# WJEC (Wales) Physics GCSE

## 1.4: Domestic Electricity

### Detailed Notes

(Content in **bold** is for higher tier **only**)

# Kilowatts & Kilowatt Hours

The kilowatt (**kW**) is the unit of **power** used in a domestic setting. The amount of electricity used by a device depends on its **power** and the **length of use**. Therefore kilowatt hours (**kWh**) can be calculated to find the relationship between power and energy, then used to calculate the **cost** of the electricity used by the device.

$$E = Pt$$

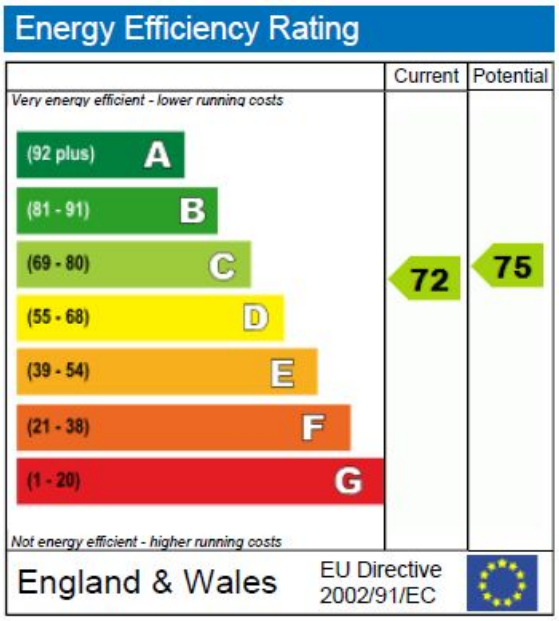
***E is energy transferred in kilowatt hours (kWh), P is the power in kilowatts (kW) and t is the time in hours (h)***

## The Cost of Electricity

Electrical energy is charged for domestically **per kilowatt hour** known as the **unit cost**. Multiplying the calculated energy transferred by the unit cost, the cost of powering a specific device can be calculated.

$$total\ cost = energy\ used \times unit\ cost$$

The data for calculating the cost of powering a device can be found directly or from secondary information such as **energy banding**. These categorise devices in bands A-G depending on their **power rating** and **efficiency**.




***Energy efficiency banding and information for a specific device (gcse.com).***

## Types of Current

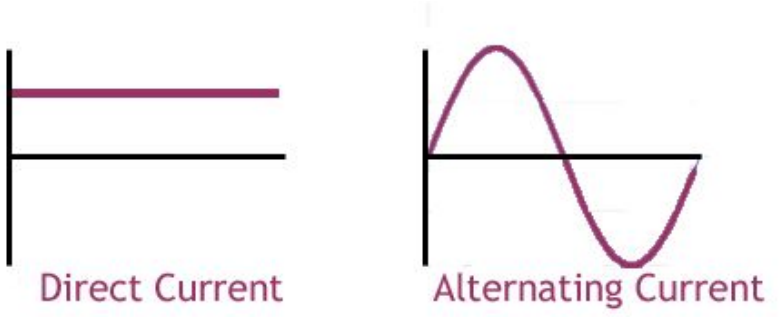
There are **two main types** of current that can be used in electrical circuits, alternating and direct.

### Direct Current

Known as **DC**, this current flows in a **single direction** around a circuit. It is the type of current typically supplied by batteries and solar cells. On an oscilloscope, the trace of the voltage will also be direct, showing as a **single straight line**.

### Alternating Current

Known as **AC**, the direction of this current is **constantly changing** around the circuit. UK mains supply is an alternating current at a voltage of **230 V** and a frequency of **50 Hz**, meaning it changes direction around the circuit 50 times every second. On an oscilloscope, the trace of the voltage will also be **alternating**, showing as a sinusoidal wave.



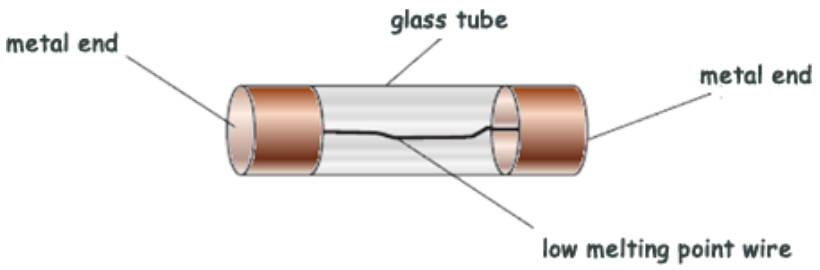

***Oscilloscope traces for AC and DC voltage (scienceaid.net).***

## Fuses & Circuit Breakers

Fuses and circuit breakers are **safety mechanisms** that protect electrical circuits and devices, by preventing too large a current from flowing.

### Fuses

A fuse is a **small piece of wire** within a glass tube that sits inside the plug of an appliance. They have **specific melting points** so that if the current flowing through it is **too large**, the piece of wire will heat up and **melt**, breaking the circuit.




***Structure of a fuse (cyberphysics.co.uk).***

Fuses come in **standard ratings**, the most common being **3A, 5A** and **13A**. Devices requiring a higher current will require a larger fuse. If a 5A current flows through a 3A fuse, it will melt and break the circuit, showing how the correct fuse must be selected for a device. Once a fuse has melted, it must be replaced for the device to work again.

### Circuit Breakers

These are **automatic switches** that act in a similar way to fuses, **breaking a circuit** when there is a fault. There are two main types of circuit breaker used for different sizes of device and circuit.

#### Miniature Circuit Breakers (MCB)

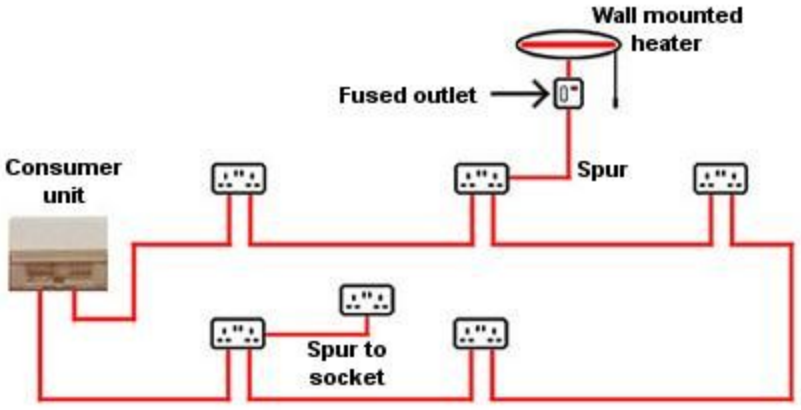
When a fault is detected, an **electromagnetic switch** opens to stop the flow of current around a circuit. MCBs stop a dangerous current much **faster** than a regular fuse and can be **reset** more easily once the fault is found without having to be replaced.

#### Residual Current Circuit Breakers (RCCB)

These monitor the current in both the **live and neutral wires** of a device. If there is a **difference** detected in the current flowing in these wires, the RCCB will 'trip' and switch off the current in the circuit. RCCBs are **very sensitive** and act automatically.

## The Ring Main

This is a **circular circuit** used in domestic settings, linking up the power input of a house to all the sockets and switches in the house. It connects all of these outlets in **parallel** so that the **same voltage (230 V)** is always supplied. Being arranged in parallel also means that switches/sockets can be independently **switched on and off**. These ring mains also link in a circuit breaker and an electricity meter.




*A basic UK ring main circuit (DIYdata.com).*

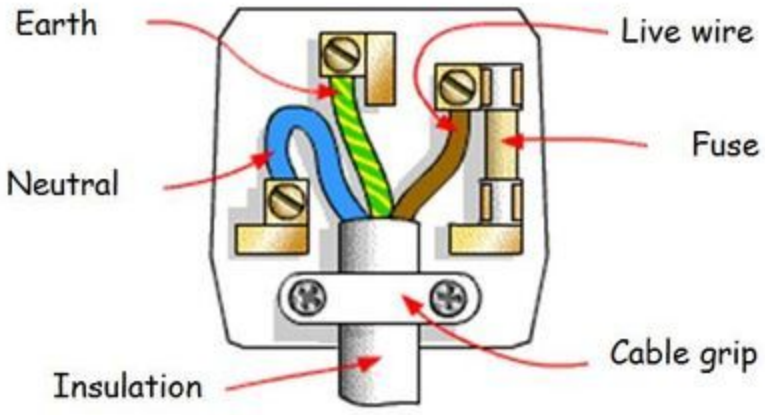
There are **three** types of wire that run through all ring mains and devices in the UK. These have different purposes and can be identified by their different colored windings.

**Live Wire**
The **brown** wire that carries **mains supply voltage** around the circuit. This wire remains dangerous even when the circuit is turned off, as it may still be carrying a current.

**Neutral Wire**
The **blue** wire **completes** the electrical circuit.

**Earth Wire**
The **green and yellow striped** wire that acts as a **safety wire**, preventing the appliance from becoming live. It is connected to **'earth'** and to the casing of an appliance so that if the live wire touches the casing making it 'live', the earth wire will carry off the dangerous current keeping the appliance safe.

All three of these wires are visible within the plug head of a device.




***Inside structure of a plug (gcsesciencedictionary.co.uk).***

Recently, it has become possible to introduce small scale **domestic renewable electricity generators** into the ring main. These include solar panels, solar cells and domestic wind turbines. It can be **cost effective** in the long term to introduce these, as less mains energy will need to be paid for. However the **payback time** of installing these devices could be very long.