PROVISIONAL

TRANSITION GUIDE

Topic: Series and Parallel Circuits

September 2015

GCSE (9–1) Twenty First Century Physics B

GCSE REFORM

OCR
Oxford Cambridge and RSA

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Welcome

Welcome to the KS3–KS4 transition guide for **GCSE (9–1) Twenty First Century 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.

Go to topic comparison

Key Stage 3 Content

Key Stage 3 National Curriculum Content

Students should be taught about:

- electric current, measured in amperes, in circuits, series and parallel circuits, currents add where branches meet and current as flow of charge
- potential difference, measured in volts, battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current
- differences in resistance between conducting and insulating components (quantitative).

Key Stage 4 Content

GCSE Content

- When a circuit is made, the battery causes free charges to move, and these charges are not used up but flow in a continuous loop.
- The larger the potential difference across the power supply in a given circuit, the bigger the current.
- The larger the resistance in a given circuit, the smaller the current will be.
- A variety of analogies to a model electric circuit can be used to help describe and predict what will happen when a change is made to the circuit. No analogy can completely model the situation, but each may offer insights into some aspects of the situation.
- In a series circuit the charge passes through all the components, so the work done on each unit of charge by the battery must equal the total work done by the unit of charge on the components.
- In a parallel circuit each charge passes through only one branch of the circuit, so the work done by each unit of charge is the same for each component and equal to the work done by the battery on each charge.

KS3 ⇨ KS4

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Explore the Guide

Comment

Differences in the demand from Key Stage 3 to Key Stage 4

At KS3 students' knowledge of electric circuits is often quite concrete. They will be aware that a complete circuit is needed for current to flow in a circuit, that a source of 'voltage' is needed to 'push' the current round the circuit, that a current is a flow of charge and that current splits up at junctions in circuits. They should also be able to identify the difference between series and parallel circuits.

Students' understanding is often rather hazy. They are frequently imprecise about what is actually flowing in the circuit and what happens to it. They are usually able to say that current remains the same in series circuits but will often then go on to say that it is used up in, for example, bulbs. This is an example of a well-documented conceptual problem that frequently occurs in which students have a single idea of current and potential difference rolled into one. It is important to try and separate these ideas in the students' heads. Analogies have often been used with students to try and aid their understanding but these can lead to further misunderstanding, as the students know no more about the context of the analogy than about circuits. For example, water in a domestic plumbing system is frequently used, although the students rarely have better knowledge of plumbing than electrics.

At GCSE level students are required to understand that free electrons are flowing in the circuit and that this makes up the current. Since real objects (electrons) are actually flowing, no charge – and therefore current - can be 'used up'. Whatever sets off from one side of the cell must make its way around the circuit to the other side of the cell. This should help them to understand that in series circuits all of the charges flow through all of the components as there is only one 'path' for them to follow. In parallel circuits the currents will split up wherever there is a junction in the circuit.

It is a good idea to teach about current in circuits using measurements made in real circuits and to keep this work well separated in time from any discussion of potential difference. This also gives an opportunity to discuss the use of ammeters and to emphasise the units of current. Further, it is a chance to bring in the idea of resistance, as the current in each limb of a parallel circuit will not be identical, even when the limbs appear to be the same. Measuring currents into and out of junctions is often helpful here.

Next

KS3 → KS4

Comment

Only when students have a firm grasp of current should potential difference be introduced. This is the concept that causes students the greatest difficulty and in many cases they only gain a hazy grasp of it. The idea of potential difference as the work done (or energy used up) between two points in a circuit by the current should be introduced immediately and stuck to rigidly. It is not a good idea to use words such as 'force' or 'push' in this context as this creates confusion, although it is often done and does occur in some of the suggested websites. Again, a good method to use is to measure potential difference for components around a circuit and note the patterns. At all times it is essential to keep the ideas of current and potential difference separate in students' minds.

The Checkpoint Activity can be used either as a diagnostic tool with students starting the work in KS4 or as a revision activity. You might wish to let the students answer the questions as a test and then use marking as a way of identifying areas that need revision or reinforcement. Alternatively, the students could be asked to work either individually or in small groups to come up with answers and explanations for the answers and to feedback to the class.

Previous

Possible Teaching Activities (KS3 focus)

Click here to view page

Electric current and potential difference

BBC Bitesize

This is an animation that can be used either with the whole group (or individually) as a revision resource. Alternatively, short sections could be used to reinforce individual aspects of the work whilst teaching the topic with the class. As always with Bitesize, there are associated revision notes including questions, as well as a video explaining series and parallel circuits and an interactive test.

Resources: http://www.bbc.co.uk/education/guides/zsfgr82/activity

Click here to view page

Voltage and current needed to power Blackpool Illuminations

BBC Bitesize

This is a video clip (3.14 in duration) demonstrating the effect of changing potential difference on Blackpool Illuminations. It could easily be used either as a starter activity to revue knowledge and understanding gained in previous lessons or as a plenary if accompanied by appropriate questioning. In either case it shows the importance of an understanding of potential difference in a practical situation. Students could be asked to think of other areas of everyday life where an understanding of potential difference could be important.

Resources: http://www.bbc.co.uk/education/clips/zrvygk7

Click here to view page

How do current and energy differ?

BBC Bitesize

Another video clip (1:21 in duration) that shows how current is not 'used up' in circuits. Again, useful as either a starter if the work has been covered on previous lesson or as a plenary activity. It can be used to emphasise how potential difference and current behave differently in circuits.

Resources: http://www.bbc.co.uk/education/clips/zxctfg8

Click here to view page

Series and parallel circuits

IEEE

This includes a lesson plan and worksheets at a simple level that could be used to introduce younger students to the ideas of series and parallel circuits. This really needs to be carried out practically. The lesson gives students a chance to use understanding gained in the first part of the lesson to make predictions of outcomes and to check these later in the lesson. It can, of course, be adapted.

Resources: http://tryengineering.org/sites/default/files/lessons/serpar.pdf

Checkpoint Tasks

Click here to view page

Click here to view page

The activity consists of a series of four questions on current and potential difference in series and parallel circuits, and on the necessity for complete circuits. The first question is intended to diagnose students understanding of the importance of complete circuits and the effect of short circuiting. All but the very weakest students should be able to deal with this question easily.

The second question is aimed at giving students a chance to show their knowledge and understanding of the effects of the number of cells and bulbs on the potential difference at various points around series circuits. The main ideas that students will need to use are that more cells gives a greater total potential difference and that the potential difference is used up over the various resistances in the circuit.

The third question is similar to the second, except that it concentrates on the effect of cells and resistance on the current around the circuit. In this case, both series and parallel circuits are considered and the effect of short circuiting some of the components is also considered. The main ideas which students will need to use are that current is divided at a junction in a circuit but stays the same in any closed loop and that any short circuited component can be discounted, as there is a lower resistance route for the current.

The final question uses the idea of a two way switch to be able to turn on a light from the front or back door of a house to diagnose students understanding of complete circuits in a more everyday setting.

The activity can be used as a test before teaching the topics at KS4, in which case the teacher should be able to identify any difficulties the students have and correct these before moving on. It could also be used as a focus for discussion in an introductory lesson to the KS4 work; students might be asked to discuss the work in groups and develop clear reasons for their answers before feeding back to the class or to each other on their answers and reasons. In the latter case the teacher will need to attend carefully to the groups so that any difficulties can be identified and dealt with before moving on.

For less able students the circuits could actually be made and this will give a more kinaesthetic and concrete aspect to the work. For more able students, the questions could be used as a starter for a lesson at the beginning of the work on circuits, just to remind students of their previous work.

www.ocr.org.uk/Images/251793--series-and-parallel-circuits-checkpoint-task-instructions.pdf

www.ocr.org.uk/Images/251794-series-and-parallel-circuits-checkpoint-task-activity.doc

Possible Teaching Activities (KS4 focus)

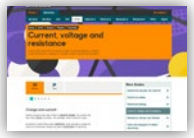
Click here to view page

Electrical circuits, AC and DC

BBC Bitesize

This video has a clear and entertaining discussion of the differences between series and parallel circuits, although to take advantage of it you will need to stop the video at regular intervals. It is probably best used either as a plenary to sum up the differences between the circuits or as a starter at the beginning of the next lesson, as a recap of previously covered work. There are associated revision notes, including test questions, and a self-assessment test.

Resources: http://www.bbc.co.uk/education/guides/zddp34j/revision



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Current, voltage and resistance

BBC Bitesize

This is a series of notes and a self-assessment test that covers more difficult concepts and the mathematical content related to Ohm's law. There are progress questions that the students can use to check on their understanding as they work through. This is really intended to be used as revision but can also be used as homework.

Resources: http://www.bbc.co.uk/education/guides/z88hvcw/revision

Click here to view page

Circuit construction kit (DC only), Virtual lab

PhET, University of Colorado

There are a variety of virtual circuit simulators available on the internet. This one is easy to use, clear and downloadable. It can be used when discussing circuits with a group, to help illustrate what is happening, or students could be asked to use it to 'build' given circuits to illustrate particular points. You will need Java to run it.

Resources: http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc-virtual-lab

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Current electricity

Schoolphysics - Keith Gibbs

This is an excellent collection of resources which can be used to support any aspect of lessons of circuits. There are a wide variety of activities from worksheets to help with experiments, word searches for use as starters or plenaries, and a selection of question and problem sheets. They are suitable for use with students of a variety of abilities.

Resources: http://www.schoolphysics.co.uk/age14-16/Electricity%20and%20magnetism/Current%20electricity/

Possible Extension Activities (KS4 focus)

Click here to view page

DC Circuit Builder – Conceptual Exploration

The Physics Classroom

This activity uses more complex series and parallel circuits to get students to investigate and use their understanding to determine what is happening in terms of the potential difference and current in the circuits. There is a link to a second website using a circuit simulator, however the activity can be undertaken practically with even greater impact, although a lot of equipment is needed. The work is not too challenging for a student who has understood the basic work.

Resources: http://www.physicsclassroom.com/Physics-Interactives/Electric-Circuits/Circuit-Builder/Circuit-Builder-Exercise-1

Click here to view page

Current Electricity

Cram

This website contains a variety of activities which can be used to consolidate students' knowledge and understanding of current electricity in both series and parallel circuits. There are a series of 'flashcards' which can be used to revise the topics, a test which can be in a variety of formats (for example, multiple choice or matching answers to questions), and two games – one similar to 'Bejewelled' and a second more in the line of 'Space Invaders'. This site is good for revision before the end of topic test or the final examination. It can be used in school but also as a homework activity.

Resources: http://www.cram.com/flashcards/current-electricity-953787

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Series Circuit Activity and Parallel Circuit Activity

The Physics Classroom

These two activities provide an opportunity to try building and testing series and parallel circuits and to think about the current and potential difference within each circuit in general and at different point around the circuit. They uses a circuit simulator but the activities could be adapted in which case they are excellent opportunities to get students building circuits and dealing with the difficulties associated with this, as well as revision of the proper use of ammeters and voltmeters and the correct units for current and potential difference.

Click here to view page

Resources: http://www.physicsclassroom.com/Physics-Interactives/Electric-Circuits/Circuit-Builder/Circuit-Builder-Exercise-2

http://www.physicsclassroom.com/Physics-Interactives/Electric-Circuits/Circuit-Builder/Circuit-Builder-Exercise-3

Resources, links and support

Additional Topic 1

Additional Topic 2

Additional Topic 3

As we develop Transition Guides for further topics we'll update these links, making it easy for you to browse all the guides for your chosen subject.

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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