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GCSE (9–1)
Transition Guide

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259
For first teaching in 2016

KS3–KS4 Focus
Generating electricity

Version 1

www.ocr.org.uk/physics

GCSE (9–1)

TWENTY FIRST CENTURY SCIENCE PHYSICS B

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

- Calculation of fuel uses and costs in the domestic context
- Comparing power ratings of appliances in watts
- Comparing amounts of energy transferred
- Domestic fuel bills, fuel use and costs
- Fuels and energy resources
- Electric current, measured in amperes, as a flow of charge
- Potential difference, measured in volts, battery and bulb ratings
- Differences in resistance between conducting and insulating components (quantitative)
- Magnetic effect of a current, electromagnets, DC motors (principles only)

Key Stage 4 Content

GCSE Content

- The main energy resources (fossil fuels, nuclear fuel, biofuel, wind, hydroelectricity, tides and solar)
- Differences between renewable and non-renewable energy resources
- Ways in which the main energy resources are used to generate electricity
- Domestic supply in the UK is a.c., 50 Hz and 230 volts
- The difference between direct and alternating voltage
- In the National Grid, transformers are used to transfer electrical power at high voltages from power stations to the network and used to transfer power at lower voltages in each locality for domestic use
- Differences in function between the live, neutral and earth mains wires, and the potential differences between these wires
- A live wire may be dangerous even when a switch in a mains circuit is open and the dangers of providing any connection between the live wire and any earthed object
- Patterns and trends in the use of energy resources in domestic, workplace and national contexts

Comment

At Key Stage 3 learners will be aware of the basic concepts of current electricity and magnetism. They should know what is meant by an electric current and by potential difference and that energy can be transferred by electrical circuits. They should be aware that this energy is used in the home in electrical devices and that this energy use can be determined in terms of the power rating of a device and the time the device is run for. They should also be aware of the different energy sources that are available for generating this electricity.

Learners usually have little difficulty in understanding how energy can be used to generate electricity from fuels but will have much greater difficulty with other energy resources. A good way to study these sources of energy is to get the learners to research them in groups and then present their work to the rest of the class. This can be done either as a presentation in front of the class, in which case clear expectations of the nature of the presentation and guidelines about how it will be marked need to be given, or as an exhibition, in which groups produce posters and other supporting material, including possibly a worksheet, and the learners move around the classroom gathering the relevant information. Usually learners have little difficulty in determining the difference between renewable and non-renewable energy resources, although they are not always able to explain the difference in words. It is not unusual for learners to speak of 'being able to use the energy again' rather than the resource being replaceable within a human lifetime. The difficulty here comes about as we speak of 'renewable energy' rather than 'resources which are renewable' and care with language might be helpful in clarifying this issue.

Although learners rarely find the difference between direct and alternating currents difficult, they frequently to not understand why electrical power is transferred as alternating current. It is worth emphasising that generators most easily produce a.c., which can be shown using an electric motor in reverse (i.e. spinning the motor and measuring the potential difference produced) and that we can only use transformers with a.c.. This latter idea is very important and it is generally a good idea to demonstrate the effect of adding a transformer to a circuit to illustrate the change in energy transfer.

Learners are often aware that there are three wires in a plug but are usually unaware of the purpose of each wire. The concept that the neutral wire is kept at zero volts and that the p.d. of the live wire varies from +230V to -230V by comparison with this may cause some problems for learners but it does allow the concept of a.c. to be emphasised. Learners usually have less difficulty in understanding the purpose of an earth wire if explained as an easy route for current to take if the live wire touches any conducting part of the appliance and the effect of this on a fuse or circuit breaker.

Electromagnetism causes learners great difficulty. At KS3 they will have seen electromagnets and motors and so should be aware of these devices in a concrete sense. It may be a good idea to show the workings of a transformer, so that learners are aware of the differences between step-up and step-down transformers, and so more aware of how they could be used, but it is best to leave out a detailed discussion of their working at this stage, except – perhaps - for the most able learners.

The idea that electricity use may vary widely in a day will probably be new to learners. They are likely to be surprised at the level of variation and how it can depend on single events, such as peaks at breakfast and dinnertimes and during particularly popular TV programmes, and to be unaware that many power stations can not just be started up at a moment's notice. This is an opportunity to introduce the idea of some types of power station being used to provide base load and other types being used to cover spikes in consumption.

Activities

Reading and calculating electricity bills efficiently
Resources: https://www.youtube.com/watch?v=x5lnOgkdBic

This is a short video illustrating how to calculate a bill from meter readings. It could be used in a lesson to show the steps involved or as support for homework.

Electricity generation - non-renewables: STEM
Resources: https://www.stem.org.uk/elibrary/resource/36277/electricity-generation-non-renewables

Electricity generation - renewables: STEM
Resources: https://www.stem.org.uk/elibrary/resource/36275/electricity-generation-renewables

These two videos discuss the use of renewable and non-renewable resources in electricity generation. They show examples of turbines and similar equipment at power stations and so give a real feel for the scale of the equipment involved.

Capturing the energy of the wind: New Zealand Wind Energy Association
Resources: http://www.windenergy.org.nz/store/doc/WindEnergyLesson.pdf

This is a suggested lesson plan on the nature of wind energy, how it works and why it is important. The lesson is intended for New Zealand schools but can be easily adapted.

Electrocity: Genesis Energy
Resources: http://www.electrocity.co.nz/

This site has an online computer game that allows players to manage their own virtual towns and cities. The learners have to provide energy, consider the environmental impact and deal with the budget.

The checkpoint tasks are intended to test quickly the understanding of two of the main topic areas that are covered at KS3 and occur in other parts of the course at KS4, specifically paying for electricity and energy resources. The tasks could be given as an introductory test at the beginning of the Generating Electricity topic, so as to help the teacher's understanding of the learners' prior knowledge and guide future activities, or they could be given as individual activities at the beginning of teaching each topic area, in which case the help can be more specifically targeted. The tasks could also be given to learners in groups for discussion and so used as a revision exercise before commencement of the teaching.

The first task is intended to assess learners understanding (and recall) of the main ideas involved in paying for electricity. The idea of a 'unit' of electrical energy is tested, along with learners ability to use the measurements from meters to calculate the energy used or to use information on the cost to calculate the amount of energy used and meter readings. The idea of a standing charge has been left out as it is not related to the energy used in any way.

The second task is intended to check if learners have recalled the main energy resources used to produce electricity which are covered at KS3 and where the energy for these resources comes from. The ideas of renewability and non-renewability are also included and learners are asked to explain what these are using individual fuels as examples, thus allowing a more concrete discussion.

Checkpoint task:

www.ocr.org.uk/Images/309723-generating-electricity-checkpoint-task.doc

Activities

How is energy produced from wind, waves and tides?: Education Scotland
Resources: http://www.educationscotland.gov.uk/stemcentral/contexts/renewables/video/index.asp

A short video showing the principles behind electricity production from three renewable resources. This could be used as a starter to introduce the main ideas to learners.

Nuclear power stations: BBC
Resources: http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/radiation/fissionrev1.shtml

This is a series of notes covering all aspects of nuclear energy generation at a suitable level for GCSE. It could be used as part of a research task or for revision and has a short follow up test.

Power lines: STEM Learning
Resources: https://www.stem.org.uk/elibrary/resource/27022/power-lines

A video showing how to demonstrate the transfer of electrical energy at high pd. This is aimed at teachers and illustrates the best way of using the demonstration in a lesson.

The electrical grid and About grid disturbances: Vestas e-learning
Resources: http://www.vestaselearning.com/explore/the-electrical-grid/

http://www.vestaselearning.com/explore/about-grid-disturbances/

These two animated videos illustrate how electrical production is linked to power consumption on the grid. They discuss how the grid and power stations respond and how a variety of stations are used for backup.

Activities

Visit a wind power plant: Vestas e-learning
Resources: http://www.vestaselearning.com/explore/visit-wind-power-plant/

This gives a virtual tour of a wind power plant. Learners can move around the plant from the control room to the top of a wind turbine tower. There is a lot of detail and this resource is probably best used with more able learners.

This island is going renewable: Education Scotland
Resources: http://www.educationscotland.gov.uk/stemcentral/contexts/renewables/challenges/index.asp

This is a series of tasks for learners to carry out which involves them making decisions about energy choices for an island, both at an individual and whole island level. The learners have to evaluate the most effective decisions to make.

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/

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Contact the team: science@ocr.org.uk

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

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