Combined Science - Physics

CP9 Knowledge organiser

P9: Electricity

Lesson sequence

1. Electrical circuits
2. Current and potential difference
3. Current, charge and energy
4. Current, resistance and potential difference
5. Resistors
6. Controlling resistance
7. Core practical – investigating resistance (CP15)
8. Energy transfers
9. Electrical power
10. Using electricity
11. Electrical safety

1. Electrical circuits	
**Delocalised electrons	Electrons that are free to move between many different atoms.
**Conventional current	The flow of positive charge from the positive terminal towards the negative terminal (goes in the opposite direction to electrons).
**Electron flow	Electrons flow from the negative terminal towards the positive terminal.
*Series circuit	A circuit in which there is only one path for the current to flow.
*Parallel circuit	A circuit with multiple paths for the current to flow.

2. Current and potential difference	
*Amperes, A	The unit of measurement for current. Amps for short.
*Ammeter	Used for measuring current. Connected in series.
*Potential difference	Aka voltage. This is what pushes electrons around a circuit.
*Volts, V	The unit of measurement for potential difference.
*Voltmeter	Used for measuring potential difference. Connected in parallel.
**Current in series circuits	The same at all points in the circuit.
**Current in parallel circuits	Less on the branches than at the battery. Current on branches adds up to that at the battery.
**Potential difference in series circuits	Potential difference is shared between the components on a circuit. It adds up to be the same as the battery.
**Potential difference in parallel circuits	The same across each branch as it is across the battery.

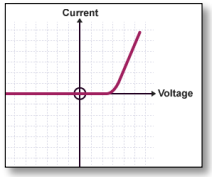
3. Current, charge and energy	
*Charge	The amount electricity that has flowed through a circuit.
*Coulombs, C	The unit of measurement for charge.
*Current	The number of coulombs of charge that flows past a point each second.
*Calculating charge	Charge = current x time Q = I x t Charge = coulombs Current = amps Time = seconds
8*The meaning of volts	The amount of energy transferred by each coulomb of charge. One volt = 1 joule per coulomb.
*Calculating energy	Energy = charge x potential difference E = Q x V Energy = joules Charge = coulombs Potential difference = volts

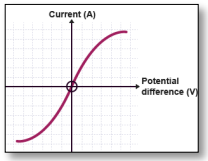
4. Current, resistance and potential difference	
*Resistance	The difficulty with which current passes through materials.
*Ohms, Ω	The unit of measurement for resistance.
**High/low resistance	Higher resistance → better insulator Lower resistance →better conductor
*Calculating current	Current = potential diff / resistance I = V / R Current = amps, A Potential diff = volts, V Resistance = ohms, Ω Note: This equation is normally written as V = IR.
**Changing current	Higher voltage → higher current Higher resistance → lower current

5. Resistors	
**Resistors	Circuit components with differing resistance to control how much current flows to parts of a circuit.
**Resistors in series	Total resistance is the sum of each of the resistors.
**Voltage and resistors in series	Voltage is shared in proportion to the resistance. The resistor with more resistances takes more of the voltage. Calculate this using V=IR.
**Resistors in parallel	Think about each branch of the circuit as a different series circuit. Resistors on different branches do not affect each other.
**Variable resistors	Resistors where you can change the resistance to adjust the current.

6. Controlling resistance	
**LDR	Light-dependent resistor. High resistance in dark, low resistance in light.
**Thermistor	High resistance when cold, low resistance when hot.
**Diode	High resistance in one direction, low resistance in the other.
**Filament lamp	High resistance causes the filament to heat up, producing light.

**Resistor graph	Current increases in direct proportion to voltage (straight line going through (0,0)).
**Filament lamp graph	Current increases as voltage increases, but levels out eventually.
**Diode graph	Graph slopes up with a positive voltage but stays at 0 with a negative voltage.





7. Core practical – investigating resistance (CP15)	
*CP15 - Aim	To explore how resistance changes in different circuits.
*CP15 - Investigating resistance	Set up a circuit with an ammeter, resistor and voltmeter across the resistor. Vary the voltage and record voltage and current.
*CP15 - Investigating series circuits	Set up a series circuit with an ammeter, two bulbs and voltmeters across each bulb and the power supply. Vary the voltage and record all readings
*CP15 - Investigating parallel circuits	Set up a parallel circuit with two bulbs and ammeters on each branch and by the power supply, and voltmeters across each bulb and the powers supply. Vary voltage, record all readings.
*CP15 - Results	Resistor – doubling voltage doubles current Series circuit – voltage at bulbs half of that at power supply Parallel circuit – voltage at bulbs equal to power supply, current half that at power supply

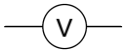
8. Energy transfer	
**Calculating energy transfer	Energy = current x potential difference x time E = I x V x t Energy = joules Current = amps Potential difference = volts Time = seconds
**Resistance and energy transfer	Electrons flowing through wires collide with atoms and lose energy. This energy is transferred to heat.
**Electrical energy dissipation	When electrical energy is transferred to wasted heat energy by resistance.
**Reducing resistance	Use thicker wires, use shorter wires, use lower-resistance metals, reduce the temperature.

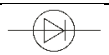
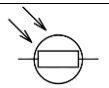
9. Electrical power	
Power	The rate of energy transfer.
*Watts, W	The unit of power: 1 W = 1 joule per second
*Power and work done	$P = \frac{E}{t}$ Where 'P' is power in W, 'E' is work done in J, 't' is time in s.
*Power, current and voltage	$P = I \times V$ Where 'P' is the power in W, 'I' is the current in A, V is the potential difference in V.
**Power, current and resistance	$P = I^2 \times R$ Where 'P' is the power in W, 'I' is the current in A, 'R' is the resistance in Ω.

10. Using electricity	
*Mains electricity	The electricity supplied from wall sockets.
*National grid	The systems of power lines and sub-stations that distributes electricity from power stations to homes and businesses.

*Heaters	Transfer energy from electrical to thermal.
*Motors	Transfer energy from electrical to kinetic.
**Direct current	Current that flows in one direction.
**Alternating current	Current that switches direction many times each second.
**Frequency of mains current	Mains current alternates (switches direction) 50 times each second. The frequency is 50 Hz.

11. Electrical safety	
*Live wire	Brown, 230 V, connects the appliance to the power station.
*Neutral wire	Blue, 0 V, completes the circuit.
*Earth wire	Green and yellow, 0 V. Connects the appliance to the ground so current can flow there in the event of a short circuit.
*Fuse	A thin metal wire that melts and breaks the circuit if there is too much current.
**Circuit breaker	Breaks the circuit if too much current flows.
**Advantages of circuit breakers	Quicker than fuses, just need switching rather than replacing.

Circuit symbols	
*Switch	
*Cell	
**Battery	
*Lamp	
*Ammeter	
*Voltmeter	
*Resistor	
**Variable resistor	

**Diode	
**LDR	
**Thermistor