Movement analysis

Sue Young shows you how to avoid common pitfalls on the PHED1 paper, with practice questions

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Running is one of seven possible sporting actions that you will be asked questions on in the exam

Analysing human movement through joints, muscles and mechanics is a popular exam topic that so far has appeared on every PHED1 paper. You can make this question seem more straightforward if you remember that the exam board will choose one of seven possible sporting actions for you to answer questions on. There are three upper body actions and four lower body actions (Table 1).

Joints you need to know

For each of these sporting actions there are several key areas you need to analyse. The first is joints but you only need to look at certain joints within these actions. An analysis of the shoulder and elbow joints is needed for the push up, overarm throw and forehand racket stroke, whereas an analysis of the hip, knee and ankle joints is needed for the jump, kick, squat and run. This means that there are only two joint types that you need to remember. The hip and shoulder are ball and socket joints and the ankle, knee

Table 1 Upper and lower body actions

Upper body	Lower body
Overarm throw	Jump
Forehand racket stroke	Kick
Push up	Squat
	Run

and elbow are hinge joints. Forget about all the other types of synovial joints — you are not required to answer questions on them.

When analysing these joints you need to know the articulating bones (Table 2). Articulating means the bones that meet and move at the joint. For example, the patella is not an articulating bone as it meets at the knee joint but is not involved in the movement. It is there for protection.

You may also be asked to identify the movements that occur at the joints. It is not necessary to learn every joint action in the shoulder and the hip. In the throw and the forehand racket stroke you will only see horizontal flexion (adduction) and horizontal extension (abduction) of the shoulder. In the jump, kick, squat and run you will see flexion and extension of the hip. No other movements are needed for the hip so why learn something the exam board won't ask? All the movements you need to identify are summarised in Table 3.

You also need to relate the movements occurring at the joints to planes and axes.

Table 2 Joints and bones

Joint	Joint type	Articulating bones
Ankle	Hinge	Tibia, fibula, talus
Knee	Hinge	Tibia, femur
Hip	Ball and socket	Femur, pelvis
Shoulder	Ball and socket	Scapula, humerus
Elbow	Hinge	Humerus, radius and ulna

There is an eccentric contraction in the triceps in the downward phase of the push up

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Table 3 Joint movements

Upper body sporting action	Movement in the shoulder	Movement in the elbow	
Overarm throw	Horizontal extension — abduction when the arm is drawn back and horizontal flexion (adduction) as the throw is performed	Flexion when the arm is drawn back and extension when the throw is performed	
Forehand racket stroke	Horizontal extension — abduction when the racket arm is drawn back and horizontal flexion (adduction) as the forehand is performed	Extension when the arm is drawn back and flexion when the racket stroke is performed	
Push up	Downward phase: horizontal flexion (adduction) Upward phase: horizontal extension (abduction)	Downward phase: flexion Upward phase: extension	
Lower body sporting action	**Movement in the hip**	**Movement in the knee**	**Movement in the ankle**
Jump	Extension	Extension	Plantarflexion
Kick	Extension	Extension	Plantarflexion
Squat	Flexion	Flexion	Dorsiflexion
Run	Drive phase: extension Recovery phase: flexion	Drive phase: extension Recovery phase: flexion	Drive phase: plantarflexion Recovery phase: dorsiflexion

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The overarm throw uses shoulder and elbow movements

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Table 4 Agonist muscles in concentric contractions

Joint	Movement	Agonist
Ankle	Plantarflexion	Gastrocnemius
	Dorsiflexion	Tibialis anterior
Knee	Flexion	Hamstrings
	Extension	Quadriceps
Hip	Flexion	Hip flexors
	Extension	Gluteals
Shoulder	Horizontal flexion	Pectorals
	Horizontal extension	Latissimus dorsi
Elbow	Flexion	Biceps
	Extension	Triceps

As most of the movements are flexion and extension all the questions set so far have required sagittal plane and transverse axis as the answer. Horizontal flexion arguably occurs in two planes and axes, one of which is sagittal plane and transverse axis. The answer is the same so don't waste time learning all the planes and axes, just learn those that are relevant.

Naming the muscles

Now that we have established the movements that occur during these actions it is also necessary to name the **agonist** muscle. This is the muscle that is responsible for the movement that is occurring. When one muscle is acting as an agonist and the other is acting as the **antagonist** the muscles are said to be working together as a pair to produce the required movement. This arrangement is commonly referred to as antagonistic muscle action. If we look at flexion of the knee, the hamstrings are the agonist and the quadriceps are the antagonist. Table 4 summarises the agonist muscles for the concentric contractions you may be asked about in your exam.

Be careful, sometimes the agonist does not automatically become the antagonist when the movement changes, for example, flexion to extension. In the downward phase of the push up most students think that the tricep is now the antagonist, but it is still the agonist as it is now lengthening as it contracts (eccentric contraction) in order to

Key term

Agonist The muscle that is responsible for the movement.

Antagonist The muscle that works in opposition to the agonist to help produce a coordinated movement.

control the lowering of the forearm while it supports body weight.

Finally, you also need to know the type of contraction that is taking place. There are three types of contraction: concentric, eccentric and isometric.

For the purposes of your exam most of the contractions that take place in the seven sporting actions are concentric. You need only to consider isometric contractions if the question mentions that the movement is still/stationary or held. An eccentric contraction takes place only twice, both times in the downward phase. There is an eccentric contraction in the gluteals, quadriceps and gastrocnemius in the downward phase of the squat and in the triceps in the downward phase of the push up.

Learning levers

Questions on levers usually require you to name and sketch the lever system. There are three classes of lever and the order of the words fulcrum, effort and resistance is what decides the classification of lever. It is the word that appears in the middle that is important. Don't worry about the order on the outside. Think of the imaginary word 'FRE' where F stands for fulcrum, R for resistance and E for effort. 'F' is the first letter in this word so a first-order lever has the fulcrum in the middle (Figure 1), 'R' is the second letter in the word so a second-order lever has the resistance in the middle (Figure 2) and 'E' is the third letter in the word so a third-order lever has the effort in the middle (Figure 3).

Key term

Force arm The name given to the shortest perpendicular distance between the fulcrum and the application of force (effort).

Resistance arm The shortest perpendicular distance between the fulcrum and the resistance.

Key term

Mechanical disadvantage When the resistance arm is greater than the force arm.

Mechanical advantage When the force arm is longer than the resistance arm.

You may also be asked to label the **force arm** or **resistance arm** (Figure 4) and talk about the advantages and disadvantages of a lever and its speed of movement.

When the resistance arm is greater than the force arm, the lever system is at a **mechanical disadvantage**. This means that the lever system cannot move as heavy a load but can do it faster. **Mechanical advantage** is when the force arm is longer than the resistance arm. This means that the lever system can move a large load over a short distance and requires little force.

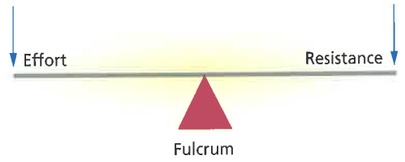


Figure 1 First-order lever

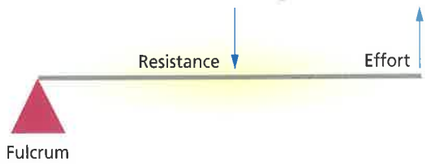


Figure 2 Second-order lever

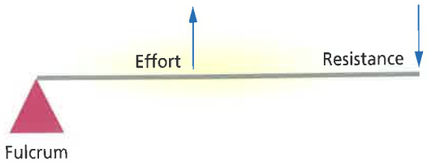


Figure 3 Third-order lever

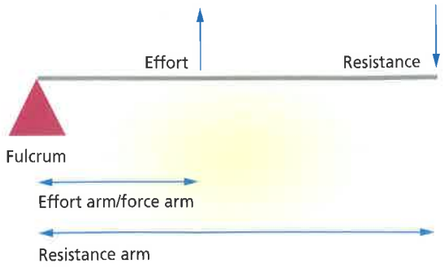
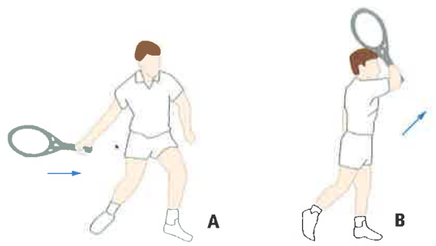


Figure 4 The force arm and the resistance arm

Questions

(1) The picture below shows the forehand in tennis. Complete the table below and identify the joint action, main agonist and the type of muscle contraction at the shoulder joint to get from position A to position B. **(3 marks)**



Joint	Joint action	Main agonist	Type of contraction
Shoulder			

(2) Weightlifters will follow a strength-training programme to ensure that they perform to their optimum level in a competitive performance. The diagram below shows a weightlifter performing a squat. With reference to this weightlifter, complete the table

Joint	Joint action	Main agonist	Type of contraction
Ankle			
Hip			

and identify the joint action, main agonist and the type of muscle contraction at the hip and ankle joint in the upward phase of the squat. **(6 marks)**

(3) Sketch and label a lever operating during flexion of the knee. **(3 marks)**

See PEReview*Online* for the answers.

Sue Young teaches sports science at Greenhead College, Huddersfield and is co-editor of PE Review