**P5.1 Electric current – a flow of what?**

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| **Before** | **Objectives** | **After** |
|  | 1. Explain that when two objects are rubbed together they become charged, because electrons are transferred from one object to the other. |  |
|  | 2. Recall that objects with similar charges repel, and objects with opposite charges attract. |  |
|  | 3. Explain simple electrostatic effects in terms of attraction and repulsion of charges. |  |
|  | 4. Recall that electrons are negatively charged. |  |
|  | 5. Recall that electric current is a flow of charge. |  |
|  | 6. Recall that electric current is measured in amperes. |  |
|  | 7. Understand that in an electric circuit the metal conductors (the components and wires) contain many charges that are free to move. |  |
|  | 8. Understand that when a circuit is made, the battery causes these free charges to move, and that they are not used up but flow in a continuous loop. |  |
|  | 9. Recall that in metallic conductors an electric current is a movement of free electrons that are present throughout such materials |  |
|  | 10. Understand that in metal conductors there are lots of charges free to move but in an insulator there are few charges free to move. |  |
|  | 11. Describe how an ammeter should be connected in a circuit to measure the flow of current at a chosen point. |  |

**P5.2 Electric circuits**

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| **Before** | **Objectives** | **After** |
|  | 1. Recall that the larger the voltage of the battery in a given circuit, the bigger the current. |  |
|  | 2. Recall that components (for example, resistors, lamps, motors) resist the flow of charge through them. |  |
|  | 3. Recall that the larger the resistance in a given circuit, the smaller the current will be. |  |
|  | 4. Recall that the resistance of connecting wires is so small that it can usually be ignored |  |
|  | 5. Understand that when electric charge flows through a component (or device), work is done by the power supply, and energy is transferred from it to the component and/or its surroundings. |  |
|  | 6. Recall that power (in watts, W) is a measure of the rate at which an electrical power supply transfers energy to an appliance or device and/or its surroundings. |  |
|  | 7. Use the equation: power = voltage × current  (watts, W) (volts, V) (amperes, A) |  |
|  | 8. Recall that resistors get hotter when there is an electric current through them, **and understand that this heating effect is caused by collisions between the moving charges and stationary ions in the wire.** |  |
|  | 9. Recall that this heating effect makes a lamp filament hot enough to glow. |  |
|  | 10. Describe how the resistance of an LDR varies with light intensity. |  |
|  | 11. Describe how the resistance of a thermistor (ntc only) varies with temperature. |  |
|  | 12. Recognise and use the electrical symbols for a cell, power supply, filament lamp, switch, LDR, fixed and variable resistor, thermistor, ammeter and voltmeter. |  |
|  | 13. Understand that two (or more) resistors in series have more resistance than either one on its own, because the battery has to move charges through both of them. |  |
|  | 14. Understand that two (or more) resistors in parallel provide more paths for charges to move along than either resistor on its own, so the total resistance is less. |  |
|  | 15. Use the equation: resistance (ohms, Ω) = voltage (volts, V)  current (amperes, A) |  |
|  | 16. Describe in words, or using a sketch graph, how the current through a component varies with voltage across it when the resistance stays constant. |  |

**P5.3 How do parallel and series circuits work?**

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| **Before** | **Objectives** | **After** |
|  | 1. Describe how a voltmeter should be connected to measure the potential difference between any two chosen points. |  |
|  | 2. Recall that the voltage across a battery (measured in V) provides a measure of the ‘push’ of the battery on the charges in the circuit. |  |
|  | 3. Recall that potential difference is another term for voltage. |  |
|  | 4. Relate the potential difference between two points in the circuit to the work done on, or by, a given amount of charge as it moves between these points. |  |
|  | 5. Describe the effect on potential difference and current of adding further identical batteries in series **and in parallel**. |  |
|  | 6. Understand that when two **(or more)** components are connected in series to a battery:  a. the current through each component is the same  b. the potential differences across the components add up to the potential difference across the battery **(because the work done on each unit of charge by the battery must equal the work done by it on the circuit components)**  c. the potential difference is largest across the component with the greatest resistance, **because more work is done by the charge moving through a large resistance than through a small one**  **d. a change in the resistance of one component (variable resistor, LDR or thermistor) will result in a change in the potential differences across all the components** |  |
|  | 7. Understand that when several components are connected in parallel directly to a battery:  **a. the potential difference across each component is equal to the potential difference of the battery**  **b. the current through each component is the same as if it were the only component present**  c. the total current from (and back to) the battery is the sum of the currents through each of the parallel components  d. the current is largest through the component with the smallest resistance, **because the same battery voltage causes a larger current to flow through a smaller resistance than through a bigger one.** |  |

**P5.4 How is mains electricity produced?**

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| **Before** | **Objectives** | **After** |
|  | 1. Recall that mains electricity is produced by generators. |  |
|  | 2. Recall that generators produce a voltage by a process called electromagnetic induction |  |
|  | 3. Understand that when a magnet is moving into a coil of wire a voltage is induced across the ends of the coil. |  |
|  | 4. Understand that if the magnet is moving out of the coil, or the other pole of the magnet is moving into it, there is a voltage induced in the opposite direction. |  |
|  | 5. Understand that if the ends of the coil are connected to make a closed circuit, a current will flow round the circuit. |  |
|  | 6. understand that a changing magnetic field caused by changes in the current in one coil of  wire can induce a voltage in a neighbouring coil |  |
|  | 7. Describe the construction of a transformer as two coils of wire wound on an iron core. |  |
|  | **8. Understand that a changing current in one coil of a transformer will cause a changing magnetic field in the iron core, which in turn will induce a changing potential difference across the other transformer coil.** |  |
|  | 9. Recall that a transformer can change the size of an alternating voltage. |  |
|  | **10. Use the equation:**  **voltage across primary coil = number of turns in primary coil**  **voltage across secondary coil number of turns in secondary coil** |  |
|  | 11. Describe how, in a generator, a magnet or electromagnet is rotated within a coil of wire to induce a voltage across the ends of the coil. |  |
|  | 12. Understand that the size of this induced voltage can be increased by:  a. increasing the speed of rotation of the magnet or electromagnet  b. increasing the strength of its magnetic field  c. increasing the number of turns on the coil  d. placing an iron core inside the coil |  |
|  | **13. Describe how the induced voltage across the coil of an a.c. generator (and hence the current in an external circuit) changes during each revolution of the magnet or electromagnet.** |  |
|  | 14. Understand that when the current is always in the same direction, it is a direct current (d.c.),e.g. the current from a battery. |  |
|  | 15. Recall that mains electricity is an a.c. supply. |  |
|  | **16. Understand that a.c. is used because it is easier to generate than d.c., and is easier and simpler to distribute over long distances.** |  |
|  | 17. Recall that the mains domestic supply in the UK is 230 volts. |  |

**P5.5 How do electric motors work?**

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| **Before** | **Objectives** | **After** |
|  | 1. Understand that a current-carrying wire or coil can exert a force on a permanent magnet, or on another current-carrying wire or coil nearby. |  |
|  | 2. Understand that a current-carrying wire, if placed in a magnetic field whose lines of force are at right-angles to the wire, experiences a force at right angles to both the current direction and the lines of force of the field. |  |
|  | 3. Recall that a current-carrying wire that is parallel to the lines of force of a magnetic field experiences no force. |  |
|  | 4. Explain how the motor effect can result in a turning force on a rectangular current-carrying coil placed in a uniform magnetic field. |  |
|  | 5. Understand that the motor effect can be used to produce continuous rotation of the coil, by using a commutator to ensure that the direction of the current in the coil is reversed at an appropriate point in each revolution. |  |
|  | 6. Explain the role and use of motors in devices including domestic appliances, hard disc drives, DVD players and electric motor vehicles. |  |