P2 Electricity

What's the science story?

Electric charge is a fundamental property of matter everywhere. Understanding the difference in the microstructure of conductors, semiconductors and insulators makes it possible to design components and build electric circuits. Many circuits are powered with mains electricity, but portable electrical devices must use batteries of some kind. Electrical power fills the modern world with artificial light and sound, information and entertainment, remote sensing and control. The fundamentals of electromagnetism were worked out by scientists of the 19th century. However, power stations, like all machines, have a limited lifetime. If we all AQA GCSE Combined Science: Trilogy 8464. GCSE exams June 2018 onwards. Version 1.1 04 October 2019 Visit aqa.org.uk/8464 for the most up-to-date specification, resources, support and administration 127 continue to demand more electricity this means building new power stations in every generation – but what mix of power stations can promise a sustainable future?

Previous knowledge:

Year 7 Electricity

Next steps…

P3 Particle model of matter

Keywords

Resistance, current, potential difference, voltage, ohms, component, series circuit, parallel circuit, national grid, transformer.

AQA GCSE Combined Science Trilogy (8464)

Working scientifically skills:	**Assessments:**
WS1 Scientific methods WS3 Make predictions WS6 Peer review WS8 Method WS9 Variables WS10 Selecting equipment WS13 Constructing tables WS15 Data WS16 Using equations WS17 Make conclusions	End of unit test (summative) Exit tickets x 2/3 (formative)

Lesson No. and Title	Learning objectives	AQA Specification	Practical equipment
1. Current and charge	3-4 – Draw and interpret simple circuit diagrams. 5-6 – Calculate the charge transferred by a steady current in a given time. 7+ – Measure the current in a circuit accurately. Calculate the rate of flow of electrons.	**6.2.1.1 Standard circuit diagram symbols 6.2.1.2 Electrical charge and current** For electrical charge to flow through a closed circuit the circuit must include a source of potential difference. Electric current is a flow of electrical charge. The size of the electric current is the rate of flow of electrical charge. Charge flow, current and time are linked by the equation: charge f low = current × time Q = I t charge flow, Q, in coulombs, C current, I, in amperes, A (amp is acceptable for ampere) time, t, in seconds, s A current has the same value at any point in a single closed loop.	
2. Series circuits	3-4 – To state how current behaves in a series circuit. 5-6 – To investigate the resistance of series circuits with several components. 7+ – To evaluate in detail the investigation of series circuits and explain discrepancies.	**6.2.2 Series and parallel circuits** There are two ways of joining electrical components, in series and in parallel. Some circuits include both series and parallel parts. For components connected in series: • there is the same current through each component • the total potential difference of the power supply is shared between the components • the total resistance of two components is the sum of the resistance of each component. Rtotal = R1 + R2 resistance, R, in ohms, Ω For components connected in parallel: • the potential difference across each component is the same • the total current through the whole circuit is the sum of the currents through the separate components • the total resistance of two resistors is less than the resistance of the smallest individual resistor. • use circuit diagrams to construct and check series and parallel circuits that include a variety of common circuit components • describe the difference between series and parallel circuits • explain qualitatively why adding resistors in series increases the total	

		resistance whilst adding resistors in parallel decreases the total resistance explain the design and use of dc series circuits for measurement and testing purposes calculate the currents, potential differences and resistances in dc series circuits • solve problems for circuits which include resistors in series using the concept of equivalent resistance. Students are not required to calculate the total resistance of two resistors joined in parallel.	
3. Parallel circuits	3-4 – To state how current behaves in a parallel circuit. 5-6 – To investigate the resistance of parallel circuits with several components. 7+ – To evaluate in detail the investigation of parallel circuits and explain discrepancies.	**6.2.2 Series and parallel circuits** There are two ways of joining electrical components, in series and in parallel. Some circuits include both series and parallel parts. For components connected in series: • there is the same current through each component • the total potential difference of the power supply is shared between the components • the total resistance of two components is the sum of the resistance of each component. Rtotal = R1 + R2 resistance, R, in ohms, Ω For components connected in parallel: • the potential difference across each component is the same • the total current through the whole circuit is the sum of the currents through the separate components • the total resistance of two resistors is less than the resistance of the smallest individual resistor. • use circuit diagrams to construct and check series and parallel circuits that include a variety of common circuit components • describe the difference between series and parallel circuits • explain qualitatively why adding resistors in series increases the total resistance whilst adding resistors in parallel decreases the total resistance explain the design and use of dc series circuits for measurement and testing purposes calculate the currents, potential differences and resistances in dc series circuits • solve problems for circuits which include resistors in series using the concept of equivalent resistance. Students are not required to calculate the total resistance of two resistors joined in parallel.	Circuits, components, voltmeters, ammeters.

4. VIR and component characteristics	3-4 – To identify components from simple V–I graphs. 5-6 – Re-arrange the VIR equation. 7+ – Apply VIR and V-I graphs.	**6.2.1.4 Resistors** Students should be able to explain that, for some resistors, the value of R remains constant but that in others it can change as the current changes. The current through an ohmic conductor (at a constant temperature) is directly proportional to the potential difference across the resistor. This means that the resistance remains constant as the current changes. The resistance of components such as lamps, diodes, thermistors and LDRs is not constant; it changes with the current through the component. The resistance of a filament lamp increases as the temperature of the filament increases. The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction. The resistance of a thermistor decreases as the temperature increases. The applications of thermistors in circuits eg a thermostat is required. The resistance of an LDR decreases as light intensity increases.	
5. VIR practical (RP)	3-4 Link circuit readings to Ohms Law 5-6 Use readings to calculate Ohms law 7+ Apply Ohms law to different components	Required practical activity 16: use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements, including a filament lamp, a diode and a resistor at constant temperature. AT skills covered by this practical activity: physics AT 6 and 7. This practical activity also provides opportunities to develop WS and MS. Details of all skills are given in Key opportunities for skills development (page 186).	Circuits, componenets, voltmeters, ammeters.
6.Cables and plugs	3-4 – To identify the live, neutral and earth wires in a three pin plug. 5-6 – To describe the choices of materials used in cables and plugs. 7+ – To explain why it is not necessary for some appliances to be earthed.	**6.2.3.2 Mains electricity** Most electrical appliances are connected to the mains using three core cable. The insulation covering each wire is colour coded for easy identification: live wire – brown neutral wire – blue earth wire – green and yellow stripes. The live wire carries the alternating potential difference from the supply. The neutral wire completes the circuit. The earth wire is a safety wire to stop the appliance becoming live. The potential difference between the live wire and earth (0 V) is about 230 V. The neutral wire is at, or close to, earth potential (0 V). The earth wire is at 0 V, it only carries a current if there is a fault. Students should be able to explain: • that a live wire may be dangerous even when a switch in the mains circuit is open • the dangers of providing any connection between the live wire and earth.	

7.Mains electricity and ACDC	3/4 - State the difference between AC and DC and give some examples 5/6 – Explain oscilloscope readings of AC and DC output 7+ - Apply knowledge in unknown situation	**6.2.3.1 direct and alternating PD** Mains electricity is an ac supply. In the United Kingdom the domestic electricity supply has a frequency of 50 Hz and is about 230 V. Students should be able to explain the difference between direct and alternating potential difference.	
8.Power equations	3/4 – State and remember both power equations 5/6 – Apply equations 7+ - Apply equations with conversion of units	**6.2.4.1 Power** Students should be able to explain how the power transfer in any circuit device is related to the potential difference across it and the current through it, and to the energy changes over time: power = potential difference × current P = V I power = current 2 × resistance P = I2 R power, P, in watts, W potential difference, V, in volts, V current, I, in amperes, A (amp is acceptable for ampere) resistance, R, in ohms, Ω	
9.Energy transfers	3-4 – Draw basic energy transfers in an appliance 5-6 – Describe useful and wasted energy in an appliance 7+ – Explain energy transfers	**6.2.4.2 Energy transfers in everyday appliances** Everyday electrical appliances are designed to bring about energy transfers. The amount of energy an appliance transfers depends on how long the appliance is switched on for and the power of the appliance. Students should be able to describe how different domestic appliances transfer energy from batteries or ac mains to the kinetic energy of electric motors or the energy of heating devices. Work is done when charge flows in a circuit. The amount of energy transferred by electrical work can be calculated using the equation: energy trans f erred = power × time E = P t energy trans f erred = charge f low × potential di f f erence E = Q V energy transferred, E, in joules, J power, P, in watts, W time, t, in seconds, s charge flow, Q, in coulombs, C potential difference, V, in volts, V circuit device is related to: • the potential difference across it the energy transferred over a given time. Students should be able to describe, with examples, the relationship between the power ratings for domestic electrical appliances and the changes in stored energy when they are in use.	

10. Equations	3-4 – State all 6 equations 5-6 – Rearrange equations 7+ – Use equations and convert units	power = potential di f f erence × current P = V I power = current 2 × resistance P = I2 R power, P, in watts, W potential difference, V, in volts, V current, I, in amperes, A (amp is acceptable for ampere) resistance, R, in ohms, Ω energy trans f erred = power × time E = P t energy trans f erred = charge f low × potential di f f erence E = Q V energy transferred, E, in joules, J power, P, in watts, W time, t, in seconds, s charge flow, Q, in coulombs, C potential difference, V, in volts, V	
11. The National Grid	3-4 – Recognise the parts of the national grid. 5-6 –Describe transformers in the national grid. 7+ –Explain the national grid.	**6.2.4.3 The National Grid** The National Grid is a system of cables and transformers linking power stations to consumers. Step-up transformers are used to increase the potential difference from the power station to the transmission cables then step-down transformers are used to decrease, to a much lower value, the potential difference for domestic use. Students should be able to explain why the National Grid system is an efficient way to transfer energy	