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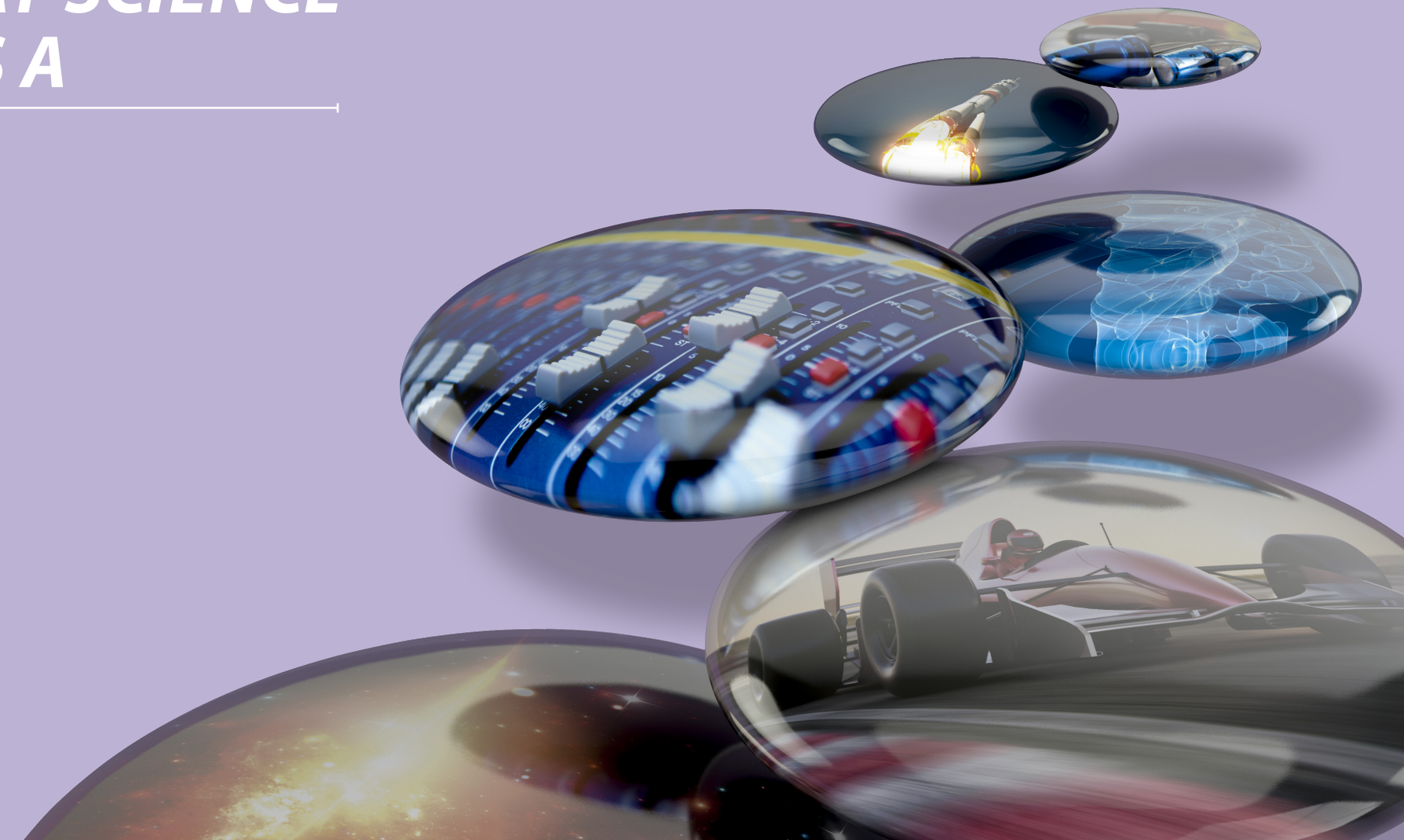
GCSE (9–1)
Transition Guide

GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

KS3-KS4
Forces

Version 1



www.ocr.org.uk/physics

GCSE (9–1)

GATEWAY SCIENCE PHYSICS A

Key Stage 3 to 4 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 3 which will help prepare students for progression to Key Stage 4;
- 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 3 and 4 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 3 and assess their 'readiness for progression' to Key Stage 4 content on this topic. This checkpoint task can be used as a summative assessment at the end of Key Stage 3 teaching of the topic or by Key Stage 4 teachers to establish their students' conceptual starting point.

Key Stage 3 to 4 Transition Guides are written by experts with experience of teaching at both key stages.

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Key Stage 3 Content

Motion

- Represent a journey on a distance-time graph.
- Describe quantitative relationship between average speed, distance and time (speed = distance ÷ time)

Newton's law

- Recognise forces as pushes or pulls
- Balanced and unbalanced forces
- Opposing forces and equilibrium

Forces in action

- Units of force (newtons)
- Moment as the turning effect of a force
- Force-extension linear relation; Hooke's Law as a special case
- Forces: associated with deforming objects
- Work done and energy changes on deformation

Key Stage 4 Content

Motion

- Apply formulae relating distance, time and speed, for uniform motion, and for motion with uniform acceleration.
- Relate changes and differences in motion to appropriate distance-time, and velocity-time graphs, and interpret lines, slopes and enclosed areas in such graphs.
- Convert units
- Explain the vector-scalar distinction as it applies to displacement and distance, velocity and speed.

Newton's law

- Apply Newton's first law to explain the motion of an object moving at uniform velocity
- Describe using free body diagrams, examples where two or more forces lead to a resultant force of an object
- Apply Newton's second law in calculations relating forces, masses and accelerations
- Define momentum and describe examples of momentum
- Recall and apply Newton's third law

Forces in action

- Become familiar with forces associated with deforming objects, with stretching and compressing springs (to include graphical representation of the extension of a spring).
- Hookes law
- Calculate the work done in stretching
- Relationship between the weight of an object and the gravitational field strength (g)
- Recall the acceleration in free fall
- Describe examples in which forces cause rotation and calculate the moment of the force in such examples
- Explain how levers and gears transmit the rotational effects of forces
- Explain a simple hydraulics system.

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Comment

The programme of study for Key Stage 3 forces introduces key ideas and key terminology so learners may meet demand for GCSE level. The Key Stage 3 focus on forces and motion is very brief and learners will find many new concepts and demands at Key Stage 4. For example the demand for the application and calculation of formulae is non existant in Key Stage 3. Learners are required to interpret graphical representations of speed/distance-time graphs.

At Key Stage 4, learners are required to demonstrate a deeper understanding of forces. It is important to be aware of the following misconceptions learners may have surrounding this topic.

Motion:

- Learners often struggle with differences between vector and scalar quantities and this can pose difficulties in understanding. This can be addressed when looking at the difference between distance-time and velocity-time graphs and ensuring specific focus is emphasised on key terminology. Learners may be provided with several quantities and asked to identify them as either scalar or vector.
- Learners confuse between speed, acceleration and velocity. Learners can be provided with an example of speed, velocity and acceleration and allow them to develop ideas of what makes them different to each other.
- Learners get confused with distance-time and speed-time graphs. Simulations from echalk's forces and motion section are an excellent way to help them understand.

Newtons law:

- Learners often have difficulty grasping the link between forces and motion, believing that no motion means that there is no force and also that no force leads to a lack of motion.
- Another concept that learners find difficult to understand is that of a reaction force, believing that when an object is set upon a table, the reason why the object doesn't fall is that the table is in the way, rather than that the table is exerting a force on the object.
- It can be difficult for learners to grasp elastic and inelastic collisions as, again, any demonstrations that we can perform are likely to be flawed by the presence of friction or air resistance. In these cases, simulations can be particularly helpful.
- Newton's third law is a concept learners find difficult. 'For body at rest, action and reaction balance' is what learners believe. University of Leicester focus on this misconception and many more in their videos.

Forces in action:

- Learners may find new terminology difficult to understand such as plastic deformation. To overcome difficulty learners could be provided with keywords and a graph, which shows a linear line with elastic limit reached (curve). Learners could share ideas about key terminology and then share the meanings as a class discussion.
- Learners may find understanding the rotation effect of gears difficult. When one gear turns clockwise the second gear in contact turns anti-clockwise. To overcome this difficulty plastic toy gears could be used to physically show learners how they work.

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Activities

Distance multiplier: Great Barr school
Resources: http://www.freezeray.com/flashFiles/distanceMultiplier1.htm

This interactive simulation allows learners to explore distance multiplier by using a bike. A great introduction to Key Stage 4 concepts such as gears. Many other simulations may be found on the site.

Forces in action game: Science kids
Resources: http://www.sciencekids.co.nz/gamesactivities/forcesinaction.html

Learners play a game which moves a truck from the start to the end of the track allowing them to experiment how gradients, weights, motion and resistance affect the movement of various objects. Allows learners to compete with one another.

Why cant we see forces?: KS3 Bitesize
Resources: http://www.bbc.co.uk/bitesize/ks3/science/energy_electricity_forces/forces/activity/

This video clip explains force at a Key Stage 3 level. It is an interactive clip which allows learners to take part in short activities during the video.

Nails Trick: Science Museum
Resources: http://www.sciencemuseum.org.uk/educators/teaching_resources/activities/nails_trick.aspx

Learners are set a challenge to see if they can outwit gravity to balance fourteen nails on the head of just one nail. Focuses on balancing and friction. Instruction sheet and learning outomes are provided.

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The checkpoint task can be used straight after teaching the Key Stage 3 forces content or before the teaching of forces at Key Stage 4 to check learners' prior learning and early identification of misconceptions. The task may be used as a starter or plenary activity directly after teaching the specific areas to determine understanding. Each activity covers a starting point of each Key Stage 4 topic P2.1 - Forces and motion, P2.2 – Newton's law and P2.3 – Forces in action. Forces is a topic with many misconceptions which can hopefully be identified early with the checkpoint task.

Teacher Guidance:

- Teachers do not need any prior preparation for the checkpoint activities. Teachers are to be aware that learners may provide several different answers for activity 3 which is fine so long as it is correct and contains keywords.

Checkpoint Task:

www.ocr.org.uk/Images/288973-forces-checkpoint-task.doc

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Activities

Forces & Motion: echalk
Resources: http://www.echalk.co.uk/Science/physics.html#Forcesandmotion

A number of simulations which clearly cover forces and motions. Simulations can be found on moments, gravity, displacement graphs. Good for learners to use during revision.

Misconceptions: Leicester University
Resources: http://www.physics.le.ac.uk/physicsconcepts/Misconceptions.shtml#Forces

A number of videos which focus on misconceptions that learners have during the teaching of Physics.

Forces and transport: TES
Resources: https://www.tes.com/teaching-resource/ocr-gcse-add-science-b-p3-forces-for-transport-6360675

A series of PowerPoints which can be used to assist with teaching forces and motion. Mini activities for each section are included.

Newton's law of motion: Youtube
Resources: https://www.youtube.com/watch?v=cP0Bb3WXJ_k

A video which clearly explains Newton's third law or action and reaction. Lots of examples are provided in the clip.

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Activities

Olympic report: OCR
Resources: www.ocr.org.uk/Images/288974-forces-learner-activity.docx

A report which looks at forces but bases it on a real life context with winter Olympics and Jamaica. Learners are to design equipment and help Jamaica win the winter Olympics.

Roller Coaster Design activity: TES
Resources: https://www.tes.com/teaching-resource/roller-coaster-design-activity-6065583

Learners design a new rollercoaster. As a cut and stick exercise as the tracks are pre-made. Teaching notes are included giving a guide for the task. The learner can choose a mass for their carriage and then calculate Gravitational Potential Energy, Kinetic Energy and Velocity.

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