2.2 Movement Analysis: Lever Systems in Sport: 30-minute Pack

AQA 8582 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 In which class of lever does the effort act between the fulcrum and the load?

- ☐ A) First class lever
- ☐ B) Second class lever
- ☐ C) Third class lever
- ☐ D) None of these

(Total for Question 1 is 1 mark)

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2 A boxer throws a jab, extending the elbow sharply using the triceps to drive the fist forward. Identify the class of lever used and justify your answer.

(Total for Question 2 is 2 marks)

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3 A tennis coach tells a player that the lever systems in the human body are built for racket speed rather than raw strength. Explain, using the term 'mechanical advantage', why most lever systems in the human body are suited to producing speed and range of movement rather than force.

(Total for Question 3 is 4 marks)

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4 Discuss how the body's lever systems help to explain why Nadia can generate high force in the scrum but can also make a fast, accurate pass, referring to at least two different lever classes and to mechanical advantage. Evaluate whether the human body is generally better suited to producing force or to producing speed and range of movement.

(Total for Question 4 is 9 marks)

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5 In a first class lever, the fulcrum sits between the effort and the load. When preparing to head a corner kick, a footballer extends their neck to tilt their head backwards.

(a) Identify the fulcrum in this example. **(1)**

(b) Identify the effort in this example. **(1)**

(c) Identify the load in this example. **(1)**

(d) The fulcrum in this example sits between the effort (behind the head) and the load (the front of the head). Explain why this arrangement is classed as a first class lever, and state one other sporting example of a first class lever at a different joint. **(2)**

(Total for Question 5 is 5 marks)

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6 A goalkeeper rises up onto the balls of their feet, pushing off the ground through a calf raise, to reach a high crossed ball at a corner kick.

(a) State whether this second class lever arrangement favours force or speed. **(1)**

(b) Explain why this favouring of force is useful for a goalkeeper in this situation. **(1)**

(c) Suggest one disadvantage of this lever arrangement for a goalkeeper who needs to jump quickly and explosively. **(2)**

(Total for Question 6 is 4 marks)

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7 A rock climber pulls their body weight upward on a hold by flexing the elbow, using the biceps brachii.

(a) Identify the fulcrum, the effort and the load in this example. **(3)**

(b) Explain why this lever arrangement means the biceps has to work especially hard to lift the climber's full body weight. **(2)**

(Total for Question 7 is 5 marks)

8 Table 1 gives four descriptions relating to lever classes.

Table 1

Row	Description
(a)	The load sits between the fulcrum and the effort
(b)	The fulcrum sits between the effort and the load
(c)	A swimmer's triceps straighten the elbow to push the arm backward during the pull-through phase of front crawl - name the lever class
(d)	This lever class is the most common in the human body

(a) Name the class of lever described in row (a). **(1)**

(b) Name the class of lever described in row (b). **(1)**

(c) Name the class of lever described in row (c). **(1)**

(d) Name the class of lever described in row (d). **(1)**

(Total for Question 8 is 4 marks)

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Mark scheme · 2.2 Movement Analysis: Lever Systems in Sport: 30-minute Pack

Question 1

C **B1**

Answer: C

Question 2

first class lever **B1**

the elbow joint (fulcrum) lies between the triceps insertion (effort) and the fist (load), oe **B1**

Answer: First class lever, because the elbow joint (fulcrum) lies between the triceps insertion (effort) and the fist (load).

Question 3

most levers in the body, particularly third class levers (the most common type), have the effort acting close to the fulcrum, oe **B1**

this makes the effort arm short compared with the load arm, giving a mechanical advantage of less than 1, oe **B1**

a mechanical advantage of less than 1 means more muscular effort force is needed than the size of the load being moved (a force disadvantage), oe **B1**

however, a small movement of the muscle close to the joint produces a much larger, faster movement at the end of the limb, which is why the body is generally suited to speed and range of movement rather than raw force, oe **B1**

Answer: Because most levers in the body (especially third class levers, the most common type) have the effort close to the fulcrum and the load much further away, the effort arm is short relative to the load arm, giving a mechanical advantage below 1; this needs more muscular force than the load itself, but it means a small movement of the muscle produces a much larger, faster movement at the end of the limb, which is why the body favours speed and range of movement over force.

Question 4

Level 3 A detailed and coherent response that accurately explains how at least two different lever classes and their mechanical advantage relate to Nadia's scrummaging force and her fast passing action, applying the discussion specifically to her situation, and reaches a well-justified evaluative judgement about the body's overall bias towards speed and range of movement. Sustained, accurate use of lever/mechanical-advantage terminology throughout. **7-9**

Level 2 Some accurate explanation of lever classes and mechanical advantage, with partial application to Nadia's scrummaging and passing, but coverage of both actions or the evaluative judgement may be incomplete or underdeveloped. **4-6**

Level 1 Basic or generic statements about levers with little or no application to Nadia's specific situation, and little or no evaluation of force versus speed. **1-3**

Level 0 No relevant content. **0**

Indicative content:

- Force in the scrum: leg drive at the ankle (calf raise, plantarflexion) is a second class lever, with the effort arm (heel to ball of foot) longer than the load arm (ankle to ball of foot), giving a mechanical advantage above 1.
- This means Nadia's calf muscles can generate a large forward driving force relative to the muscular effort used, which is well suited to the sustained, powerful push needed in a scrum.
- Speed in the pass: extending the elbow to release the ball, using the triceps, is a first class lever (fulcrum between effort and load); with the triceps inserting close to the elbow, the effort arm is short relative to the load arm, giving a mechanical advantage below 1.
- This means a small, fast contraction of the triceps produces a much larger, faster movement of the hand, which is exactly what is needed for a fast, accurate pass immediately after the scrum.
- Most joint actions used in passing/throwing (elbow, wrist) are third class or, as here, first class levers with a low mechanical advantage, favouring speed and range of movement over force.
- Evaluative point: because most lever systems in the human body have the effort acting close to the fulcrum (mechanical advantage below 1), the body as a whole is generally better suited to producing speed and range of movement than raw force.
- Evaluative point: the scrum example shows force-favouring arrangements do exist (mainly at the ankle and in similar second class arrangements), but they are the exception rather than the rule in the body's overall lever system.
- Balanced conclusion: Nadia's two actions show that the same body can produce both outcomes, but only because a small number of joints (like the ankle) provide the force-favouring arrangement that most of the body's mainly speed-favouring levers do not.

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Question 5

(a) the joint between the skull and the top of the spine (the atlanto-occipital joint), oe **B1**

(a) Answer: The joint between the skull and the top of the spine.

(b) the neck extensor muscles (e.g. trapezius/splenius capitis), pulling on the back of the skull, oe **B1**

(b) Answer: The neck extensor muscles, pulling on the back of the skull.

(c) the weight of the front of the head/face (in front of the pivot point), oe **B1**

(c) Answer: The weight of the front of the head and face.

(d) the fulcrum lying between the effort and the load is, by definition, a first class lever, oe **B1**

(d) a correct different example, e.g. the triceps extending the elbow, with the elbow joint (fulcrum) between the triceps insertion (effort) and the hand (load), oe **B1**

(d) Answer: It is a first class lever because the fulcrum lies between the effort and the load. A different example is the triceps extending the elbow, where the elbow joint (fulcrum) lies between the triceps insertion (effort) and the hand (load).

Question 6

(a) favours force **B1**

(a) Answer: It favours force.

(b) it allows the calf muscles to lift the goalkeeper's full body weight upward without needing to generate more force than that body weight, oe **B1**

(b) Answer: It allows the calf muscles to lift the goalkeeper's full body weight upward without needing to generate more force than that body weight.

(c) the body load acts through the ankle, which moves a shorter distance and less quickly than the heel effort point as the foot rotates about the stationary ball of the foot, oe **B1**

(c) so this lever arrangement is comparatively slow at producing height/range of movement, which could be a disadvantage when explosive, fast movement is needed to reach a fast-moving ball, oe **B1**

(c) Answer: The ball of the foot is the stationary fulcrum. The body load acts through the ankle, which moves a shorter distance and less quickly than the heel effort point. This limits the speed at which the goalkeeper gains height, a disadvantage when reaching a fast-moving ball.

Question 7

(a) fulcrum: the elbow joint **B1**

(a) effort: the biceps brachii, pulling on the radius close to the elbow joint, oe **B1**

(a) load: the weight of the climber's body, acting through the hand gripping the hold, oe **B1**

(a) Answer: Fulcrum: the elbow joint. Effort: the biceps brachii, pulling on the radius close to the elbow. Load: the weight of the climber's body, acting through the hand.

(b) the effort (biceps insertion) is much closer to the elbow than the load (the hand) is, so the effort arm is short compared with the load arm, oe **B1**

(b) this gives a mechanical advantage below 1, meaning the biceps must produce a force greater than the climber's own body weight to move the hand, oe **B1**

(b) Answer: The effort (biceps insertion) acts much closer to the elbow than the load (the hand), so the effort arm is short compared with the load arm, giving a mechanical advantage below 1: the biceps must produce a force greater than the climber's own body weight to move the hand.

Question 8

(a) second class lever **B1**

(a) Answer: Second class lever.

(b) first class lever **B1**

(b) Answer: First class lever.

(c) first class lever **B1**

(c) Answer: First class lever.

(d) third class lever **B1**

(d) Answer: Third class lever.

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