44 Electrical supply

A Direct current and alternating current

The current from a cell is **direct current** (DC) – a constant flow of electricity which travels around a circuit in one direction. The electricity supplied to homes and other buildings – called **mains electricity** – is **alternating current** (AC). Unlike a **DC supply**, an **AC supply** flows backwards and forwards – its direction continually **alternates**. The rate at which the current alternates – called the **frequency** – is measured in **hertz** (Hz). For example, in the UK, AC supply is 50 Hz – it alternates 50 times per second. On a graph, the AC supply of mains electricity forms a **sine wave**.

The current supplied to most homes is **single-phase** – it forms one sine wave. In factories and large buildings, which have powerful electrical equipment, the supply is often **three-phase** – effectively three currents, each with a different **phase** (timing). This provides a smoother supply as it reduces the gaps between the voltage peaks.

Note: The term **mains electricity** is not used in American English – terms like **supply** are used.

B AC generation and supply

Mains electricity is **generated** (produced) at sites called **power stations**, which use large **generators**. A generator converts mechanical energy to electrical energy. A generator rotates a magnet within an iron surround. The iron – called an **armature** – has coils of wire around it, called **field coils** (or **field windings**). As the magnet rotates, it causes current to flow through the field coils, due to **electromagnetic induction**.

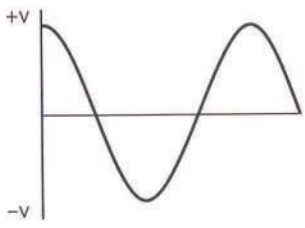
Current from the generators leaves the power station and enters the **power grid** (or **grid**) – the network of **power lines** (cables) which transmit it around the country. At the point where it enters the grid, the electricity flows through **transformers** – specifically **step-up transformers**, which increase voltage and decrease amperage. This reduces the energy lost from the power lines over long distances, as **high-voltage** (HV) supplies flow more efficiently than **low-voltage** (LV) supplies. Before the supply is used by homes and other buildings, it passes through several **step-down transformers**, which reduce its voltage and increase its amperage.

The supply may be **stepped up** to over 400,000 volts at the point where it enters the large **transmission lines** (long-distance power lines) leaving the power station. It is normally then **stepped down** in stages, first passing through a wider network of lower-voltage transmission lines, and finally through the small **distribution lines** which supply streets and houses – in many countries at around 230 volts.

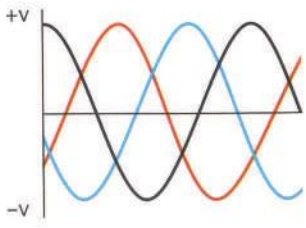
C DC generation and use

The extract below is from a consumer magazine.

> **Photovoltaic cells** (**PVs**) – or solar cells – are an effective way of generating your own electricity from sunlight. The current they produce can be used immediately, may be stored in **rechargeable batteries** (like the ones in cars), or can be fed into the power grid and sold to the electric company. But PVs produce direct current. This is fine for **charging** batteries, but is not suitable for powering household appliances, which require alternating current. For this, the DC supply from PVs and batteries needs to go through an **inverter** – a device which converts DC to AC.



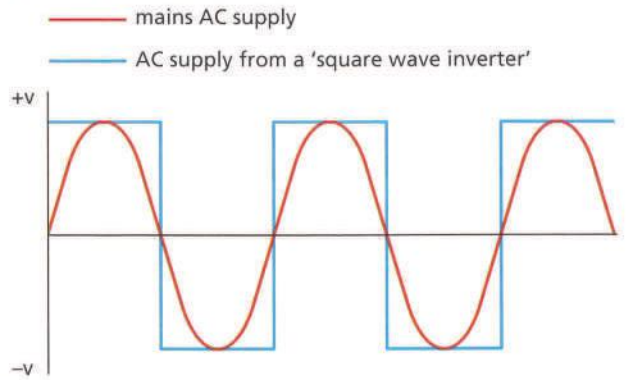
A single-phase AC supply



A three-phase AC supply

44.1 Complete the text about inverters using words from A opposite. Look at A, B and C opposite to help you.

Inverters convert (1) .... to (2) .... If an inverter is used to supply electrical appliances in a home, it must copy the supply of (3) ..... electricity produced by the generators at power stations. Most inverters can produce a current which alternates precisely at the required (4) ..... – for example, 50 (5) ..... (50 cycles per second). However, not all types are able to produce a current which follows the pattern of a (6) ...., like that of the (7) ..... AC supply used in homes. So-called 'square wave inverters' only produce a very approximate copy of this wave, which can affect the functioning of many electrical appliances.



44.2 Choose the correct words from the brackets to complete the descriptions of different stages of AC generation and supply (a–f). Then, put the stages in the correct order. Look at B opposite to help you.

a After the step-up transformer, the current enters a (distribution / transmission) line.
b Current is produced, by electromagnetic induction, in the (magnet / field coils) of a generator.
c The current goes from the last step-down transformer to a (distribution / transmission) line.
d The current leaves the power (grid / station) and enters the home.
e Amperage is reduced and voltage is increased by a (step-up / step-down) transformer.
f The current is stepped (up / down) from a higher voltage to a lower voltage, in stages.

44.3 Decide whether the sentences below are true or false, and correct the false sentences. Look at A, B and C opposite to help you.

1 Photovoltaic cells produce direct current.
2 The electricity supply from PVs can be used to charge rechargeable batteries.
3 Rechargeable batteries supply electricity as alternating current.
4 Inverters convert sunlight to alternating current.

Over to you

Think of some large and small electrical appliances you're familiar with. Explain their electrical supply requirements. What type of current is required, and how is it supplied and/or converted?