Qualification Accredited

Oxford Cambridge and RSA

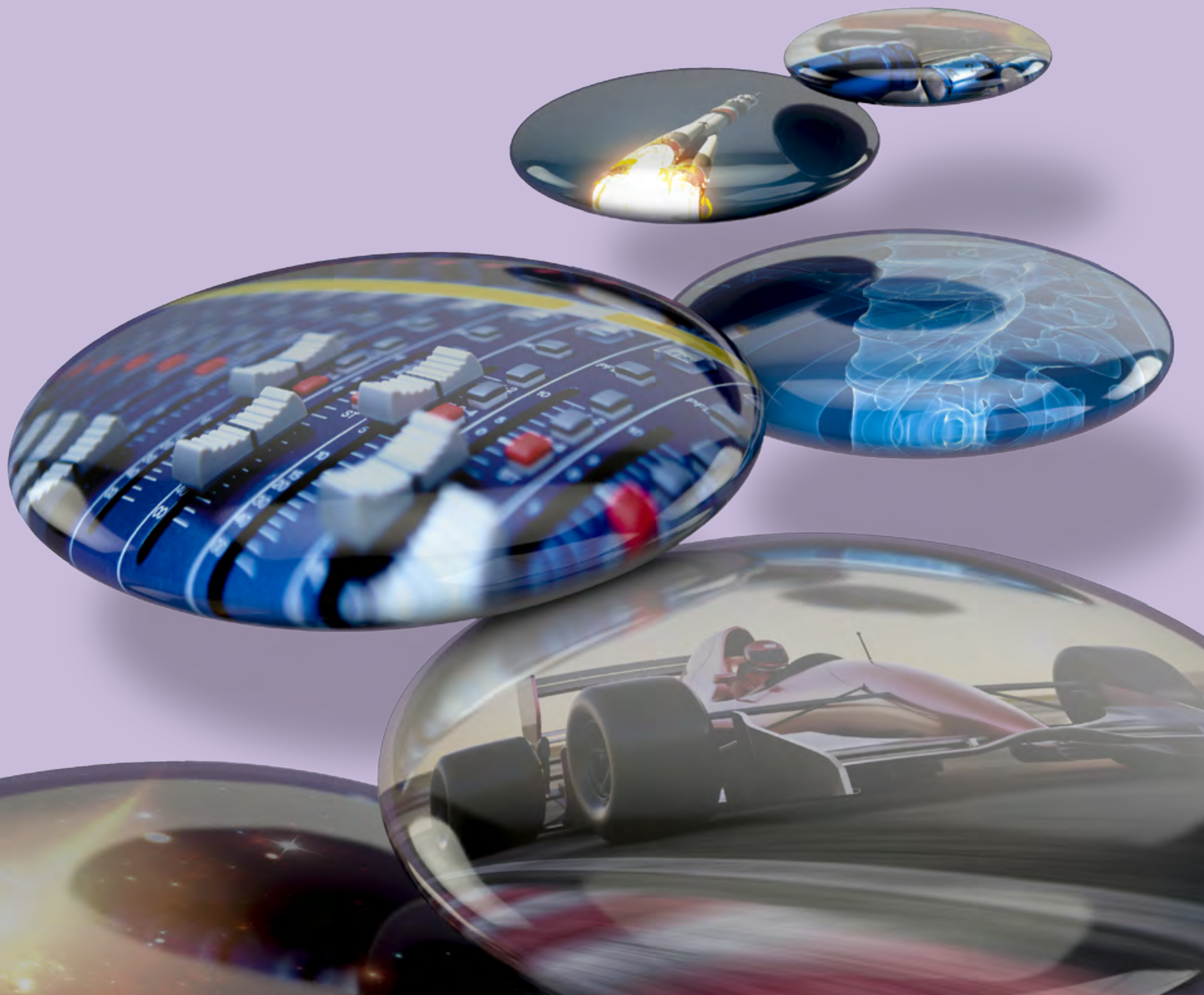
GCSE (9–1)
Transition Guide

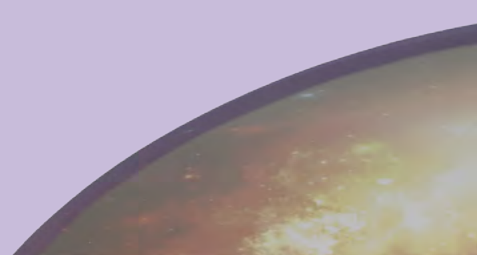
GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

KS3–KS4 Focus
Energy

Version 1





www.ocr.org.uk/physics

Introduction

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.

Key Stage 3 Content

From study at Key Stages 1 to 3 learners should:

- have compared energy uses and costs in domestic contexts, including calculations using a variety of units
- have considered a variety of processes that involve transferring energy, including heating, changing motion, burning fuels and changing position in a field.

Key Stage 4 Content

P7.1a: describe for situations where there are energy transfers in a system, that there is no net change to the total energy of a closed system (qualitative only)

P7.1b: describe all the changes involved in the way energy is stored when a system changes for common situations

P7.1c describe the changes in energy involved when a system is changed by heating (in terms of temperature change and specific heat capacity), by work done by forces, and by work done when a current flows

P7.1d make calculations of the energy changes associated with changes in a system , recalling or selecting the relevant equation for mechanical, electrical, and thermal processes; thereby express in quantitative form and on a common scale the overall redistribution of energy in a system

P7.1e calculate the amount of energy associated with a moving body, a stretched spring and an object raised above groud level

P7.2a describe, with examples, the process by which energy is dissipated, so that it is stored in less useful ways

P7.2b describe how, in different domestic devices, energy is transferred from batteries or the a.c. from the mains

P7.2c describe, with examples, the relationship between the power ratings for electrical appliances and how this is linked to the changes in stored energy when they are in use

P7.2d calculate energy efficiency for any energy transfer

P7.2e describe ways to increase efficiency

P7.2f explain ways of reducing unwanted energy transfer

P7.2g describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls (qualitative only)

Comment

Energy is a central concept in physics, yet one that can cause significant challenges for students and teachers alike. A simple model is to recognise energy as the 'currency' of an 'accounting system' of changing physical systems. That is, defining absolute energy can be hard. By contrast, by defining the start and end point of a system, the differences or changes in energy can be more easily calculated and discussed.

Energy stores are a useful model in understanding the energy. Elastic stores are one of the easiest to grasp as they can be modelled simply with springs and elastic bands. Kinetic stores are intuitively understood as most students will have experience with impacts with slow and fast objects! Equally, thermal stores can be understood in the context of having touched a kettle before and after it has been used. Finally, magnetic stores can 'felt' by pushing two identical magnet poles together.

The gravitational store is conceptually challenging, although often used to introduce the idea of potential energy. Using elastic potential energy first is recommended as the demonstrations are more visceral and hands on (stretching rubber bands) and the ideas that forces are involved more easily grasped.

Chemical potential energy usually uses fuels as the example, although often the importance of oxygen is omitted. A fuel, such as petrol, is only a useful chemical store of energy when mixed with oxygen, as otherwise the combustion reaction cannot occur. The idea of potential energy here can be grasped with the energetic outcome of a combustion reaction readily observable.

The transfer of energy between different stores describes the changes to systems, and our interest extends to understanding the efficiency of such transfers and the rate of those transfers. The transfers can happen in four distinct ways:

- mechanically – by a force over a distance
- electrically - by a charge moving through a potential difference
- heating – due to temperature differences
- radiation – by electromagnetic radiation or other waves (e.g. sound)

For example, boiling water on a camping stove. The initial store is a chemical store of the propane and oxygen. The final store is the thermal store of the water. The transfer route is by heating. If 200 kJ is released from the propane/oxygen store and 160 kJ is transferred to the water, then the efficiency of the transfer is 160/200 = 0.8 or 80%. If the transfer takes 2 minutes, then the rate of energy transfer into the water, i.e. the power, is 160,000/240 = 670 W (J/s).

The every-day usage of scientific terminology can lead to a lot of the confusion in the discussion of energy, so careful definition and use of terms is required: energy, power, force, potential etc.

Energy intersect with many other topics throughout the specification including P2 (Forces), P3 (Electricity) and P5 (Waves). Practical work and demonstrations can help exemplify ideas and give students sensory hooks on which to hang their emerging understanding.

http://practicalphysics.org/helpful-language-energy-talk.html

http://neilatkin.com/2016/06/09/teaching-energy-new-approach/

Activities

Energy
Sixty Symbols

https://www.youtube.com/watch?v=iyxy1sZfDTA

A 7-minute video in which physics professors from Nottingham University attempt to define the word "energy", with some interesting digressions.

Richard Feynman: Jiggling Atoms – Fun To Imagine
BBC

https://www.youtube.com/watch?v=v3pYRn5j7oI&list=PL04B3F5636096478C

The first of a series of excerpts from an interview with Richard Feynman in which he explains various concepts in science in terms understandable to a layman.

Conservation of Mechanical Energy
https://www.youtube.com/watch?v=mhIOylZMg6Q

An arresting demonstration of the conservation of mechanical energy , which should under no circumstances be replicated by learners in the classroom.

Pendulum Lab - Pendulum | Periodic Motion
PhET Interactive Simulations – University of Colorado, Boulder

https://phet.colorado.edu/en/simulation/legacy/pendulum-lab

An interactive in which users can experiment with a virtual pendulum, adjusting various parameters and observing the energy transfers.

Bill Nye on Making His House Energy-Efficient
Wall Street Journal

https://www.youtube.com/watch?v=H5s1ia50-aw

An interview with American popular scientific/educational TV presenter Bill Nye, in which he describes the ways in which his house is energy-efficient.

Overview

Since a conceptual grasp of the ideas in this chapter is important in many areas of the topic, the questions in the Checkpoint task provide a range of opportunities for learners to demonstrate not only depth but also breadth of understanding, by asking them to think of as many examples of answers as they can as well as asking them to go into detail where possible. In general, the questions will have some more obvious "textbook" answers and potentially some more creative ones; learners should be encouraged to be original where possible, as long as their ideas convey real understanding of the concepts.

For example, in Learner Task 1.2, learners are asked to think of ways of making the process of driving cars more efficient. Although there are many obvious answers, more creative and lateral-thinking answers such as car-sharing to minimise the energy wasted per person should be encouraged.

Tasks 1.1 and 1.2 feature mostly familiar examples of energy transfers, but the questions in the extension task, which relate to the answers to 1.1 and 1.2, are designed to challenge learners to think a little more broadly and, in the case of question 2, to research a specific topic of their choce in order to describe in more detail one aspect of one of the phenomena they have already analysed on a more generalised scale.

Since the emphasis is on encouraging learners to think originally, there are a large number of possible answers; more interesting ones should be favoured.

Checkpoint task

Activities

Potential and Kinetic Energy

Bozeman Science

https://www.youtube.com/watch?v=BSWl_Zj-CZs

A 6-minute video featuring explanations, with diagrams, of potential and kinetic energy, including examples of transfers between them.

Energy Skate Park - Energy | Conservation of Energy | Kinetic Energy

PhET Interactive Simulations – University of Colorado, Boulder

https://phet.colorado.edu/en/simulation/legacy/energy-skate-park

An interactive app in which users can experiment with a "track" of varying height and a variety of virtual "skaters" in order to investigate transfers between potential and kinetic energy, conservation of momentum and dissipation.

Richard Feynman: Fire – Fun To Imagine

BBC

https://www.youtube.com/watch?v=lTpDrdtGAmo&index=2&list=PL04B3F5636096478C

The second in the series, this section of the interview features a description of the process by which light and heat radiated by the sun can become trapped in, and released from, plant material, as well as the incidental observation that trees are mostly made out of air.

Energy Units

APS Physics

https://www.aps.org/policy/reports/popa-reports/energy/units.cfm

A useful recap of various units used to measure energy, including many obscure and perhaps unfamiliar standard equivalents in terms of, for instance, various forms of petroleum products.

GCSE Bitesize: Temperature

BBC

http://www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway/home_energy/heating_housesrev1.shtml

A sequence of pages recapping ideas from the GCSE curriculum related to energy transfers, temperature and heat.

Activities

What if the Death Star were real?
Sixty Symbols

https://www.youtube.com/watch?v=HDL0KAm9Cbs

A short (7m40s) video in which a professor of astrophysics tries to work out what the power requirements of the Death Star (from the Star Wars films) would be.

Richard Feynman: Rubber Bands – Fun To Imagine
BBC

https://www.youtube.com/watch?v=XRxAn2DRzgI&index=3&list=PL04B3F5636096478C

The third in the series, this video goes into some detail about the mechanisms underlying the behaviour of rubber band.

World's Most Asked Questions: What Is Energy?
SciShow

https://www.youtube.com/watch?v=CW0_S5YpYVo

Another video about definitions and examples of energy, with some more detail and a brief introduction to the idea of energy/mass equivalence.

Which Power Source Is Most Efficient?
DNews

https://www.youtube.com/watch?v=0c4xk5dB014&t=96s

A short video in which the various diferent methods of energy generation are compared in terms of efficiency, in which hydroelectric power comes out as the winner by some way.

Propulsion Efficiency
Sixty Symbols

https://www.youtube.com/watch?v=TSxWstqs0Po

A 6-minute video featuring a simple explanation of how jet engines work, with a potentially counterintuitive example of how to achieve greater propulsion efficiency for the same amount of work.

Resources, links and support

Science Spotlight – Our termly update Science Spotlight provides useful information and helps to support our Science teaching community. Science Spotlight is designed to keep you up-to-date with Science here at OCR, as well as to share information, news and resources. Each issue is packed full with a series of exciting articles across the whole range of our Science qualifications: www.ocr.org.uk/qualifications/by-subject/science/science-spotlight/

Find resources and qualification information through our science page: http://www.ocr.org.uk/qualifications/by-subject/science/

Contact the team: science@ocr.org.uk

Continue the discussion on the science community forum: http://social.ocr.org.uk/

and follow us on Twitter, @ocr_science

To find out more about GCSE and A Level reform please visit: http://www.ocr.org.uk/qualifications/gcse-and-a-level-reform

The small print

We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

Whether you already offer OCR qualifications, are new to OCR, or are considering switching from your current provider/awarding organisation, you can request more information by completing the Expression of Interest form which can be found here: www.ocr.org.uk/expression-of-interest

OCR acknowledges the use of the following content:
Square down and Square up: alexwhite/Shutterstock.com

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: resources.feedback@ocr.org.uk

Looking for a resource?

There is now a quick and easy search tool to help find **free** resources for your qualification:
www.ocr.org.uk/i-want-to/find-resources/

www.ocr.org.uk/gcsereform

OCR Customer Contact Centre

General qualifications
Telephone 01223 553998
Facsimile 01223 552627
Email general.qualifications@ocr.org.uk