

2.1. Lever Systems

2.2 Planes and Axes of Movement

Teacher Answer Booklet



Topic	Description from Specification	Pupil comments – How confident do you feel on this topic?
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	
2.2.1	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	

What do you think of when you hear the word 'lever'?

Something that generates movement. A system that includes a pivot.

How do you think parts of your body can be referred to as levers?

Joints allow movement to take place and muscles can produce the force required to move parts of the body, acting as a lever.

Every lever has 3 components. Use the words below to fill in the gaps.

A **fulcrum** – The **axis** around which the lever **rotates**

A **load** – The **force** of the thing that you want to **move**

An **effort** – The **force** that is applied by the user of the **lever** system

force axis move force lever rotates

Think about a darts player throwing a dart. What would be the....

Fulcrum: Elbow

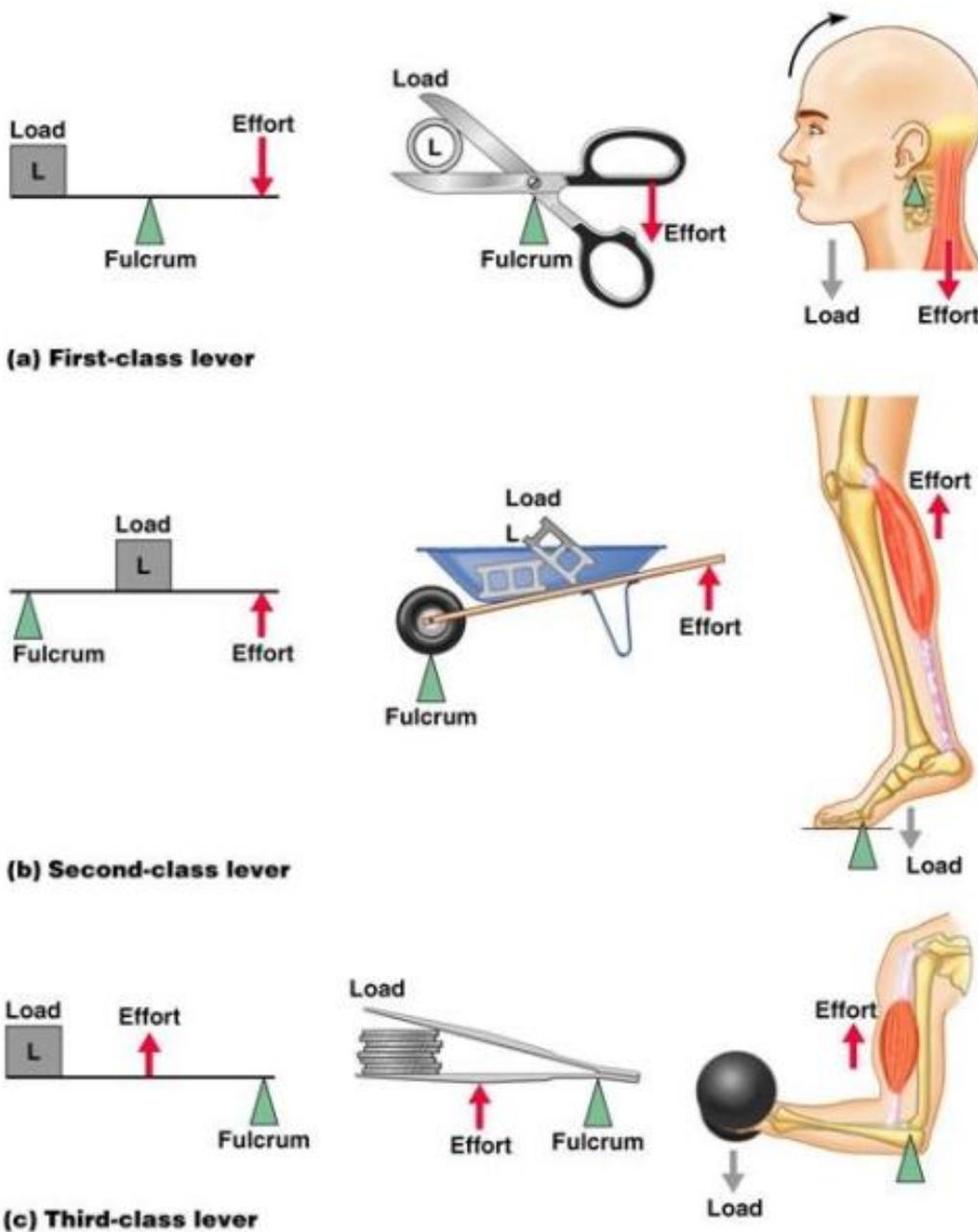
Load: Dart

Effort: Tricep



Different Classes of Lever:

Levers are classified as either **First Class**, **Second Class** or **Third Class** according to the placement of the fulcrum, load and effort.



1st Class = **Fulcrum** in the middle

2nd Class = **Load** in the middle

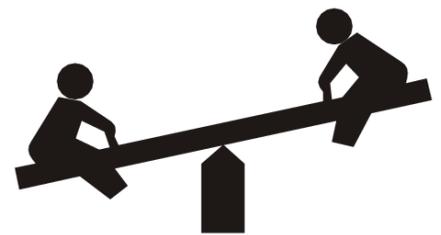
3rd Class = **Effort** in the middle

To remember what is in the middle you simply need to think FLE. Think 'FLY LITTLE ELF' to remember this.

First Class Levers: Load – Fulcrum - Effort

In this lever system the fulcrum sits in the middle, between the load and the effort.

For the pictures shown, fill in the table below.



Exercise/Activity	Load	Fulcrum	Effort
Row	Water	Top of the Oar	Biceps
Tricep Dip	Body Weight Through the Hands	Elbow	Triceps
See-Saw	Left Person	Middle	Right Person

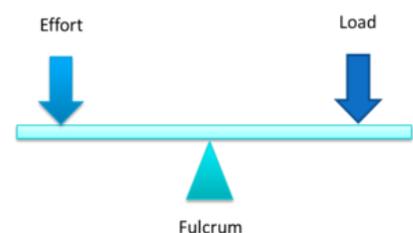
Can you think of any other first class lever systems?

Nodding your Head:

Load – The weight of the head through the chin

Fulcrum – The top of the neck

Effort – The muscles at the bottom of the neck



Second Class Levers: Fulcrum – Load - Effort

In this lever system, the load sits between the fulcrum and the effort

For the pictures shown, fill in the table below.



Exercise/Activity	Fulcrum	Load	Effort
Calf Raise	Balls of Feet	Weight going through the centre of the feet	Gastrocnemius
Wheelbarrow	Wheel	Contents	Person Pushing

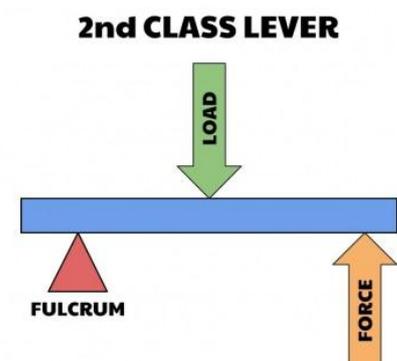
Can you think of any other second class lever systems?

Stapler:

Fulcrum – The back of the stapler

Load – The item being stapled (in the middle of the stapler)

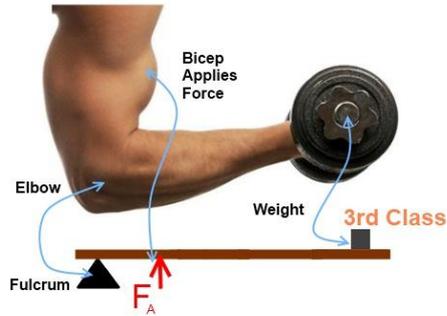
Effort – The top of the staple



Third Class Levers: Fulcrum – Effort - Load

In this lever system, the effort is applied between the fulcrum and the load.

For the pictures shown, fill in the table below.



Exercise/Activity	Fulcrum	Effort	Load
Bicep Curl	Elbow	Bicep	Dumbbell
Digging	Right hand at the top of the spade	Left hand in the middle	Soil at bottom of spade

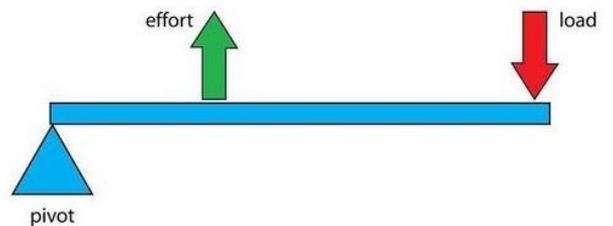
Can you think of any other third class lever systems?

Tweezers:

Fulcrum – End of tweezers

Load – Item being lifted

Effort – Middle of tweezers



Hint - you must know the difference between each lever system and the location of the fulcrum, effort and load

Advantages/Disadvantages of lever systems:

Class of lever	Advantage	Disadvantage
First Class	Mechanical Advantage – A large load can be lifted with relatively little effort, due to the effort ‘arm’ being long	Slower Movement Limited Flexibility
Second Class	Mechanical Advantage – A large load can be lifted with relatively little effort, due to the effort ‘arm’ being long	Slower Movement Limited Flexibility
Third Class	Fast Movement Large Range of Motion	Mechanical Disadvantage – Cannot lift as heavy a load with the same amount of effort, due to the effort ‘arm’ being short

Why is your head an example of a first class lever system? (3)

Nodding your head is a first class lever system because the fulcrum is in the middle. The load is the weight of the head through the chin, the fulcrum is the top of the vertebral column and the effort is the muscles in the neck.



Analyse the first class lever system used at your head. (3)

The first class lever system used at your head has a mechanical advantage as there is little effort required in order to lift a relatively large load. However the disadvantage is that it generates slower movement and has limited flexibility.

Think about the word ‘analyse’ and what this question is asking

Rowing is an example of which lever system? (1)

First Class Lever System



Analyse the role of this lever system in affecting a rowers' performance?

It is a first class lever system because the fulcrum (the top of the oar) is in the middle, either side of the load (the water) and the effort (the bicep). This lever system has a mechanical advantage as due to the long lever, relatively little effort is required from the rower in order to propel the rower through the water, which can be deemed as a large load.

A bicep curl is an example of which type of lever system? (1)

Third Class



Give one advantage and one disadvantage of the lever system used when performing a bicep curl (2)

Advantage – Fast movement is possible

Disadvantage – Mechanical Disadvantage – a large effort is required to lift a relatively small load

Planes & Axes of Movements:

Different sports often require different types of movement and positioning. For the following sports, in your own words describe the positioning of the body.

Tennis **Upright/Vertical**

Swimming **Horizontal**

Trampolining **Twisting/Turning**

Planes:

Planes are theoretical divisions that divide the body into sections. There are three planes of motion in the body.

1. The Sagittal Plane:

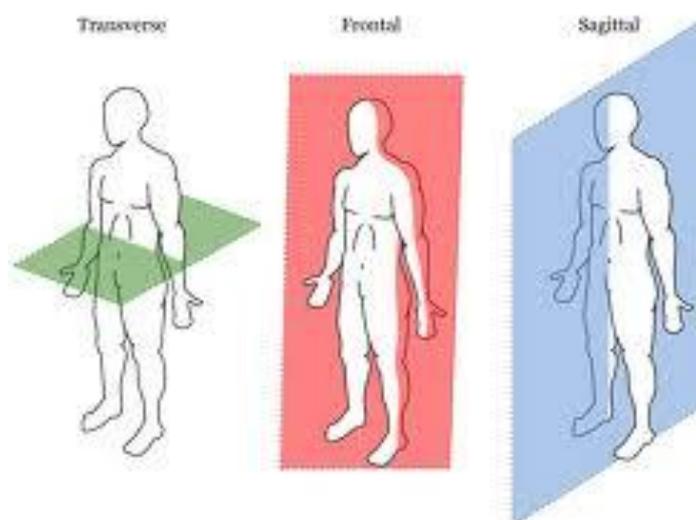
Splits the body down the middle resulting in a **left** side and a **right** side.

2. The Frontal Plane:

Divides the body so that there are **front** and **back** sections.

3. The Transverse Plane (AKA Horizontal Plane):

Divides the body across the middle (horizontally), giving a **top** section and a **bottom** section.



Underneath each of the pictures shown above, write down one of the following phrases to describe the movement possible within the plane. Think about how the person could move and **still keep the plane intact**:

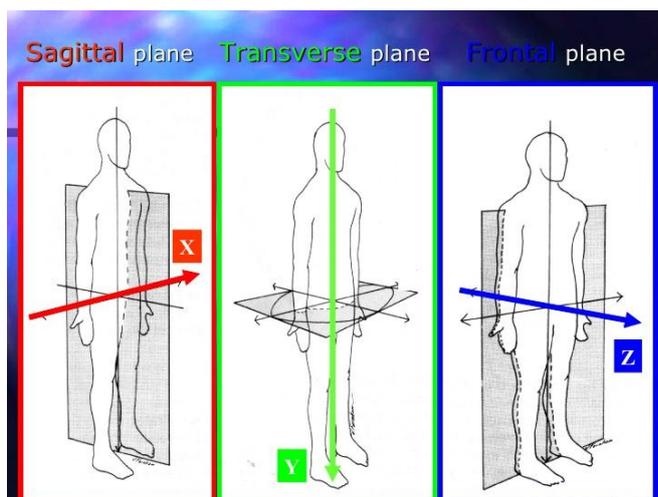
- Forward or backward
- Side to side
- Rotational

Use the table below to select the plane of movement for each exercise/sporting action:

Exercise/Action	Plane
Walking	Sagittal
Side Bends	Frontal
Side Stepping	Frontal
Jogging	Sagittal
360 degree twist	Transverse

Axes:

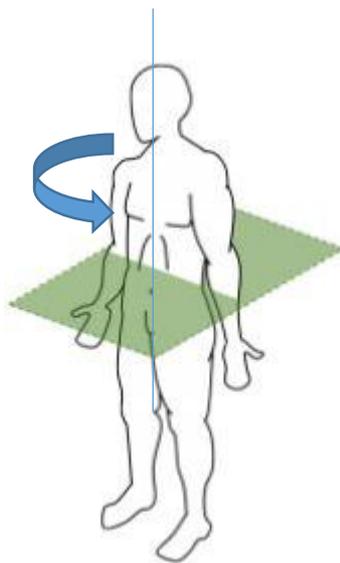
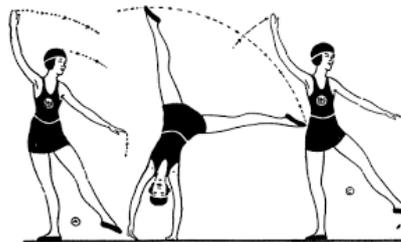
The joints in our bodies rotate around one of three different axes. These axes allow rotation to take place in one of the planes. There are three different axes:



1. **The Frontal Axis:**
From hip to hip
2. **The Vertical Axis:**
Vertical line - top to bottom
3. **The Sagittal Axis:**
Stabs through the body

Use the table below to state the plane and axes present during each movement/action.

Movement/Action	Plane	Axes
Forward Roll	Sagittal	Frontal
Cartwheel	Frontal	Sagittal
Somersault	Sagittal	Frontal
Twist Jump	Horizontal	Vertical



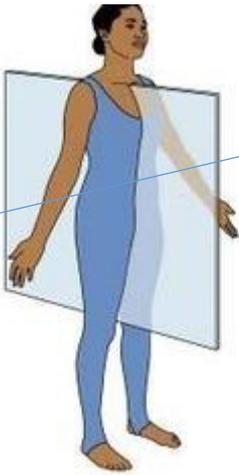
Sample exam questions:

Identify the plane and axis shown in the figure on the left (1)

Plane – Transverse Axis - Vertical

Give an example of a sporting action used at this plane and axis?

Twist Jump - Trampolining



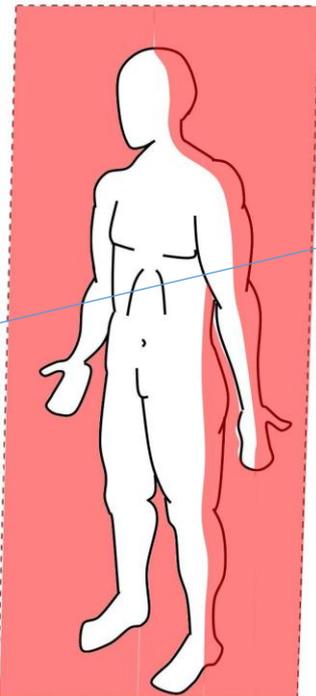
Sample exam questions:

Identify the plane and axis shown in the figure on the left (1)

Plane – Sagittal Axis - Frontal

Give an example of a sporting action used at this plane and axis?

Forward Roll



Sample exam questions:

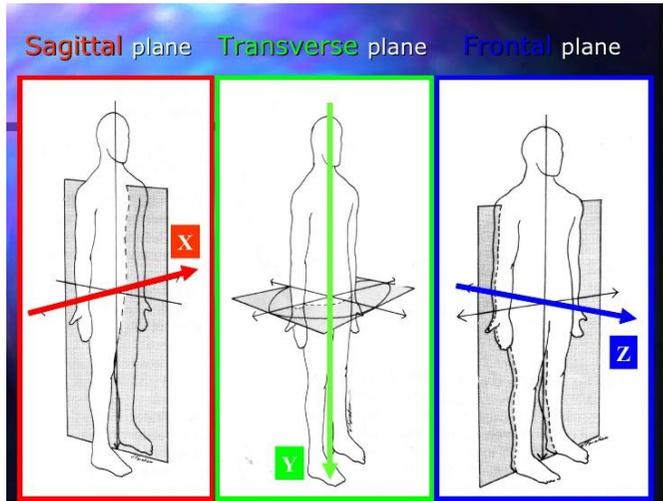
Identify the plane and axis shown in the figure on the left (1)

Plane – Frontal Axis - Sagittal

Give an example of a sporting action used at this plane and axis?

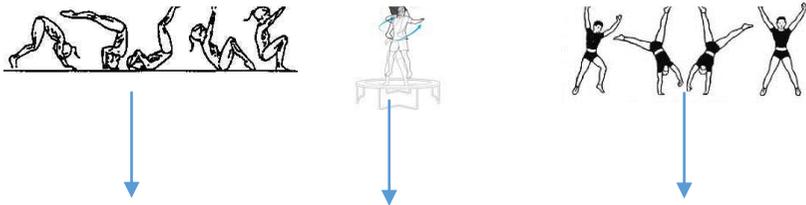
Cartwheel

Revision



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Frontal Axis **Vertical Axis** **Sagittal Axis**



Planes:

Sagittal = **Split** down the middle

Transverse = **Top** and bottom

Frontal = **Front** and back

Axes:

Frontal = **From** hip to hip

Vertical = **Vertical** line

Sagittal = **Stab** through the body

Sagittal Plane and Frontal Axis = **Forward Roll**

Transverse Plane and Vertical Axis = **Twist**

Frontal Plane and Sagittal Axis = **Cartwheel**

Key Terms:

Fulcrum – The point around which the lever rotates

Load – The force of the thing that you want to move

Effort – The force that is applied by the user of the lever system

Mechanical Advantage – A large load can be lifted with relatively little effort

Mechanical Disadvantage – Cannot lift as heavy a load with the same amount of effort

Plane – An imaginary line dividing the body vertically into left and right sides

Axis - An imaginary line dividing the body vertically from front to back