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A LEVEL
Transition Guide

PHYSICAL EDUCATION

H555
For first teaching in 2016

GCSE to A Level
KS4 to KS5 – Biomechanics

Version 1

www.ocr.org.uk

Mapping KS4 to KS5 | Checkpoint task | Possible Teaching Activities (KS5 focus) | Possible Extension Activities (KS5 focus)

A LEVEL

PHYSICAL EDUCATION

Key Stage 4 to 5 Transition guides focus on how a particular topic is covered at the different key stages and provide information on:

- Differences in the demand and approach at the different levels;
- Useful ways to think about the content at Key Stage 4 which will help prepare students for progression to Key Stage 5;
- Common student misconceptions in this topic.

Transition guides also contain links to a range of teaching activities that can be used to deliver the content at Key Stage 4 and 5 and are designed to be of use to teachers of both key stages. Central to the transition guide is a Checkpoint task which is specifically designed to help teachers determine whether students have developed deep conceptual understanding of the topic at Key Stage 4 and assess their 'readiness for progression' to Key Stage 5 content on this topic. This checkpoint task can be used as a summative assessment at the end of Key Stage 4 teaching of the topic or by Key Stage 5 teachers to establish their students' conceptual starting point.

Key Stage 4 to 5 Transition Guides are written by experts with experience of teaching at both key stages.

Key Stage 4 GCSE Content

1.1.c. Movement analysis

Learners must

a) Know the three classes of lever and their use in physical activity and sport:
   - 1st class lever
     – Neck
   - 2nd class lever
     – Ankle
   - 3rd class lever
     – Elbow.

b) Know the definition of mechanical advantage.

c) Know the locations of the planes of movement in the body and their application to physical activity and sport:
   - Frontal
   - Transverse
   - Sagittal.

d) Know the location of the axes of rotation in the body and their application to physical activity and sport:
   - Frontal
   - Transverse
   - Longitudinal.

Key Stage 5 A Level Content

1.3.a Biomechanical principles, levers and the use of technology

Learners must develop knowledge and understanding of:

- Newton's Laws of motion: *define and apply*:
  - Law of inertia
  - Law of acceleration
  - Law of reaction.
- Force (net, balanced, unbalanced, weight, reaction, friction and air resistance):
  - Factors affecting friction and air resistance
  - Free body diagrams showing vertical and horizontal forces
  - Calculations of force, momentum, acceleration and weight
  - Centre of mass
  - Factors affecting the position of centre of mass
  - Relationship between centre of mass and stability.
- Levers:
  - Components of a lever (load, effort, fulcrum, effort arm and load arm)
  - 1st class lever
  - 2nd class lever
  - 3rd class lever
  - Mechanical advantage of a 2nd class lever.
- Analysing movement through the use of technology:
  - Definition and use of limb kinematics, force plates and wind tunnels
  - How each type of technology optimises performance.

1.3.b. Linear motion, angular motion, fluid mechanics and projectile motion

- Linear motion:
  - Definition and creation of linear motion
  - Definitions, calculations and units of measurement for quantities of linear motion
  - Plot and interpret graphs of linear motion.
- Angular motion:
  - Definition and creation of angular motion:
    Longitudinal
    Frontal
    Transverse
  - Definitions, calculations and units of measurement of quantities of angular motion
  - Factors affecting moment of inertia
  - Relationship between moment of inertia and angular velocity
  - The conservation of angular momentum in relations to analogue of Newton's first law
  - Interpret graphs of angular velocity, moment of inertia and angular momentum.
- Fluid mechanics:
  - Factors affecting horizontal distance travelled by a projectile
  - Free body diagrams showing forces acting on a projectile in flight
  - Resolution of forces using parallelogram
  - Patterns of flight paths
  - Bernoulli's principle
  - Design of equipment to create a downwards lift force
  - Magnus force.

Comment

The main differences in context for these sections is the depth of understanding students have to demonstrate in the A Level compared to the GCSE. Whilst at GCSE students will be expected to recall definition and give examples, at A Level, students are expected to apply the principles and concepts to practical examples from sport and use these examples to explain. The A Level is looking for learners to develop their knowledge and understanding of the more technical aspects of performance and will expect them to be able to apply biomechanical principles to optimise technique.

The two topics of Levers and Planes and Axes at GCSE that make up the movement analysis section are only small parts of a much wider understanding that is required for Biomechanics at A Level. However, they form a valuable stepping stone for students into these larger topic areas. For example an understanding of planes of movement and axes of rotation is a fundamental starting point for angular motion.

A clear understanding of Newton's Laws of motion is paramount for the A Level and a suggested starting point. The ability to apply Newton's Laws to sporting examples competently is fundamental to a lot of the other content and thus a significant amount of time should be spent here.

For many students it will be the first time they visit a number of these topics and clear examples will need to be given to aid understanding and application. Keep examples simple.

Students often find it difficult to explain in writing the relationship between moment of inertia, angular velocity and angular momentum; and the conservation of angular momentum. Whilst they grasp the technicalities of it, when it comes to expressing this they can often get confused. Again, a clear example which they can relate to will help but some kind of writing framework or guideline may need to be given initially. If you have the capacity, it would be helpful to use some practical demonstrations so that students can experience the relationship, like twisting or somersaulting in trampolining. Alternatively, good video footage of an ice skater spinning can be helpful. When looking at the axes of rotation at GCSE, just posing the question 'How can we speed rotation about this axes up?' can encourage students to start approaching the thinking behind this topic at the higher key stage.

Students are going to be introduced to precise definitions of key terms that are used interchangeably in every day language. For example, there is a clear difference between mass and weight; and speed and velocity however they are often used incorrectly in general conversation and therefore students can quite often substitute one word for another. When it comes to definitions and calculations for quantities of linear and angular motion, encouraging the students to keep glossaries is helpful. It is also important to be extremely vigilant in the classroom at encouraging the correct use of these terms; when writing exam answers, students can often use speed instead of velocity, for example, affecting the accuracy of their answer. Conscious attempts at GCSE to correctly apply the terms mass and velocity during instructions and discussion will help understanding at A Level.

There are a number of scenarios when students will need to plot and interpret graphs. While this should not be new to them and some graphs will already have been covered in GCSE maths and science, a number of students can find it difficult. Applying these graphs to sporting situations is always advantageous as students can identify the velocity patterns of a 100m sprinter and therefore can use this to help them to interpret the graphs. Students will need to practice verbally explaining the patterns that they see as well as practise writing this down.

Students need to be able to complete the two worksheets for the checkpoint task competently.

Students who can identify their levers/planes and axes have a good grasp of the topic and ready to move onto A level with support.

If students can explain the extension tasks in their own words they are demonstrating a strong understanding and already applying their knowledge to practical application.

Teacher guidance

Teachers might want to cover a range of examples in terms of figure skating/diving/ trampolining routines where whole body actions can be analysed. Students should manage these competently and then some more isolated skills such as a tennis serve or kicking a football should be analysed. When looking at individual joints, students might find identifying an axis etc more difficult.

Students should be given the worksheet as a 'starter of next lesson' or plenary activity once the information has been covered. Worksheet 1 should take 15 mins. Worksheet 2 Questions 1-4 should take 10-15 mins. The extension task could be a homework project of half a lesson in groups.

Student task questions are on the worksheet which can be downloaded from:

http://www.ocr.org.uk/Images/285313-biomechanics-checkpoint-task.doc.doc

Answers have been provided on the answer document.

Activities

The following tasks will test your knowledge and understanding of lever systems, planes of movement and axes of rotation and your ability to apply these to sporting scenarios.

Student task 1.1

Checkpoint task – Worksheet 1: Lever Systems is an example of the tasks. Pictures have been used from the internet to demonstrate how it should be set out/look but any picture can be used.

1. Students must identify from a picture the class of lever and give a practical example from sport of that lever.
2. Define Mechanical Advantage.
3. Using a practical example, explain what mechanical advantage is.

Student task 1.2

Checkpoint task – Worksheet 2: Planes and Axes of rotation is an example of how the tasks may be presented. Pictures have been used from the internet to demonstrate how it should be set out/look but any picture can be used.

1. For the pictures below draw on the plane of movement.
2. Identify which axis of rotation is being used.

Extension task

The last question on Checkpoint task – Worksheet 2 is a step towards extension.

1. How can an athlete increase the velocity of their rotation? Use an ice skater spinning to help your explanation.
2. How can an athlete decrease the velocity of their rotation? Use a high diver to help.

Ask students to create a storyboard or video on the levers, planes and axes used for a skill of their choice.

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