

# Why kettles boil slowly in the US

The voltage of mains electricity varies from country to country: the majority of countries use between 200 and 240 volts, but a small minority (most notably the US, Canada and Japan) use between 100 and 127 volts.

The voltage of an electrical supply is what pushes electrons around in a circuit. The higher the voltage, the faster the electrons move and thus the higher the current (one amp is equivalent to about six billion billion electrons flowing past a point per second).

With a low voltage the rate of transfer of electrical energy is therefore much slower. In the UK, with a mains voltage of 230 V and a limit of 13 A per socket the maximum possible power to one appliance is .....

In the USA, with a mains voltage of 120 V and a limit of 15 A per outlet the maximum possible power is reduced to only ....., which is why in the US many large appliances (e.g. washing machines, tumble dryers) have to be connected to a separate high-voltage circuit.

To raise the temperature of one litre of water from 15°C to boiling at 100°C requires a little bit over ..... kilojoules of energy. An “average” kettle in the UK runs at about 2800 W and in the US at about 1500 W; if we assume that both kettles are 100% efficient then a UK kettle supplying 2800 joules per second will take ..... seconds to boil and a US kettle supplying 1500 J/s will take ..... seconds, more than a minute and a half longer. This is such a problem that many households in the US still use an old-fashioned stove-top kettle.

*Answer the following questions on a separate sheet.*

1. “one amp is equivalent to about six billion billion electrons flowing past a point per second”. Write this figure in powers of ten.
2. Calculate the maximum electric power provided by a socket in the UK.
3. Calculate the maximum electric power provided by a socket in the USA.
4. Why do washing machines have to be connected to a separate circuit in the USA?
5. How much energy is required to raise the temperature of one litre of water from 15°C to boiling at 100°C?
6. In the conditions given by the text, how much time will it take to boil one litre of water in the UK? In the USA?



*An electric kettle*



*A wall socket, as used in the UK*



*A stove-top kettle*