Qualification Accredited

OCR
Oxford Cambridge and RSA

GCSE (9–1)

Delivery Guide

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259
For first teaching in 2016

Sustainable Energy

Version 2

www.ocr.org.uk/physics

Introduction

GCSE (9 –1)

TWENTY FIRST CENTURY SCIENCE PHYSICS B

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- Content: A clear outline of the content covered by the delivery guide;
- Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk

P2.1.1: Describe how energy in chemical stores in batteries, or in fuels at the power station, is transferred by an electric current, doing work on domestic devices, such as motors or heaters.

P2.1.2: Explain, with reference to examples, the relationship between the power ratings for domestic electrical appliances, the time for which they are in use and the changes in stored energy when they are in use.

P2.1.3: Recall and apply the following equation in the context of energy transfers by electrical appliances :
energy transferred (J, kWh) = power (W, kW) x time (s, h)

P2.1.4: Describe, with examples, where there are energy transfers in a system, that there is no net change to the total energy of a closed system (qualitative only).

P2.1.5: Describe, with examples system changes, where energy is dissipated, so that it is stored in less useful ways.

P2.1.6: Explain ways of reducing unwanted energy transfer e.g. through lubrication, thermal insulation.

P2.1.7: Describe the effects, on the rate of cooling of a building, of thickness and thermal conductivity of its walls (qualitative only).

P2.1.8: Recall and apply the equation :
efficiency = useful energy transferred ÷ total energy transferred
to calculate energy efficiency for any energy transfer, and describe ways to increase efficiency.

P2.1.9: Interpret and construct Sankey diagrams to show understanding that energy is conserved.

Battersea Power Station

Approaches to teaching the content

A simple 'energy circus' can be used as a recap on the different energy stores and transfers, which learners should have previously covered. Place different devices and appliances around the room and have learners go round and describe how energy is being stored and transferred. This can help learners understand the idea of efficiency in different devices, which is covered in sections P2.1.5-9.

This circus can also be used to help describe power ratings. This would be very useful if different light sources were used (such as a different torches and desk lamps) or different types of heaters. Learners can look at these different appliances and be asked to look for a power rating on the device, and link this to how bright/hot the device can get. This should link the concept of power to how much energy is converted per second.

This can link to section P2.1.3, where a link can be made to the possible uses of different power appliances, and their comparative running costs.

Following on from the previous section, learners can use appliances that they have previously seen and calculate the amount of energy transferred using the equation:

energy transferred (J, kWh) = power (W, kW) x time (s, h).

Section 2.1.4 - 2.1.9

This section includes a lot of different concepts that can be included together.

Following on from section P2.1.1, learners should refer back to their previous work and explain for the appliances they examined if all of the energy transfers were useful or not.

This can lead to a discussion over what counts as useful, for example, a light bulb dissipating thermal energy to the surroundings may be useful in a kitchen to keep food warm, but not useful in other situations.

After this discussion, learners should practice the efficiency equation from section P2.1.8.

After learners are able to calculate efficiencies, they should have Sankey diagrams explained to them. Groups can be given a device and large paper/mini whiteboards and asked to draw out Sankey diagrams after being shown how to. Alternatively, an 'energy circus' like the one used in section P2.1.1 could be used, where learners go round a selection of appliances, where they have to draw a Sankey diagram for each one.

2.1.7 describe the effects, on the rate of cooling of a building, of thickness and thermal conductivity of its walls (qualitative only).

This can be demonstrated to the learners by a brief practical, that can be expanded into a full investigation if time is permitting. To demonstrate the rate of cooling depending on thermal conductivity learners could do a practical on the rate of cooling of hot water in different containers. This can be combined with section P2.1.6 when talking about thermal insulation.

Common misconceptions or difficulties students may have

Care must be taken when introducing this work, as learners can often find unit conversion difficult. It is important to be very clear with learners the differences in the units. For simplicities sake it is often best to stay with one unit type until learners fully understand it, for example, if learners need to calculate the energy transferred in kWh (if calculating the cost of electricity, for example) ensure learners can convert minutes into hours, and watts into kilowatts.

Lower ability learners might prefer a more hands on approach. To demonstrate the concept of energy being conserved learners could use beads/buttons to represent the energy into a device. After writing down how many buttons of energy a device takes in from an energy store, they can show how this energy is transferred. This can show how the total energy out is the same as the total energy in.

Conceptual links to other areas of the specification - useful ways to approach this topic to set learners up for topics later in the course

P3.4.1 describe the energy transfers that take place when a system is changed by work done when a current flows through a component

P3.4.2 explain, with reference to examples, how the power transfer in any circuit device is related to the energy transferred from the power supply to the device and its surroundings over a given time

power (W) = energy (J) / time (s)

P3.4.5 use the idea of conservation of energy to show that when a transformer steps up the voltage, the output current must decrease and vice versa.

Select and use the equation:

potential difference across primary coil x current in primary coil = potential difference across secondary coil x current in secondary coil

Approaches to teaching the content

After learners understand the concept of energy in and out, they should be encouraged to explain how devices can be made more efficient. The Sankey diagrams they have drawn will all indicate common energy losses including thermal energy dissipated to the surroundings. Learners can be put into teams of designers, and given a project to raise profits for running a racing car or heating a building. By looking at the energy losses, they should realise that they could reduce thermal energy transfer done using insulation/lubrication. Learners could be asked to pitch their ideas for increasing profits to the class by a presentation or written task.

Learner Activity 1
Energy transfers

https://www.youtube.com/watch?v=LEMK_v-p70Q

This video can be a resource for energy transfers.

Activity 2

Energy research

http://tinyurl.com/muxs47b

A resource that can be used for learners as a homework research activity, it also contains useful revision questions.

Activity 3

Power and kWh

https://www.youtube.com/watch?v=49GQCKyHJ7s

Here is a video which can help with the introduction of the concepts of power and kWh.

Activity 4

Efficiency

https://www.youtube.com/watch?v=uQEyTRR7B4g

Here is a video tutorial which can help learners calculate efficiency.

Activity 5

Power and efficiency revision

(s-cool)
http://www.s-cool.co.uk/gcse/physics/energy-calculations/revise-it/power-and-efficiency

This website is a useful source of revision, it also includes an interactive program that gives a visual representation of different efficiencies.

Activity 6

Sankey diagrams

https://www.youtube.com/watch?v=EHg3bmq-NrA

This video includes a helpful tutorial on drawing out sankey diagrams.

Activity 7

Investigating the effect of insulation

(scienceteacher.org)
http://scienceteacher.org.uk/?page_id=292

Link to a practical which links to this work, where learners investigate the effect of insulation.

Activity 8

Revision task

http://tinyurl.com/osd958f

This booklet contains a lot of material and activities relating to sections P2.1.1-9. It would be useful as a revision task at the end
of the section, or a set of tasks that can be completed throughout the course.

Activity 9

Power ratings

http://tinyurl.com/ozvlmb7

This worksheet has a large amount of calculations on it which can help learners calculate the power rating of devices.

Activity 10

Energy transfers

http://www.nuffieldfoundation.org/practical-physics/examples-energy-going-one-thing-another

Here is a selection of simple practicals that can be used to show energy transfers.

Activity 11

Power

(Nuffield foundation)
http://www.nuffieldfoundation.org/practical-physics/power

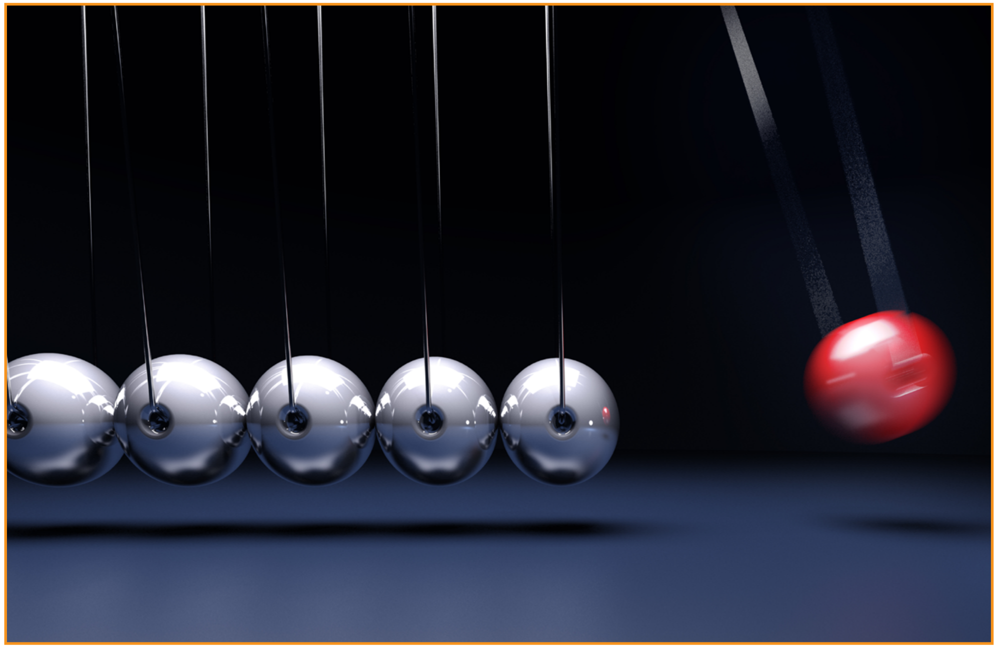
Here is a selection of practicals that can be used to explain power.

Activity 12

Sankey Diagrams

(myphysics)
http://www.myphysics.org.uk/ks4p3hotpot04.htm

A quiz on drawing sankey diagrams.



A Newtons' Cradle demonstrating energy transfer.

Curriculum content

Subtopic 1– P2.2 How can electricity be generated?

P2.2.1: Describe the main energy resources available for use on Earth (including fossil fuels, nuclear fuel, biofuel, wind, hydroelectricity, the tides and the Sun).

P2.2.2: Explain the differences between renewable and non-renewable energy resources.

P2.2.3: Compare the ways in which the main energy resources are used to generate electricity.

P2.2.4: Recall that the domestic supply in the UK is a.c., at 50Hz and about 230 volts and explain the difference between direct and alternating voltage.

P2.2.5: Recall that, in the national grid, transformers are used to transfer electrical power at high voltages from power stations, to the network and then used again to transfer power at lower voltages in each locality for domestic use.

P2.2.6: Recall the differences in function between the live, neutral and earth mains wires, and the potential differences between these wires; hence explain that a live wire may be dangerous even when a switch in a mains circuit is open, and explain the dangers of providing any connection between the live wire and any earthed object.

P2.2.7: Explain patterns and trends in the use of energy resources (in domestic contexts, workplace contexts, and national contexts).

P2.1.7: Describe the effects, on the rate of cooling of a building, of thickness and thermal conductivity of its walls (qualitative only).

P2.1.8: Recall and apply the equation :
efficiency = useful energy transferred ÷ total energy transferred
to calculate energy efficiency for any energy transfer, and describe ways to increase efficiency.

P2.1.9: Interpret and construct Sankey diagrams to show understanding that energy is conserved.

Rows of solar panels and wind turbines gather energy from the sun and wind.

Approaches to teaching the content

For this section a research 'marketplace' could be done. This is where learners, in small groups, are given a large sheet of paper divided into sections, one per type of electricity generation. Around the room could be revision guides and other research materials. Learners have to take it in turns to go to different areas, then return to their group to share with others what they have learned, which is then written on their research sheet.

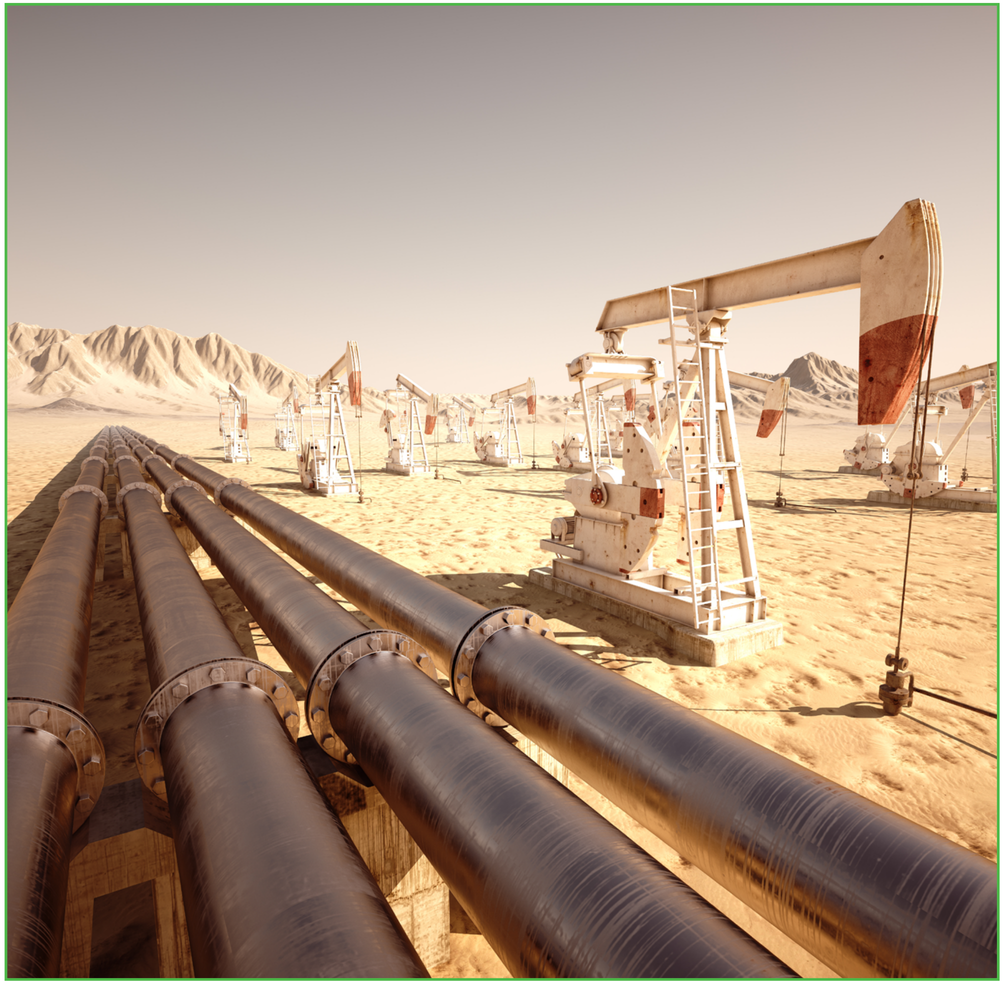
If learners need (or time is permitting) more experience comparing different methods of generating electricity, the previous presentation work could be expanded. This time groups, when given a type of electricity generation, are instructed to pitch their ideas to a panel (which could be other learners or a teacher), explaining the advantages of their method and the disadvantages of others. This could lead to some interesting debate, as long as learners made sure that they stick to the facts!

This section links to many others, and can be delivered in conjunction with the section on transformers (P3.3.5–7). Learners may be aware of our mains supply being 230V but unaware of the nature of AC and DC, so care must be taken to explain the difference. As these concepts may seem somewhat abstract reinforcing this area with practical work will be very useful.

When discussing the different functions of the live, earth and neutral wires, if possible learners can be encouraged to wire a plug. This will give some useful context to the definition of the different wires. That said, it should be explained to learners that due to EU regulations very few plugs can be wired now.

Common misconceptions or difficulties students may have

Learners are generally able to understand and differentiate different methods of generating electricity. A common area of misunderstanding is the definition of what a fossil fuel is, as learners often directly link fossil fuels to all non-renewable energy sources. This can result in nuclear power erroneously being labelled as a fossil fuel.



Rocking oil pumps with oil pipelines in the foreground.

Approaches to teaching the content

As this section is very content-driven, a research task can be set to learners. Learners could be given the task of delivering a presentation to the class on a chosen method of electricity generation. To ensure other learners pay attention, groups could also be instructed to write a set of questions about their presentation to give to learners after.

Learners could be asked to visualise a scenario of what would happen if there was suddenly no electricity being generated. They can be asked to explain what would happen to themselves, friends and family, nearby shops and businesses and the country as a whole. Groups of learners could examine what might happen to different companies and groups, for example, how a lack of energy would affect local hospitals.

Activity 1

Non renewable energy resources

https://www.youtube.com/watch?v=S0lc4mq8lIo

Here is a video that shows how electricity can be made from non renewable sources.

Activity 2

Nuclear power

https://www.youtube.com/watch?v=VrhzkoNU84g

Here is a video detailing nuclear power.

Activity 3

Renewable electricity generation

https://www.youtube.com/watch?v=bhnvkj0W_4k

Here is a video detailing renewable electricity generation.

Activity 4

Electricity generation

(energyquest)

http://www.energyquest.ca.gov/projects/geothermal-pp.html

Here is a practical that can help demonstrate to students how electricity is generated. The main concept of using a spinning turbine to generate electricity is explained as being used in coal, oil, gas and nuclear power stations as well as in ones used in geothermal power stations.

Activity 5

National grid

https://www.youtube.com/watch?v=-1SLFzqLU5k

A brief video that explains the national grid, and why the voltage is stepped up to higher voltages from power stations, and then transferred to lower voltages for domestic use.

Activity 6

Power Lines

(National stem centre)

http://www.nationalstemcentre.org.uk/elibrary/resource/2085/power-lines

A video explaining how power lines are used.

Activity 7

National grid

(bitesize)

http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/mains/generatingelectricityrev8.shtml

A useful resource for learners who have to research the national grid.

Activity 8

dc powerlines

(Nuffield foundation)
http://www.nuffieldfoundation.org/practical-physics/model-dc-power-line

This practical demonstration is a model D.C power line, which can be used to explain the importance of raising the voltage when transmitting electricity over a distance.

Activity 9

Patterns and trends in energy use

(BBC bitesize)
http://www.bbc.co.uk/schools/gcsebitesize/history/tch_wjec/usa19101929/2riseandfall2.shtml

http://www.bbc.co.uk/schools/gcsebitesize/geography/energy_resources/sustainable_energy_rev2.shtml

Learners can use the links above to research the context of energy use over time, and how it has increased. Learners should be encouraged to explain what implications this energy use has for the future, given the use of non renewable resources learnt from section P3.2.1. This can be done in the form of a written task or a discussion depending on time and learner ability.

Activity 10

Generation of electricity

http://tinyurl.com/k9mu9ec

Here is a 'web quest' – an interactive internet research task that learners can use to guide them through researching how electricity is generated.

Activity 11

National grid

http://tinyurl.com/mm5y3f2

A booklet that includes information on the national grid, and also has questions to test recall.

Electricity powerlines and pylons

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, Battersea Power Station: Peter Wallace/Shutterstock.com, Newton's Cradle: Franck Boston/Shutterstock.com, Wind and solar power: Vaclav Volrab/Shutterstock.com, Oil pumps and pipes: Dabarti CGI/Shutterstock.com, Eletrical pylons: gyn9037/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