# Edexcel core science Unit P1a

*Items in **bold** are for higher tier only*

## Topic 9 — Producing and Measuring Electricity

In a world without electricity, cars, computers and essential equipment used in hospitals could not exist; we would forgo the pleasures of televisions and personal stereos; we would lose the convenience of appliances such as mobile phones, microwaves and washing machines. Hence electricity is at the heart of the modern world. It provides a very convenient form of energy to power a wide variety of both portable and fixed equipment. Technological developments led to the production of devices that are used to maintain a constant temperature in industrial processes and
devices that respond to changes in light intensity.
This topic is designed to extend the student's knowledge of electricity from Key Stage 3. It gives students the opportunity to explore different sources of electric current and to investigate the relationship between voltage and current in a resistor and a filament lamp. This will give students experience in building circuits and using a voltmeter and ammeter. Students will also have the opportunity to investigate devices that respond to changes in temperature and light intensity, possibly with the aid of data-logging equipment.

**Have you ever wondered?**
- Why is my phone wireless, but I have to plug my hairdryer into the wall?
- How does my digital camera take great pictures automatically?
- How can I make the batteries in my MP3 player last longer?
- Why did people believe electricity could cure all your aches and pains?
- Which invention changed the world the most?
- How can a train possibly go at 500 kilometres per hour?
- Is it true my clothes will soon become wearable computers?

**Some facts:**
- There is a variety of ways we can produce electricity.
- Electrical quantities can be measured.
- The voltage, current and resistance in a circuit are related.
- The change in resistance of electrical devices is used in a variety of applications.

**Glossary**

| | | | |
|---|---|---|---|
| ammeter | rechargeable | battery | current |
| dry-cell | superconductivity | capacity (ampere-hours) | (amperes/amps/A, milliamps/mA) |
| potential difference | battery | magnet | parallel circuit |
| solar cell | light-dependent | resistor | series circuit |
| ampere-hours (amp-hours) | resistor (LDR) | voltage (volts/V, millivolts/mV) | |
| dynamo | resistance (ohms/Ω) | | |
| | thermistor | | |

**You should be able to**:
- explain the differences between alternating and direct current
- describe and compare sources of direct current, including batteries, solar cells and generators
- explain how to produce an electric current by the relative movement of a magnet and a coil of wire, eg in a dynamo, in a generator
- state the factors that affect the size and direction of an induced voltage

- explain how changing the resistance in a series circuit **and a parallel circuit** changes the current for a given voltage
- describe how the resistance of a light-dependent resistor (LDR) changes with light intensity and the resistance of a thermistor changes with temperature
- recognise and explain applications depending on resistance change, eg controlling the exposure time for a digital camera, controlling central heating
- explain that current in a wire is a rate of flow of negatively charged electrons and that it can be measured by an ammeter placed in series in a circuit
- demonstrate understanding that a battery has a stated capacity in amphours and use this to predict the number of hours a battery should last when supplying a given current
- use data to describe and explain how current varies with voltage for fixed value resistors and filament lamps and describe how this can be investigated experimentally
- use the relationship between the voltage, current and resistance: $V = I \times R$
- investigate practically or otherwise the voltage and current output, and the advantages and disadvantages of different batteries (both dry cell and rechargeable), including considerations of their cost, performance and impact on the environment
- discuss the impact that the electric telephone and electricity has had on the development of the modern world
- **use data to explain how new technology develops as a result of scientific advances, eg Maglev trains developed from the use of electromagnets and, in some cases, the discovery of superconductivity**
- use data relating the size of electric circuits to the processing speed of computers to suggest future applications and implications
- explain how ICT can be used to collect and display data from electric circuits for analysis, and compare this with traditional methods in terms of reliability and validity of data, and ease of use.

**Topic 10 — You're in Charge**

Electric power is transferred to the home and industries from power stations via the national grid. The efficiency of this process is always less than 100% because electrical energy is lost in the form of heat energy; this affects the environment as well as increasing the cost of electricity. To cost electricity, the electrical energy used by homes and industries needs to be measured. Electric currents can be lethal so precautions need to be taken to protect users, including the use of double insulation and an earth wire. Devices such as fuses and residual current circuit breakers (RCCBs) can also protect equipment and protect users from severe electrical shocks. There is some opportunity for practical work, eg investigating the factors that affect the rating of a fuse. Conclusions drawn from this investigation could be used to design a fuse that blows at a particular current. Electrical machines perform many manual tasks allowing us many social benefits, for example, more leisure time.

**Have you ever wondered?**

- What if all the electricity in the world went off and stayed off?
- Why don't many people in rural Africa have electricity at the flick of a switch?
- What kind of car will you be driving in 10 years time?
- Could your bedroom be powered by renewable energy?
- Could you increase your pocket-money allowance by saving electricity?
- Will a 240V electric shock kill you?
- How many devices can you safely plug into one wall socket?

**Some facts:**

- The rate of transfer of electrical energy and its efficiency can be calculated.
- A motor may be controlled using electricity.
- It is important to consider the economical costs and environmental effects of energy use.
- Safety issues must be fully considered when working with electricity.

**Glossary**

| | | | |
|---|---|---|---|
| double insulation | voltage (volts/V,millivolts/ mV) | residual current circuit breaker (RCCB) | solar cell |
| energy (joules/J, kWh) | earth wire | wind power | electricity |
| power (watts/kilowatts/kW) | fuse | efficiency | motor |
| | | insulation | solar power |

**You should be able to**:

- use data to evaluate the economic, environmental and social impact of renewable and non-renewable energy/power sources, and discuss their use in meeting the UK's future electricity needs
- **evaluate the benefits and drawbacks of implementing technology, such as a new national grid for distribution of electricity describe how scientific ideas change over time, eg changes in the medical uses of electricity**
- describe and explain how a DC electric motor works
- demonstrate understanding that electrical power is the rate of transfer of electrical energy
- use the equation to calculate electrical power: power = current × voltage
- use the term 'efficiency' and calculate efficiency using the equation: efficiency = useful output × 100% total input

- interpret data about solar cells, including their efficiency, and suggest why they are not yet in widespread use
- use the equation to calculate the cost of electricity: cost = power × time × cost of 1kWh where power is measured in kilowatts and time is measured in hours
- discuss whether an energy efficiency measure is cost effective, eg insulating a home, using energy-saving bulbs, and use data to compare energy efficiency measures
- explain how the earth wire, together with a fuse, provides protection for the user, and a fuse provides protection for the appliance and the circuit including the connecting wires
- **describe the advantages of a residual current circuit breaker (RCCB) and understand that it works by detecting any difference between the currents in the live and neutral wires.**