**Investigating Combinations of Resistors and their use in Potential Divider Circuits**

**Introduction**

This series of experiments sets out to link from GCSE to A level with the first set of activities designed to reinforce the drawing of circuit arrangements and using the formulae for resistors in series and parallel.

The following activity sets out to give a very practical and visual demonstration of the action of a potential divider where the potential difference across components is in direct proportion to their resistance.

**Aims and skills covered**

* To determine the combined value of resistor combinations
* To observe that potential is distributed across resistors in series in proportion to their value
* To design, construct and check circuits using a DC power supply and range of components
* To use appropriate digital meters including multimeters to measure resistance

**Links to Specifications**

**Physics A**

* 4.2.1(a)(b) circuit diagrams using circuit symbols
* 4.2.2(a) potential difference and the unit *volt*
* 4.3.1(c)(d)(e) analysis of circuits with components including both series and parallel
* 4.3.3(a) potential divider circuit with components – note candidates expected to know about potentiometer as a potential divider
* 4.3.3(c) potential divider equations

**Physics B**

* 3.1.2a(iii) resistance, including series and parallel combinations
* 3.1.2a(vii) action of a potential divider
* 3.1.2b(ii) recognise standard circuit symbols
* 3.1.2c(ii) use formulae for resistors in series and parallel
* 3.12c(iii) simple cases of a potential divider in a circuit

**Practical Skills**

* 1.2.1(a) apply investigative approaches and methods to practical work
* 1.2.1(b) safely and correctly use a range of practical equipment and materials
* 1.2.1(c) follow written instructions
* 1.2.1(d) make and record observations/measurements
* 1.2.1(e) keep appropriate records of experimental activities
* 1.2.1(f) present information and data in a scientific way
* 1.2.1(j) use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification
* 1.2.2(b) use of appropriate digital instruments including electrical multimeters to measure resistance
* 1.2.2(g) design, construct and check circuits using DC power supplies and a range of circuit components.

**CPAC**

* (1) Follows written procedures
* (2) Applies investigative approaches and methods when using instruments and equipment
* (3) Safely uses a range of practical equipment and materials
* (4) Makes and records observations

**Mathematical skills**

* M0.1 Recognise and make use of appropriate units in calculations
* M0.3 Use ratios, fractions and percentages
* M1.1 Use an appropriate number of significant figures
* M2.3 Substitute numerical values into algebraic equations using appropriate units for physical quantities
* M2.4 Solve algebraic equations

**Equipment (per learner or group)**

**A) Combining resistors**

* 5 different values of resistor,
* multimeter measuring resistance in ohms
* leads
* crocodile clips (if using unmounted components)

**B) Potential and potential difference across resistors in a circuit**

* 5 resistors (to be used in combinations of 3)
* power supply set at 5V
* 3 voltmeters

**Health and safety**

* Safe use of electrical circuits

Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.

**Notes**

* These practical activities are not controlled assessments, should not be carried out in exam conditions and can be adapted by the centre. Students can collaborate during the activities which should take place as part of the normal teaching sequence. They are intended to be formative with students acquiring and practising skills throughout the course.
* To achieve a pass in the Practical Endorsement each student is required to demonstrate competence in all the skills, apparatus and techniques listed in section 1.2 of the specification and assessed against the Ofqual Common Practical Assessment Criteria (CPAC) at the end of the course.
* The skills, apparatus and techniques can be demonstrated during any practical work undertaken during the A Level course whether an OCR practical activity or not.
* Whilst using a multimeter may appear very simple, students are often confused by the ranges. They should be taught to start on higher range and increase sensitivity until they have an appropriate reading. Some multimeters will be auto-ranging, but still cause problems giving 0 or E readings for out of range which also happens when leads or connections are faulty.

CLEAPSS document R151 “*Ammeters,Voltmeters etc,for Class Use*” and the Laboratory Handbook sections 12.3.1 “*DMMs compared to analogue meters*”, 12.3.2 “*Provision of digital multimeters*” and 12.3.3 “*Which DMMs to buy*”, contain useful information on selection and use of digital multimeters.

* A more convenient form of the formula  for use on scientific calculators is

*R = (R1-1 + R2-1 + …. )-1*

* In the second part of the experiment students will work through to see that potential difference is distributed in proportion to resistance. It is possible to use the formula V1=V x R1/(R1+R2) but this method should reinforce the direct use of ratio. It also supports the mathematical requirement for calculating ratios and percentages.
* The extension seeks to establish the idea that all points in space have an electrical potential and that of greater importance than potential is potential difference. Reference can be made to birds sitting on 132kV power lies. Defining one point as zero allows the potential of each other point in the circuit to be measured.
* Observant students may notice that there is a deficit of potential difference between the sum of pds across the resistors and the output of the power supply. This is normally accounted for within the leads and connections.

**Recording**

* Learners should not need to re-draft their work but rather keep all their notes as a continuing record of Practical Activity.
* As evidence for the Practical Endorsement learners should have the data collected in a clear and logical format.

In addition, to support the assessment of practical work in the written examinations:

* Learners should have clearly sketched their circuit diagrams
* Learners should have calculated the combined values of resistance
* Learners should have evidence of their multimeter readings
* Learners should annotate their work if discrepancies are noted or errors are made and corrected to support the use of the lab book as a contemporaneous record
* Learners should have completed the tables for potential divider circuits
* Learners should have drawn conclusions consistent with the evidence obtained