim of sports providers in the voluntary sector is to meet the needs of people in the local area. Voluntary provision of sport is not-for-profit and is usually run by people in the local area who have an interest in and a passion for sport and their local community. This requires these individuals to give up their own time to organise training sessions and supervise fixtures, among other roles. Costs towards facility hire, equipment and running the club are mainly covered by subscriptions from registered members, but may also be partly self-f... d, elped out through grants and sponsors, or generated thr... ug... f... aising events.

Examples include amate... ...ubs that compete in local leagues or for fun, football. This allo... ... to train for their sports using physical fitness metho... skill-relat... ...ing methods related to the sport.

Advantages	Di
• Sports provision is tailored to the needs of the local area • Cost of participation is low, making it accessible for people with a low disposable income • Can provide a range of sports or physical activity opportunities	• Requires volunteer... their free time to r... • Provision of sport ... operating in debt ... or an increased co...

Chapter C6: The effects of long-term fitness on the body systems

Training for the different components of fitness results in certain responses to the training over the space of 6–12 weeks, the repeated exposure to training for the v application of training principles to fitness programmes results in adaptations to t permanent changes to the structure and function of the body's systems, and are t improvements in each component of physical fitness. This section will look at the for each component of physical fitness.

Aerobic endurance training

Training for aerobic endurance resu[illegible]d[illegible]ations to the **cardiovascular** and **respiratory** systems.

Cardiac h[illegible]rophy

This is the in[illegible] in the size of the heart that occurs as a result of regular aerobic endurance training. In particular, it is the left ventricular wall that increases in thickness. This is because blood flows from the left ventricle to the rest of the body during exercise, allowing the left ventricle to contract with more force to increase stroke volume.

Stro
bloo
ven

Decreased resting heart rate

As more blood is able to leave the heart per beat (increased stroke volume), the h achieve the same volume of blood needed by the body's tissues at rest in fewer b applies during exercise: when training for aerobic endurance, over time, heart rate any given speed as it has become more efficient at pumping blood around the bo working muscles.

Research activity

A resting heart rate below 60 bpm may not always be a sign of good health and fitness. Read more about what is a 'normal' pulse rate on the British Heart Foundation website:

zzed.uk/12122-pulse

Increased strength of respiratory muscles

Respiratory muscles include the intercostals and the diaphragm, and are the important muscles involved in the processes of inhalation (breathing in) and exhalation (breathing out). The intercostals run between th[illegible]s and the diaphragm, found at the base of the ribs. When w[illegible]or at[illegible]in, these muscles contract and the diaphragm flattens, whic[illegible] th[illegible]ribcage up and out and allows air to fill the lungs. When v[illegible]o[illegible]out, these muscles relax and the diaphragm becomes dom[illegible]which reduces the volume of the chest cavity and fo[illegible]air [illegible]e lungs. An increased strength of respiratory muscles allo[illegible]e air to be drawn into the lungs per breath, known as an increased tid[illegible]ume.

R
c
b
f

Capillarisation around alveoli

Capillaries are microscopic blood vessels that branch out from arteries and veins in the body. They are involved in gaseous exchange at the lungs and at the oxygen from the atmosphere is exchanged for carbon dioxide produced as a by-p muscles. Training for aerobic endurance increases the density of capillaries – an a capillarisation. This increases the rate of gaseous exchange at the lungs, allowing the blood to the working muscles. Gaseous exchange occurs at the alveoli, a colle end branches of the respiratory system.

Flexibility training

Training for flexibility results in adaptations to the **muscular** and **skeletal** systems

Increased flexibility of connective tissue

Ligaments and tendons are connective structures around the joint. Ligaments join to bone whereas tendons join muscles to bone. When the muscle contracts, the t pulls on the bone to cause movement. Flexibility training can increase the pliabilit these connective tissues, allowing them to safely stretch to a greater degree.

Increased muscle length

Muscle is an elastic tissue that is able to stretch and shorten during contraction. T biomechanical effect of flexibility training results in an [illegible] changes to the mus which allow it to increase in length. This increases the [illegible] range of motion that a is able to move through.

Increased range of motion permitted at the joint

Both an inc[illegible] flexibility of connective tissue and an increase in muscle length greater rang[illegible] motion at the joint. This is what ultimately leads to improvement flexibility as a component of fitness, and translates to an enhanced performance i and sporting actions requiring flexibility, such as gymnastics and hurdle jumping.

Muscular endurance training

Training for muscular endurance results in adaptations to the **muscular** system.

Capillarisation of muscle tissues

Just as capillarisation occurs around the alveoli with aerobic endurance training, it also occurs around the muscles as a result of muscular endurance training. Many activities that develop aerobic endurance will develop muscular endurance as well, and so capillarisation as an adaptation to training will occur around both the alveoli and the muscle at the same time. Increased capillarisation around the muscle allows the muscle cell to extract more oxygen from the blood and remove more carbon dioxide produced as a by-product during exercise.

Increased muscle tone

Muscular endurance training helps to build lean muscle and burn fat. This improv the ratio of fat-free mass to fat mass. This, in turn, results in a toned appearance.

Applied activity

How might an increased muscle tone benefit an endurance [illegible]?

Muscular strength and power training

Training for muscular strength results in adaptations to the **muscular** and **skeleta**

Increased bone density

Any activity that places a stress on the skeletal system can help to increase bone d
training involves loading the muscle under large forces. In order to produce move
to cause the tendon to pull on the bone. This action places a stress on the bones,

Power training involves bounding exercises that result in large forces on the skeletal system. Weight-bearing activities such as hurdle jumping result in constant remodelling of bone, which increases bone mass and bone density.

Weight-
any acti
support

Muscle hypertrophy

Hypertrophy refers to the inc in s of a tissue. In this case, it is the skeletal
that are being worked through muscular strength and power training. Strength tr
places a lar ha tension on the muscles as they work under high loads.
stimulates t nesis of muscle protein, which increases muscle size.

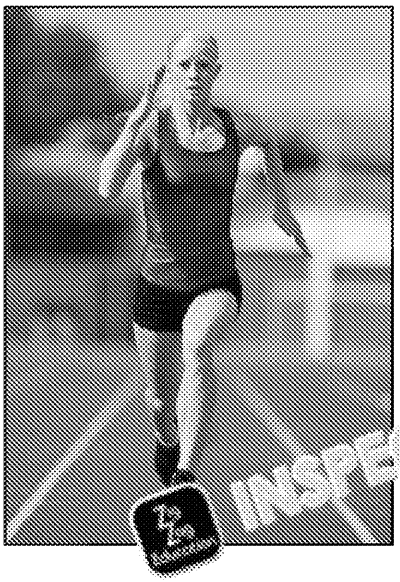
The eccentric action of plyometric exercises when power training results in structu
damage to the muscle. The reparation of this damage adds muscle protein, which
contributes to increases in the size of muscles.

Increased strength of ligaments and tendons

Alongside increases to the size and strength of muscles, muscular strength and po
ligaments and tendons. This helps protect against tendon and ligament injuries th
weights or when performing explosive exercises.

Speed training

Training for speed results in adaptations to the **muscular** system.



Lactic acid is a by-product of anaerobic exerci
painful sensations felt when performing high-i
training methods involve repeated sprints that
system, it results in a build-up of lactic acid in

Over time, training helps the body to improve
from the muscle and its ability to tolerate it. T
a higher intensity of exercise before lactic acid
and also helps them maint in the same exercis

Did you know?

Lactic acid removed from the muscle can be transported to the liver and converted to glucose to be used as a fuel source for exerc

Checking understanding questions

1. Identify **one** advantage and **one** disadvantage of voluntary sport and physica activity provision.

2. Explain **two** long-term effects of flexibility training.

Taking it further questions

1. Patricia is looking into the negatives of different type sporting provision which would be most suitable for her.
   a) State **one** disadvantage of publi sic of sport and the impact this have on Patricia.
   b) State **one** disad private provision of sport and the impact this ha Pa

2. Chiwetel a triathlete who has benefited from cardiac hypertrophy as a res aerobic endurance training.

   Explain **one** reason why cardiac hypertrophy would benefit Chiwetel's perfo in the triathlon.

Learning Outcome D: Investigate fitnes to improve fitness and sports per

Overview

In this section you will gain an understanding of the personal information that aids the design of a fitness training programme, and how the programme itself is designed.

You will also learn about the different motivational techniques for fitness programming and the benefit they have on the performer, as well as the principles of goal-setting and h setting person and long-term goals can influe vation.

Learning outcomes

After studying this chapter you should be able to:

D1/D2: Understand the personal information which is used programme design.

- ❑ Identify the different pieces of personal information a fitness programme design
- ❑ Explain how the differen eces of information are u
- ❑ Analyse the app tra ning methods and appli fitn s ro ra me

Und stand the motivational techniques that are used goals can be set to influence motivation.

- ❑ Identify the different types of motivation and the SM
- ❑ Describe short- and long-term goals and give examp
- ❑ Explain the impact of goal-setting on motivation an sports performer

Key terms

Aims	outline what the participant is hoping to achieve overa
Attitude	the way in which an individual approaches a task
Lifestyle	how someone lives their life and the factors involved
Motivation	the external stimuli and reasons we have that stimulate behaviour
Intrinsic motivation	the internal drivers for success
Extrinsic motivation	the external stimuli that direct behaviour
Objectives	outlines how the performer intends to meet their aim
SMARTER principles of goal-setting:	
Specific	goals should relate to the overall aims of the training p an aspect of the performer's sport/activity that needs i
Measurable	goals should be able to be monitored through some s as time taken or weight lifted
Achievable	goals should be tailored to all 'quick wins' to be
Realistic	goals should be s vi the capabilities of the perfo effects
Time-related	oa should be given a set duration in which to achiev against what was expected
Exciting	to prevent the boredom of training, goals should allow excitement to maintain motivation
Recorded	goals should allow a record to be kept for reference w training programme
Short-term goals	goals set over a short period of time, usually between
Long-term goals	goals set over a longer time frame which lay out what in the future

Chapter D1: Personal information to aid fitness training programm

It is important to gather relevant pieces of information about the participant you a programme for. This allows the fitness trainer to develop a programme that is tail meets their unique needs. Personal information that aids the programme design i lifestyle and physical activity history, and the individual's attitude, mindset and mo

Aims and objectives

The aims of a training programme outline ***what*** th participant is hoping to achie Performers at all levels use set aims for th ining programmes. An elite perfor programme in order to qualify for an t ing competition or make it as a regul performer may complet t ing programme in order to take up a sport or achi Whatever th m , the performer must set objectives to help them achie

The objectives of a training programme, therefore, outline ***how*** the performer inte meet their aim. These are set by considering the appropriate components of fitne methods of training required for the sport. For example, a performer hoping to ta tennis as a sport should set objectives to improve their aerobic endurance, agility, and coordination, which are all components of fitness important for that sport. Th do this by programming appropriate training methods, such as interval training, p and specific training exercises for agility and coordination.

Lifestyle, medical and physical activity history

It is important that information about an individual's lifestyle and their medical an gathered to aid the design of a fitness training programme. This information is us Activity Readiness Questionnaire, known as a PAR-Q.

Lifestyle information aims to identify any factors that may influence training or t designed. Common lifestyle information includes smoking status, alcohol consum example, interventions may be put in place for someone who reports sleeping un affecting performance during their training programme.

Medical history includes any health conditions the individual may have, any medi injuries they have had that may affect their ability to participate in training. For ex may be required to have an inhaler with them in order to take part, or low-impact for someone who has suffered from joint issues.

Physical activity history is gathered to establish ow ex ienced a performer m training and in order to establish a startin for the training programme. For muscular strength training pro ramm the first time will require a gym induct correct use of equipment

Attitud e mind and personal motivation for tra

Attitude – the way in which an individual approaches a task.

It is important for the fitness trainer to understand individual's attitude and motivation towards trainin Everyone participating in a training programme ha different motivations for training. These may be re sports performance or they may be related to imp health and fitness. The fitness trainer can tailor their approach around the individ attitude and motivations. For example, a fitness trainer may use a lot of encourag and positive feedback to someone with a hard-working attitude who responds we kind of motivation.

Chapter D2:
Fitness programme desig

Once the personal information is gathered from the sports participant through qu
is time to use that information to design the fitness training programme. Below is
that might be asked in a questionnaire administered prior to completing a training

Physical Activity Readiness Questionnaire (PAR-Q)

Please read each of the statements below carefully and provide a 'yes' or 'no' answer, or other, where indicated.

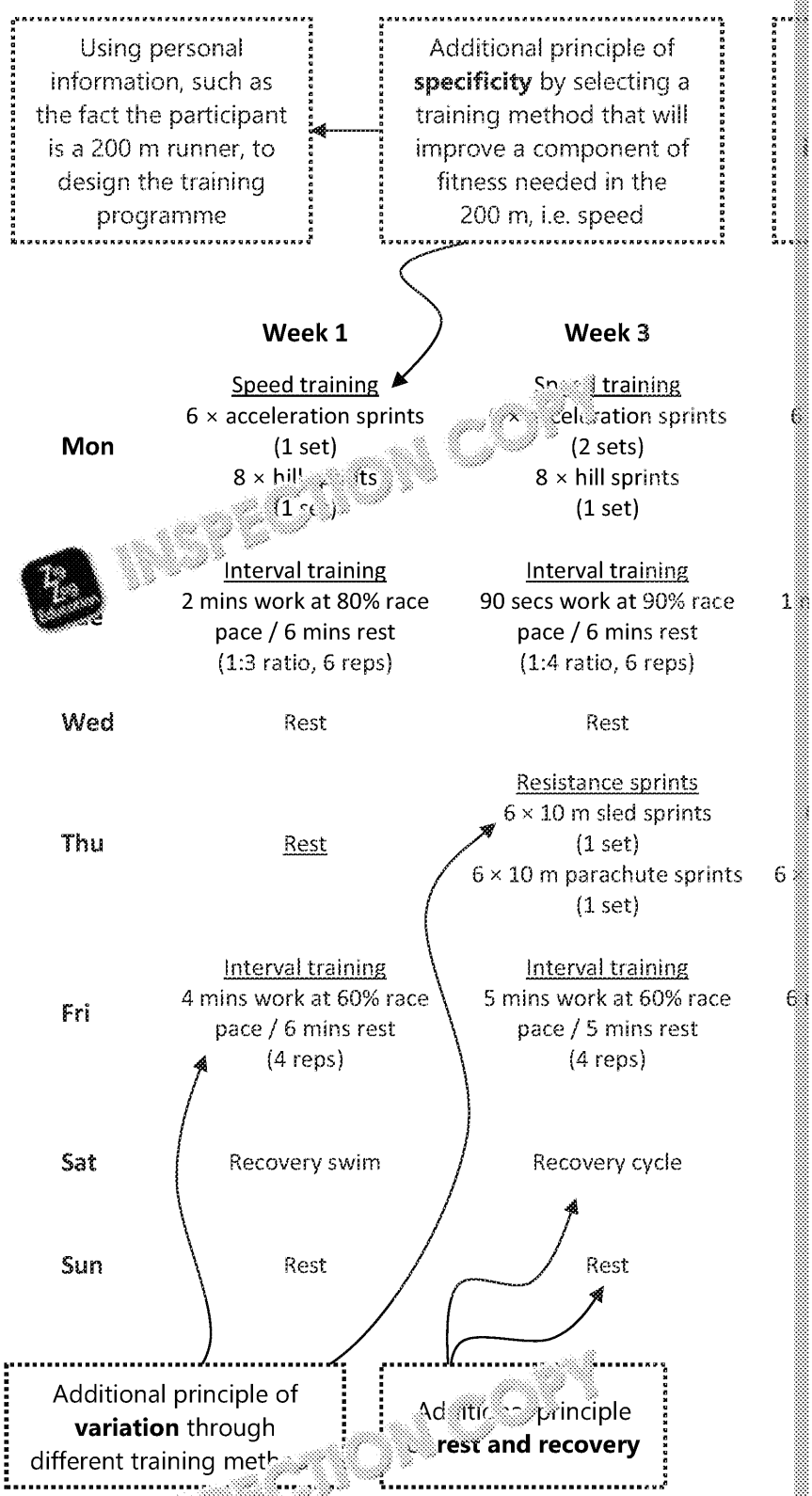
Are you a smoker?	
Do you consume more than 14 units of alcohol on average per week?	
Do you usually get less than 7 hours sleep at night?	
Do you have any health conditions?	
If 'yes', please state which:	
Do you get any pain in your chest when you exercise?	
Do you suffer from joint issues?	
Do you currently have any injuries?	
Are you currently taking any medication?	
Is there any possibility that you are pregnant?	
On average, how many hours per week do you exercise?	

Consideration
account for e
1. **Smoking** stop or r individua of breath
2. **Alcohol** not train of alcoh
3. **Sleep** – gets suff between
4. **Health c** measure someone
5. **Pain in c** to obtain beforeha
6. **Joint iss**
7. **Injuries** the abilit
8. **Medicat** not inter participa
9. **Pregnan** are at ris
10. **Exercise** of famili

Applied activity
Complete the same questionnaire in pairs and swap sheets with a partner. Suggest ways that you would use the information they provided in the design of a training programme.

Selecti[illegible] most appropriate training methods/a applyin[illegible] principles of training

The programme should include information about the training methods and activi components of physical and/or skill-related components related to the participan six-week training programme is shown on the next page for a 200 m runner, with information, training methods and activities, and the principles of training, are app



- **Specifi** ap[illegible]ou to ensure training methods are developing the speed re 200 m r[illegible]g. acceleration (acceleration sprints) and sustained peak speed (
- **Progressive overload** of training is applied through the FITT principles to ens to the increased loads placed on them, but are comfortable enough to deal w injury or fatigue (e.g. increasing the intensity of interval training sessions but r
- **Individual differences** take into account the personal information of the clie the programme is designed around them
- **Adaptation** is achieved through progressive overload of training which provi **rest and recovery** (e.g. through sleep and rest days), where adaptation takes
- Training in each week avoids any **reversibility** in fitness, which would put the
- **Variation** is achieved through different training methods and activities, which

Chapter D3:
Motivational techniques for fitness p

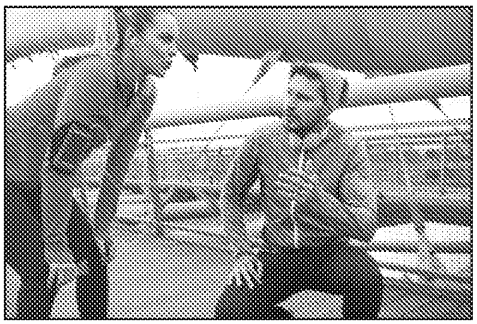
Motivation is key if a performer wants to achieve their training aims. It consists of external stimuli such as encouragement from others, as well as personal reasons for training, helping to provide direction to behaviour. Motivation has many benefits. It allows the performer to put all their effort into each session, helping them get the most out of their training.

Goal-setting over the short term and the long term can act as a motivational tool t adhere to the training programme week by week, and t le focus on the end the types of motivation, the benefits for the perfo ne the use of personal go

Types of motivati

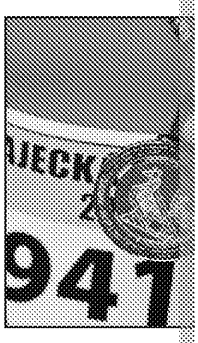
There are two main t motivation – intrinsic and extrinsic.

Intrinsic motivation – the internal drivers for success



Examples include the pride associated with achieving a goal or the self-satisfaction from achieving a personal best performance.

Extrins the external stim



Examples include winning or the pra following a good p

Intrinsic motivation is more personal to the performer and helps them to maintain the long run. Use of extrinsic motivation can help spur the performer on through it is important for it not to be overused as the performer may become reliant on it consistently given for good performances.

Applied activity

Think about w tiv s you to participate in sport Are th or extrinsic factors, or both? Is one a source of motivation to you than the other?

ou could share your responses with a partner.

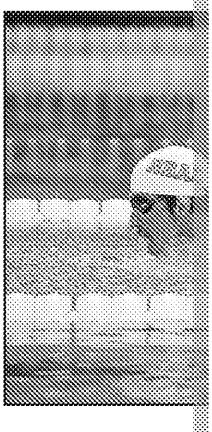
Principles of goal-setting to increase and direct mo

Goal-setting can be used to provide direction for behaviour and to maintain focus programme. However, certain principles of goal-setting must be applied in order encompassed by the SMARTER principles of goal-setting.

SMARTER principle	What it means
Specific	Goals should relate to the overall aims of the training pr an aspect of the performer's sport/activity that needs im
Measurable	Goals should be able to be monitored through some sor as time taken or weight lifted.
Achievable	Goals should be tailored to a[illegible] or 'quick wins' to be n
Realistic	Goals should b[illegible] hin the capabilities of the perform demonstrating effects.
Time[illegible]d	[illegible]s should be given a set duration in which to achieve against what was expected.
Exciting	To prevent the boredom of training, goals should allow t excitement to maintain motivation.
Recorded	Goals should allow a record to be kept for reference whe training programme.

Case study

Michael Phelps used goal-setting throughout his career. When he was young he wrote down a goal 'to win an Olympic gold medal' before crossing it out and replacing it with the goal 'to make the Olympic team'. Even then he was applying the SMARTER principle of 'realistic'. He would go on to use goal-setting for the rest of his career to motivate him towards 23 gold medals.



Applied activity

Create your own goal for a sport of your choice, which meets all the SMARTER principles of goal-setting. You should be able to justify how it satisfies all SMARTER principles.

Goals are set over the short term and the long term. **Short-term** goals are set between a day and a month in duration, whereas **long-term** goals set out what the performer wants to achieve over a longer period of time. Therefore, multiple short-term goals [illegible]ly [illegible]ed into one or two bigger long-term goals.

Short-term go
of time, usual
Long-term go
frame and lay
wishes to ach

For exampl[illegible]tb[illegible] player may set a short-term goal of giving 100% in the nex make it in th[illegible]ing line-up for the next game. Their linked long-term goal may season to feature in the starting line-up for over 80% of games. From this, it is cle that are achieved within a month can lead to long-term goals set to be achieved i

Influence of goal-setting on motivation

Goal-setting is key to providing direction for behaviour and maintaining focus on t
the training programme and offers the performer something to work towards that

Providing direction for behaviour

Goals that apply the SMARTER principles are clear on setting out what the performer is hoping to achieve and when they are hoping to achieve it by. All their behaviours, whether it be their attitude to training, their social life, or the amount of sleep they get, will be directed towards achieving the goal.

Maintaining fo

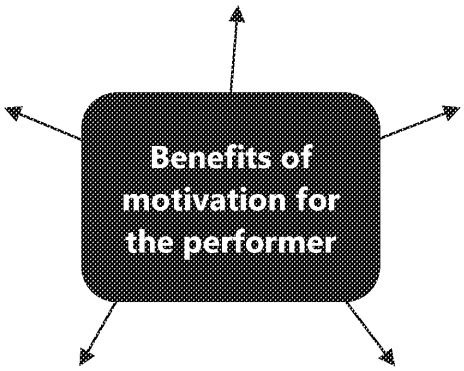
Goals inform the de
as all methods an
achieving the goa
with the focus they
programme, as th
towards

Benefits of motivation on the sports performer

If motivatic ed appropriately by the performer, and they do not become ove
there are ma efits for the performer:

Increased fitness
By adhering to training and maintaining the intensity of training, the performer is able to get the most out of training and increase their levels of fitness.

Increased participation
Having the motivation to train helps to increase participation. It is important to find out what motivates certain people to train and offer these incentives to increase participation rates in sport.



Maintained training intensity
Being motivated for a training session helps the performer to meet the required training intensity. This allows th
get the most out
session.

Improve
By attending
and putting
effort into tra
levels of fit
translate to in
in the

Checking understanding questions

1. Describe the difference between aims and objectives.
2. Identify **two** pieces of lifestyle information which would aid the design of a training programme.
3. Define motivation.
4. Give **two** examples of extrinsic motivation.

Taking it further questions

1. Using a sporting example of your choice, give an example of a suitable aim a
2. Give one example of a short-term goal for a 1500 m athlete who is aiming t the Olympics.
3. Explain **one** way that goal-setting can improve motivation.

Chapter A1

Checking understanding

1. Reaction time

2. Aerobic endurance (1) and muscular endurance (1)

3. Power = Strength (1) × Speed (1)

4. Sprinters require a high muscle mass (1) in order to maxim[illegible] mass that can be us[illegible] contractions (1)

5. Power – any activities requiring e[illegible] movements, e.g. sprinting, high jump
   Muscular endurance – an[illegible] that requires repeated contraction of a muscle, e.g. [illegible] open-water swim[illegible]
   Flexibil[illegible] ac[illegible]ity that requires a large range of movement at the joint, e.g. gym[illegible]
   Coordin[illegible] any activity that uses two or more body parts at the same time, e.g. se[illegible] basketball, drop goal in rugby
   Accept other appropriate responses.

Taking it further

1. e.g. when sidestepping an opponent in rugby / performing a feint in basketball / drib[illegible]
   (or any other suitable examples)

2. Any two named components and supporting examples (max. 4 marks):
   - Flexibility (1) in order to produce a large range of motion at joints in actions suc[illegible]
   - Strength (1) in order to maintain body position on the high rings (1)
   - Balance (1) in order to stay upright on the balance beam (1)
   - Power (1) in order to leap into the air when performing a somersault (1)

   (or any other named components and suitable examples)

3. Max. 6 marks from the following:
   - Aerobic endurance is needed to maintain running intensity / prevent fatigue in t[illegible]
   - Speed is needed in situations such as dribbling with the ball or chasing an oppo[illegible]
   - Aerobic endurance is important for recovery between bouts of sprinting or high[illegible]
   - Aerobic endurance may be more important for players in positions that cover a [illegible]
   - Speed may be more important for players on the wings
   - Aerobic endurance and speed are not important for a goalkeeper
   - Reaction time and agility are more important for a goalkeeper and are also impo[illegible]

   Accept other appropriate responses.

4. Max. 6 marks from the following:
   - Power is needed to hit the ball with speed
   - Coordination is needed to hit the ball wit[illegible] th[illegible] ri[illegible] part of the racquet so that i[illegible] opponent's service box
   - The tennis player requi[illegible] uppe[illegible] body power in the swing of the racquet, as wel[illegible] into the swing
   - A [illegible] w[illegible] power gives the opponent less time to react and successfully retu[illegible]
   - Th[illegible] player should be careful that they are not sacrificing accuracy for pow[illegible]
   - A te[illegible] player has two attempts at a serve, so they may wish to focus on power[illegible] accuracy for the second serve
   - The serve requires multiple subroutines that need to be linked together, which r[illegible]
   - Good coordination allows for an efficient movement, meaning the tennis player [illegible] maximise the power they get behind the serve
   - Hand–eye coordination is required to focus on the ball at the same time as swin[illegible] the sweet spot (full extension of the body)

   Accept other appropriate responses.

Checking understanding

1. Frequency (1)

2. By calculating maximum heart rate (220 – age) (1) and using this value to identify the training zone (1), which is between 60% and 80% HR max (1)

3. Any two from:
   - Heart rate monitors
   - Smartwatches / fitness trackers
   - (Mobile) apps

4. 150 bpm (1)

5. Above 70% (1)

Taking it furth

1. Any tw
   e.g. by i g the number of training sessions performed per week
   e.g. by increasing the %1RM of gym exercises
   e.g. by increasing the length of strength training sessions

2. To recover between training sessions (1), allowing the body to adapt (1)

3. 3 marks for:
   - Heart rate max = 220 – age OR 220 – 36
   - Anaerobic training zone = 80–100% OR 184 bpm × 0.80 to 184 bpm × 1.00
   - = 147 bpm to 184 bpm

4. - Specificity – e.g. performing interval training to improve aerobic endurance need the full duration of a game (1)
   - Individual differences – e.g. to develop the speed of a hockey player for whom thi
   - Variation – e.g. to perform interval training sessions alongside agility training ses components and maintain the motivation of the player (1)

   Accept other suitable examples.

Chapters B1, B2, B3 and B4

Checking understanding

1. Any three from:
   - Provides baseline data that can be used as a comparison to future testing in ord
   - Informs the design of training programmes based on test results that highlight s
   - To see whether the training programme is working by testing midway through
   - Provides the performer with something to aim for
   - Allows the performer to set goals in line with the results

2. Any two from:
   - To ensure participants are aware of the test protocols
   - To ensure participants are aware of any risks
   - To ensure participants are aware that they are free to withdraw at any time
   - To give participants the opportunity to ask questions about the test
   - To protect the person administering the test

3. Any two from (max. 4 ma
   - The calibration of equipment (1) will determine whether the results recorded wit
   - Th ation of the participant (1) will determine how much effort they put in
   - The conditions of the test environment (1) will determine how much of an effect playing surface will have (1)
   - The experience of the person administering the test (1) will influence how well th results are recorded and analysed (1)
   - Compliance with the test procedures (1) affects how closely steps are followed (

4. 1 mark for:
   The measure of whether the results of a test actually reflect the component of fitness

5. Any two from:
   - Multistage fitness test
   - Yo-yo test
   - Harvard step test
   - 12-minute Cooper run/swim

6. **a.** Coordination (1)
   b. 3 marks for:
   - The participant stands 2 m away from a wall
   - The participant throws a tennis ball off the wall with one hand and catches
   - The number of successful catches in 30 seconds is used as the test score

7. 4 marks for:
   - Client A – Normal weight
   - Client B – Underweight
   - Client C – Obese
   - Client D – Overweight

Taking it further

1. Any two from:
   - The grip dynamometer and the plates / bells / squat rack / gym membership both be costly, so tests are equally impractical
   - The 1RM test take perform, so is less practical
   - The com the 1RM and the grip dynamometer could take a similar amo ar practical
   - Th taken to analyse the results from both tests is minimal, so both tests ar
   - Only one participant can be tested at any one time for both tests (as equipment is

2. 1 mark for component of fitness and 1 mark for justification, maximum 2 marks:
   - Agility (1) – their rating on the Illinois agility run test is below average, and they change direction quickly in response to the opponent's shots (1)
   - Power (1) – their rating is only average on the vertical jump test, and they need e.g. during a serve (1)
   - Coordination (1) – despite having an above average rating on the alternate-han still improve their hand–eye coordination between racquet and ball (1)

   Accept other suitable explanations.

Checking understanding

1. a. Any two from:
   - Low-to-moderate intensity
   - Constant intensity
   - > 30 minutes in duration

   b. Fartlek training (1) and circuit training (1)

2. An active stretch is one that uses an internal force to stretch the muscle (1) whereas a
external force is applied to the body in order to stretch the muscle (1)

3. Any two from:
   - Training for muscular strength uses high load
   - Training for muscular strength uses
   number of reps
   - The duration of rest

4. 2 marks
   - The intensity of work periods is greater when interval training for speed compar
   - The number/length of rest periods is greater when interval training for speed co

Taking it further

1. e.g. rugby
   - Squats are relevant for improving strength when tackling or scrummaging
   - Deadlifts are relevant to lifting in the line-out

   Accept other suitable sports that require muscular strength/endurance and justifications

2. Any two from:
   - Throwing a ball up in the air with one arm and swinging the other arm back to
   - Rallying with a partner to improve hand–eye coordination between the ball and
   - Juggling the ball with the tennis racquet to improve coordination between ball a

   Accept other suitable examples.

3. e.g. cricket

   Warm-up (sub-max. 3 marks):
   - Pulse raiser to increase heart rate / blood flow to working muscles
   - e.g. running around the boundary of the pitch
   - Mobiliser to increase range of movement at the joints
   - e.g. swinging the arms in circles / using resistance bands for shoulder mobility
   - Stretches to increase the flexibility of muscles / pliability of ligaments and tendo
   - e.g. stretching the main muscles used in cricket (shoulder muscles and leg musc

   Cool-down (sub-max. 3 marks):
   - Light activity to gradually lower pulse and breathing
   - e.g. jogging between two sets of cones
   - Stretching to return muscles to pre-
   - e.g. shoulder reach-through

   Accept other appropriate

Checking understanding

1. Advantages – any one from:
   - Sports provision is tailored to the needs of the local area
   - Cost of participation is low, making it accessible for people with a low disposabl
   - Can provide a range of sports and physical activity opportunities

   Disadvantages – any one from:
   - Requires volunteers who are willing to give up their free time to run a club
   - Provision of sport may stop if consistently operating in debt due to a lack of pay hiring facilities

   Accept other appropriate responses.

2. Any two from:
   - Increased flexibility of connective tissue as tendons/ligaments become more
   - Increased muscle length (1) due to the biomechanical effect of stretching (1)
   - Increased range of movement at the joint (1) due to the increase in flexibility of con mu ng (1)

Taking it fu

1. Public provision – 1 mark for any disadvantage and 1 mark for the impact on Patricia:
   - Basic, poorly maintained equipment and facilities lacking range (1), meaning the part in / equipment may be out of order (1)
   - Lack of specialist provision for different groups (e.g. people with disabilities) (1), accessibility in and around the facility / activities will be inappropriate for some
   - Limited additional services (e.g. crèche or cafeteria) (1), meaning there is little ac beyond cheap pricing (1)

   Private provision – 1 mark for any disadvantage and 1 mark for the impact on Patricia:
   - High cost of using facilities (1), meaning that participation is only affordable to t income (1)
   - Many private facilities have an image of exclusivity (e.g. golf members being par such facilities intimidating (1)
   - Access to members only (1), meaning there is little opportunity to try out facilitie

   Accept other suitable answers.

2. 2 marks for:
   - The heart is able to contract with greater force and increase the delivery of bloo the muscle
   - Chiwetel is able to work at a higher intensity for longer as the muscles are able t and delay fatigue

   Accept other appropriate responses.

Chapters D1, D2 and D3

Checking understanding

1. Aims are *what* the performer is wanting to achieve overall with a training programme
   is planning to achieve their aims (1)

2. Any two from:
   - Smoking status
   - Alcohol consumption
   - Diet
   - Sleep quality/quantity
   - Previous or existing health conditions
   - Stress levels

   Accept any other suitable example.

3. The external stimuli and reasons [illegible] that stimulate and provide direction for beh

4. Any two from:
   - Pa
   - Mo
   - Trophies
   - Medals
   - Awards
   - Certificates

   Accept other suitable examples.

Taking it further

1. e.g. to improve body composition, a suitable aim may be to move from an overweigh
   category (1), and objectives could be to perform three interval training sessions a wee
   energy balance (1)

2. e.g. qualify for regional/national competitions / improve personal best time / improve
   the 1500 m (e.g. speed and muscular endurance)
   Accept other suitable examples.

3. Any one from:
   - Provides direction for behaviour (1) so that the performer completes all planned
   - Maintains focus on the task in hand (1) so that the performer is fully dedicated to

   Accept other suitable explanations.