# Topic Guide 2: Movement Analysis

## GCSE (9-1) Physical Education

**Pearson Edexcel Level 1/Level 2 GCSE (9-1) in Physical Education (1PE0)**

**Pearson Edexcel Level 1/Level 2 GCSE (9-1) in Physical Education (Short Course) (3PE0)**

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# Topic Guide: GCSE Physical Education 2016 and 2017 – Movement Analysis

## Contents

# Introduction

This topic guide gives an overview of the specification topic: Movement Analysis. The guide is designed to give support by detailing content changes in relation to this topic and to give further clarity over the required breadth and depth that needs to be covered. The guide signposts possible resources to aid preparation and delivery and also gives some teaching ideas to assist with planning and delivery.

# Content and content changes

## Component 1, Topic 2: Movement Analysis

| Subject content | What learners need to learn |
|---|---|
| In this topic, learners will develop knowledge and understanding of the basic principles of movement and their effect on performance in physical activity and sport through the following content. | |
| **2.1** **Lever systems, examples of their use in activity and the mechanical advantage they give in movement** | **2.1.1** First, second and third class levers and their use in physical activity and sport |
| | **2.1.2** Mechanical advantage and disadvantage (in relation to loads, efforts and range of movement) of the body's lever systems and the impact on sporting performance |
| **2.2** **Planes and axes of movement** | **2.2.1** Movement patterns using body planes and axes: sagittal, frontal and transverse plane; and frontal, sagittal, vertical axes, applied to physical activities and sporting actions |
| | **2.2.2** Movement in the sagittal plane about the frontal axis when performing front and back tucked or piked somersaults |
| | **2.2.3** Movement in the frontal plane about the sagittal axis when performing cartwheels |
| | **2.2.4** Movement in the transverse plane about the vertical axis when performing a full twist jump in trampolining |

This complete topic is new for 2016. A requirement of all GCSE PE specifications is the inclusion of movement analysis so that learners have the opportunity to develop their knowledge and understanding of the basic principles of movement, and their effect on performance in physical activity and sport. This area of the specification meets these requirements by focusing on two subject areas: lever systems, and planes and axes of movement. Each subject area gives an introduction to this area of movement analysis, forming a foundation for future development as learners progress through their education.

All specification topics have the same Assessment Objectives. This means any topic within Component 1 and Component 2 could be used to assess the learner's:

- knowledge and understanding of factors underpinning performance
- ability to apply their knowledge and understanding of factors underpinning performance
- ability to analyse and evaluate factors underpinning performance.

In this topic, learners will develop knowledge and understanding of the basic principles of movement and their effect on performance in physical activity and sport through the following content.

# Movement Analysis: lever systems

| | |
|---|---|
| **2.1**<br>**Lever systems, examples of their use in activity and the mechanical advantage they give in movement** | **2.1.1** First, second and third class levers and their use in physical activity and sport |
| | **2.1.2** Mechanical advantage and disadvantage (in relation to loads, efforts and range of movement) of the body's lever systems and the impact on sporting performance |

Learners will be expected to **know and understand**:

- the names of the three different lever systems:
  - first class
  - second class
  - third class.
- the names of the components that make up each lever system and the recognised shapes used to depict a level system:
  - Fulcrum – a triangle
  - Load – a square
  - Effort – an arrow
  - Lever arm – straight line.
- mechanical advantage of levers (first and second class levers)
- mechanical disadvantage of levers (third class levers).

Learners should be able to sketch and label each of the lever systems, placing the components in the correct order for the given system, and recognise the lever systems within the body.

Learners will be expected to **apply** their knowledge by using examples that show the use of each type of lever within physical activity, or recognition of their use.

For example:

- A biceps curl uses a third class lever system.
- The fulcrum is the elbow joint.
- The load is the weight being lifted.
- The effort is the force exerted by the muscles. It lies between the fulcrum and the resistance where the muscle pulls on the lever (the bone) to lift the weight.

Learners will be expected to **analyse and evaluate** lever systems.

- An analysis could involve breaking down a given example of a lever system into its component parts, or how the lever system works to bring about the required sporting action.
- An evaluation could involve a comparison of the mechanical advantage and disadvantage of a lever system within sport.

# Movement Analysis: levers – activity ideas

## Activity 1

This topic may be a totally new concept to your learners; therefore, delivery through a mixture of theoretical and practical work may support their understanding.

You could create a video clip or PowerPoint presentation of a range of sporting activities where levers are clearly in use so that learners can see their relevance and importance.

For example:

- an athletics field event, e.g. javelin
- rowing a boat
- kicking a rugby ball
- heading a football
- playing a forehand drive in tennis
- a weights session, e.g. demonstration of a bicep curl
- hitting a ball in cricket.

This type of clip could be used in a number of ways:

- to introduce the topic
- to check understanding, e.g. learners could work in pairs and analyse a specific movement on the clip, identifying the type and components, analysing how the body is acting as a lever system and its mechanical advantage or disadvantage
- for revision.

An alternative starting activity would be to create some levers. Using a ruler, an eraser and a board marker, or similar (one set per learner would be ideal, but this could also be completed in small groups), learners should arrange the 3 items in different ways to try to lift the eraser. They should draw the arrangement of the items when they find a way that allows them to move the eraser, and indicate where they applied effort (force) to the ruler to bring about the movement. They should try to find at least three different ways to arrange the items.

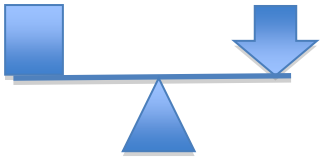
At this point learners will not be aware of the names each item represents, or the conventions for drawing levers. To facilitate this, you may wish to assign a shape to each item before learners begin:

- Ruler = 
- Eraser = 
- Board marker = 
- Effort =  (arrow head to to be drawn in direction that effort is applied)

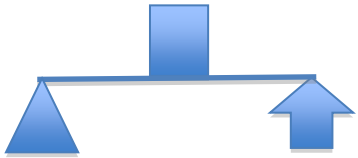
Once each individual or group has found at least one type of lever learners can feedback their findings, possibly drawing the arrangements on the board (or equivalent). Once correct drawings are on the board they can be named (first, second, third class).

Each learner shoud have a drawing of the following:

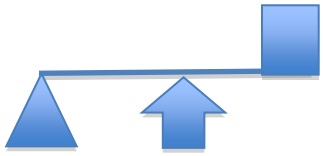
First Class Lever



Second Class Lever



Third Class Lever



The names of the components of the lever systems, and the recognised shape to depict each component, can be discussed by the learners. They should decide the role of each item in their lever system:

- ruler = lever arm
- eraser = load
- board marker = fulcrum
- effort = their muscles.

They should add the following key to their notes:

1. fulcrum  represented by a triangle
2. effort  represented by an arrow (point in the direction of the effort)
3. resistance  represented by a square
4. the lever arm represented by a straight line. 

## Activity 2

One more use of these rudimentary lever systems could be to introduce the concept of mechanical advantage. Learners could recreate each lever system and identify:

- the most efficient arrangement in terms of being able to lift the load
- the least efficient
- whether it makes any difference how far along the lever arm the load or fulcrum are
- how far the load moves when effort is applied.

Clearly it would be easier to differentiate between the types if a more significant load could be used, possibly in a practical session, using weights as the load.

Knowledge gained through this activity could be reinforced by using a selection of sporting images, where learners draw the components of a lever system on the image and from this try to establish the class of lever being used. For example, the images could be a biceps curl, a press up and heading a ball. This would help learners make connections between the theory and practical application. If a practical facility is available, learners could reinforce their learning by carrying out some practical skills and analysing the lever systems in use.

To reinforce work on mechanical advantage and to give a resource that can be on display to help reinforce learning, learners could be given the following task.

Each learner is given a lever system to focus on. They should research the mechanical advantage and disadvantage for that lever system and feedback to the rest of the group to ensure all have the correct information.

The learners could then produce a poster to display in the sports hall or classroom of a sporting image using the lever system they are focusing on. If the sports are varied this will help broaden learners' knowledge so they have an understanding of a broader range of sports to help with future assessment.

The poster should include:

- the class of the lever system at its location
- components drawn over the image
- an explanation of the mechanical advantage and disadvantage of that lever system.

For example:

**Lever system =**

Operating at the elbow

Mechanical **advantage** of a …… lever system is:

Mechanical **disadvantage** advantage of …… lever system is:

# Movement Analysis: planes and axes

| | |
|---|---|
| **2.2**<br>**Planes and axes of movement** | **2.2.1** Movement patterns using body planes and axes: sagittal, frontal and transverse plane; and frontal, sagittal, vertical axes, applied to physical activities and sporting actions |
| | **2.2.2** Movement in the sagittal plane about the frontal axis when performing front and back tucked or piked somersaults |
| | **2.2.3** Movement in the frontal plane about the sagittal axis when performing cartwheels |
| | **2.2.4** Movement in the transverse plane about the vertical axis when performing a full twist jump in trampolining |

This topic is intended as an introduction to planes and axes, in preparation for future study. Learners are not required to go into a great deal of depth, but they should understand the reason for movement analysis, i.e. the basic concept that it is important at elite level to understand exactly what is happening in any given movement or skill so that it can be improved. In order to help analyse movement, the body is split into three different planes and axes.

Learners will be expected to **know and understand**:

- The names of the three **planes** used for movement analysis, their location and how they divide the body:
  - sagittal – divides the left and right side of the body, vertically
  - frontal – divides the front and the back of the body, vertically
  - transverse: – divides the top and bottom of the body, horizontally.
- The names of the three **axes** used for movement analysis, their location and how they divide the body:
  - frontal – runs through the body horizontally, from left to right
  - sagittal – runs through the body horizontally, from back to front
  - vertical – runs through the body vertically, from top to bottom.
- Learners should be able to link the basic movement possibilities at each plane and each axis:
  - flexion/extension – sagittal plane/frontal axis
  - abduction/adduction – frontal plane/sagittal axis
  - rotation – transverse plane/vertical axis

**NB** all axes allow a body part to rotate around them, which is why a tucked, piked or straight summersault occurs in the sagittal plane about the frontal axis.

Learners will be expected to **apply** their knowledge through the recognition of examples of the use of planes and axes in a range of sporting activities.

For example: A cartwheel occurs in the frontal plane about the sagittal axis, the movement is abduction and adduction. Specific examples are given in the specification that learners should learn.

# Movement Analysis: planes and axes – activity ideas

## Activity 3

Learners should know that, in order to help analyse movement, the body is split into three different planes and axes. A general definition to understand the difference between a plane and axis is a good starting point before giving specific detail of each.

**Plane** – an imaginary straight line that divides the body into sections. The line can cut through the body from front to back, side-to-side or top to bottom. Think of a ream of paper as representing the whole body. When stood upright, each sheet of paper could represent a plane in the body running from top to bottom, lay the stack of paper flat and the pages could represent the side-to-side planes through the body and so on.

**Axis** – an imaginary lines that bisects the plane and allows people to rotate or move around them; this rotation may be of the whole body or a body part. The axis always goes through the joints of the body, for example, flexion of the arm at the elbow. Movements in sport occur in a plane about an axis.

Once learners know the names and locations of the different planes and axes (as detailed above), they should practice applying their knowledge – for example, in a practical trampoline session, each learner could be asked to complete the task shown below. (Rather than be required to draw an image of each plane and axis, learners could be given these images, or learners could complete that part of the task as classwork/homework prior to the practical session.)

## Task

Complete the table by:

1. inserting an image to show the location of each plane
2. inserting an image to show the location of each axis
3. identifying where rotation is taking place and name the axis
4. selecting the correct plane: sagittal, frontal or transverse
5. selecting the correct axis: sagittal, frontal or vertical
6. selecting the movement: flexion/extension, adduction/abduction or rotation

| Skill/technique | Axis | Movement at joint | Plane |
|---|---|---|---|
| Seat drop | | | |
| ½ twist | | | |
| Tuck jump | | | |
| Cartwheel | | | |
| Pike jump | | | |
| Front somersault | | | |
| Star jump | | | |

As an extension to this task learners could:

- complete a similar activity but in relation to their own sport
- use sporting images and annotate to show the plane, axis and movement at one or more of the joints where there is clear movement in the image.

## Developing statements in written responses

To ensure learners acquire the ability to use their knowledge and understanding to develop any response to match the demands of the question, they should practice this skill. This skill can be developed in the classroom by giving a series of statements that need justifying. This idea can be applied to any theoretical topic in the specification. For example, learners could be given the following statements and asked to expand on them to develop the initial point being made.

- The rowers can apply can use the lever system to their advantage, applying a little amount of effort to the oar….
- Second class levers give an athlete a mechanical advantage….
- Third class levers are said to operate at a mechanical disadvantage….
- The body is mainly made up of third class levers….
- The athlete's muscles give the effort required to move the load….

# Sample assessment questions

### Assessment of knowledge:

**Figure 1** shows one plane and one axis of the human body.

The plane is represented by the square.

The axis is represented by the dotted line.

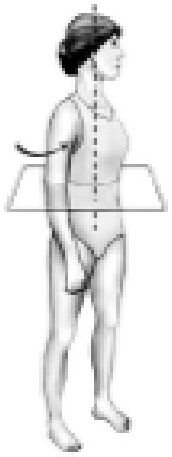


**Figure 1**

(d) Identify the plane and axis shown in **Figure 1.**

**(1)**

| | | |
|---|---|---|
| **A** | Sagittal plane and frontal axis | [ ] |
| **B** | Frontal plane and vertical axis | [ ] |
| **C** | Transverse plane and frontal axis | [ ] |
| **D** | Transverse plane and vertical axis | [ ] |

(c) Which one of the following describes a second class lever system?

**(1)**

| | | |
|---|---|---|
| **A** | The load is at the right-hand end of the lever | [ ] |
| **B** | The fulcrum is in the middle of the lever | [ ] |
| **C** | The load is in the middle of the lever | [ ] |
| **D** | The load and the fulcrum are at the same point on the lever | [ ] |

## Assessment of ability to analyse:

**Figure 4** shows rowers in a race.

The rowers are using a first class lever system. The fulcrum in this lever system is formed where the oars are attached to the boat.

**Figure 4**

**© - Altrendo Images/Getty Images**

Analyse the role of the first class lever system in affecting the rowers' performance in **Figure 4**.

**Figure 5** shows a man weight training.

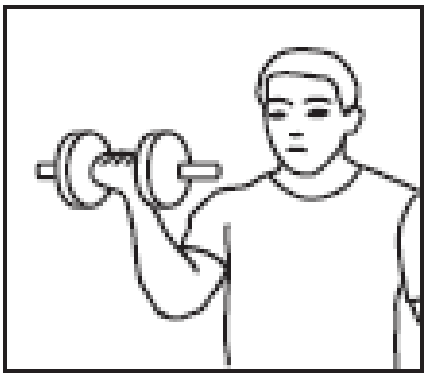


**Figure 5**

Analyse how the following parts of the lever system allow the weight trainer in **Figure 5** to lift the weight.

(i) Fulcrum

**(2)**

(ii) Effort

**(2)**

## Extended answer responses

In the new specification there will be two extended answer questions at the end of each paper. These questions will be marked out of 9 marks. The increase in the available number of marks should allow a better differentiation between learners, and give more opportunity to reward learners for the skills they demonstrate.

Each extended answer question will be used to assess the learner's ability to:

- demonstrate knowledge and understanding (AO1)
- apply their knowledge and understanding (AO2)
- analyse and evaluate relevant knowledge and understanding (AO3).

Each of these Assessment Objectives will be credited with a maximum of three of the nine available marks. This means that a learner who is very knowledgeable about a topic but unable to apply their knowledge could still gain 3 marks for their knowledge. If they were able to apply this knowledge the number of marks gained could increase to 6 marks. If they are able to form a judgement based on the knowledge presented they will be able to access the final 3 marks for these questions.

In this sample question, learners are asked to analyse and evaluate the use of third class levers in the body when completing a specific action, for example, taking a penalty.

A learner that knows about third class levers and responds by describing them, talking about the different components, the order of those components and so on could gain 3 marks (AO1).

Compare this to the learner who is able to link the characteristics of the lever system to the activity; for example, by correctly identifying the third class lever system in operation and linking the correct parts of the body to the lever system given the question context of taking a penalty (AO2). An alternative example answer could detail the third class lever operating at the knee, the knee acting as the fulcrum allowing the performer to move the leg to kick the ball and so on. This learner could score up to 6 marks.

Finally, a learner that is able to analyse and evaluate the effectiveness of this lever system by referring to the mechanical disadvantage, in terms of amount of force needed to be generated by the muscles, and the advantage of speed and range of movement, would gain access to the last set of 3 marks, (AO3).

# Resources

**Levers**

http://www.brianmac.co.uk/levers.htm

https://www.youtube.com/watch?v=ny8k7LUUIEk

http://www.humankinetics.com/excerpts/excerpts/levers-work-to-create-movement-in-the-human-body

**Planes and axes**

http://www.physical-solutions.co.uk/wp-content/uploads/2015/05/Understanding-Planes-and-Axes-of-Movement.pdf

(Please note: this link may not work in some browsers e.g. Safari)

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