UNIT-2

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Electricity

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(a)	Units
Students should:	
2.1	use the following units: ampere (A), coulomb (C), joule (J), ohm (Ω), second (s), volt (V) and watt (W)

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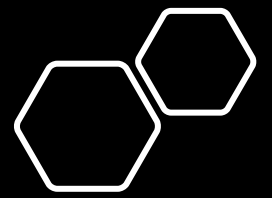
Learning Objectives



Learning Objectives

(b)	**Mains electricity**
Students should:	
2.2	understand how the use of insulation, double insulation, earthing, fuses and circuit breakers protects the device or user in a range of domestic appliances
2.3	understand why a current in a resistor results in the electrical transfer of energy and an increase in temperature, and how this can be used in a variety of domestic contexts
2.4	know and use the relationship between power, current and voltage: power = current × voltage $P = I \times V$ and apply the relationship to the selection of appropriate fuses
2.5	use the relationship between energy transferred, current, voltage and time: energy transferred = current × voltage × time $E = I \times V \times t$
2.6	know the difference between mains electricity being alternating current (a.c.) and direct current (d.c.) being supplied by a cell or battery

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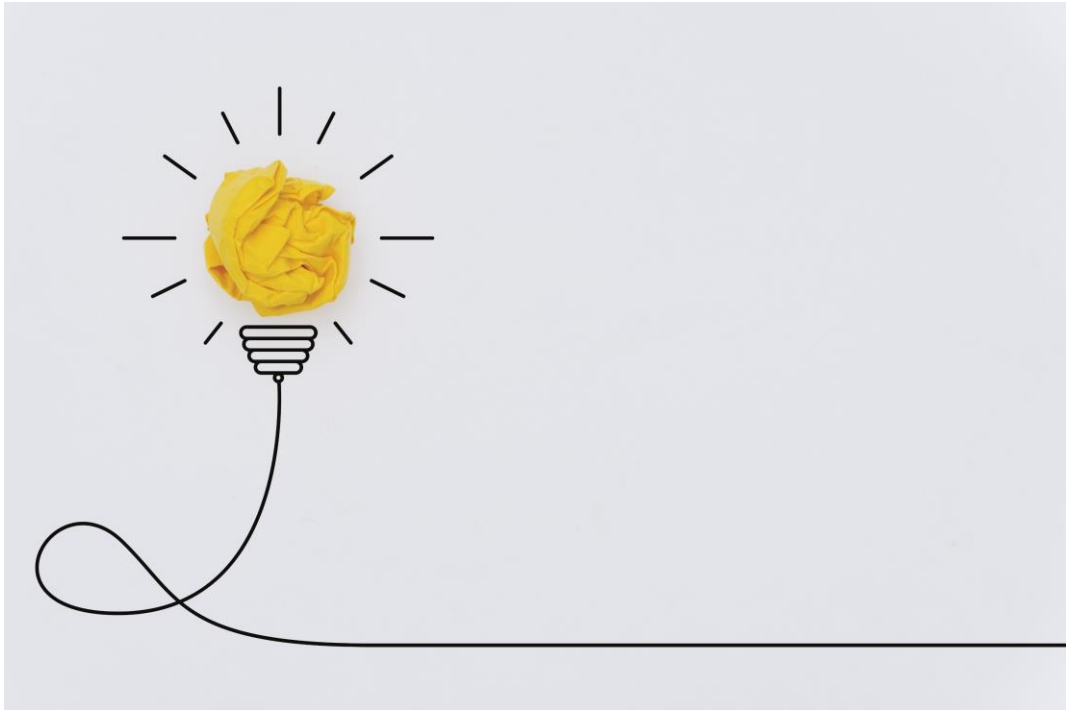
Units

- Current(I)-ampere(A)
- Voltage(V)-volt(V)
- Charge(Q)-coulomb(C)
- Energy(E)- joule(J)
- Resistance(R)-ohm(Ω)
- Time(t)- second(s)
- Power(P)-watt(W)



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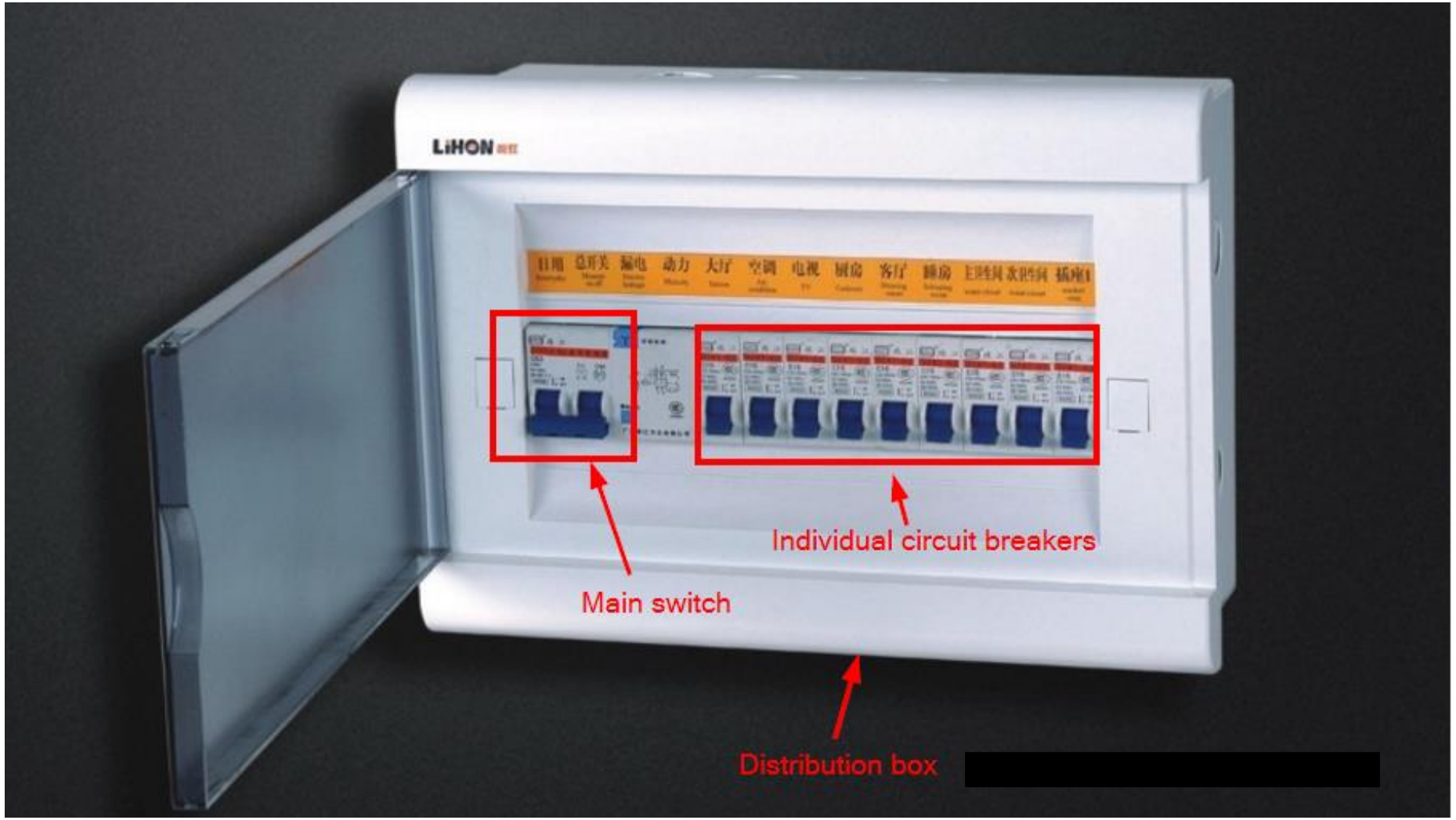
Mains Electricity.



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Mains Electricity

- **Mains electricity is the electricity supply from power stations to households**.

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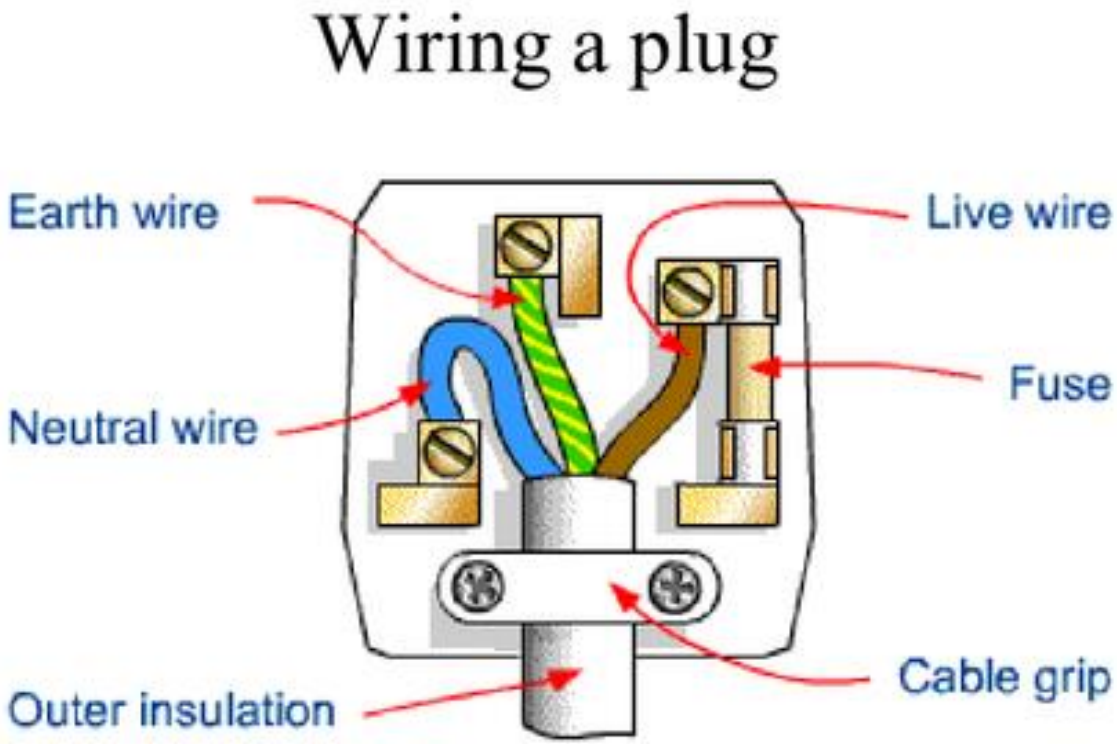
Three wires-Mains electricity.

Live wire- Provide a path for the electrical energy coming from power supply.

Neutral wire- completes the circuit from the appliance back to the supply. It is usually at 0 V.

Earth wire- Provide a path for the current to escape to the ground without passing through the user.



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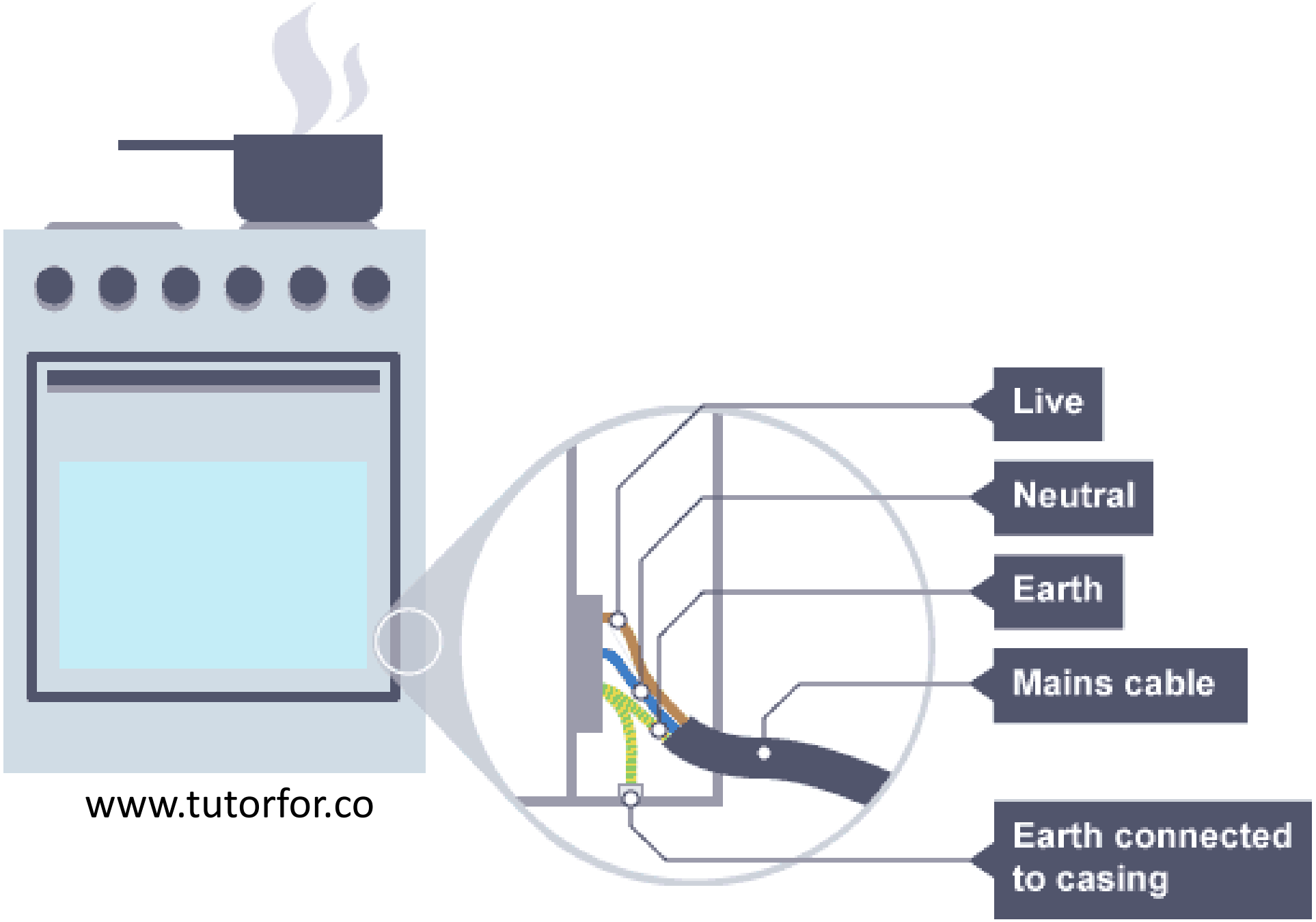

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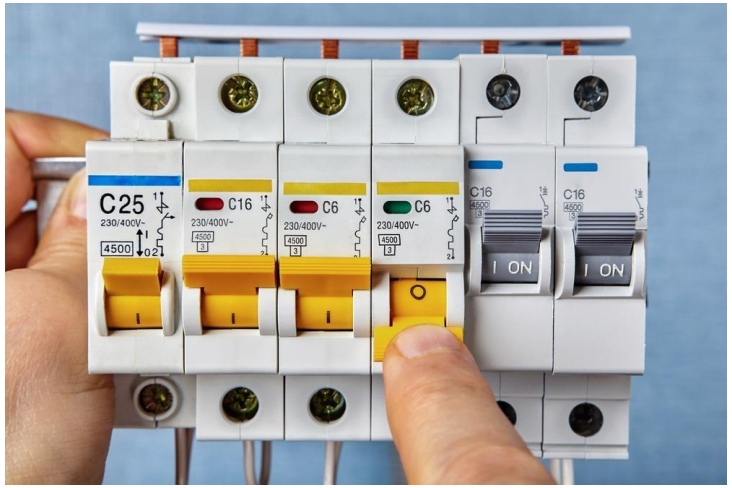

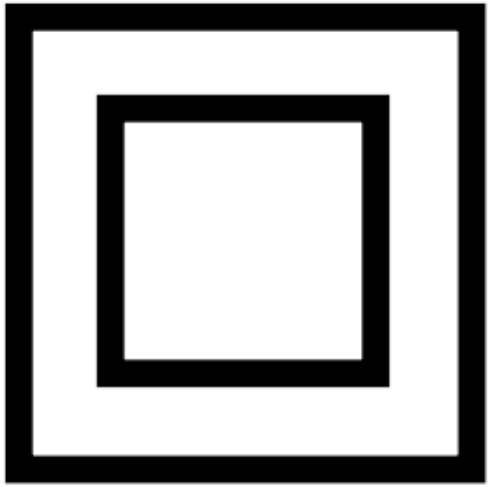

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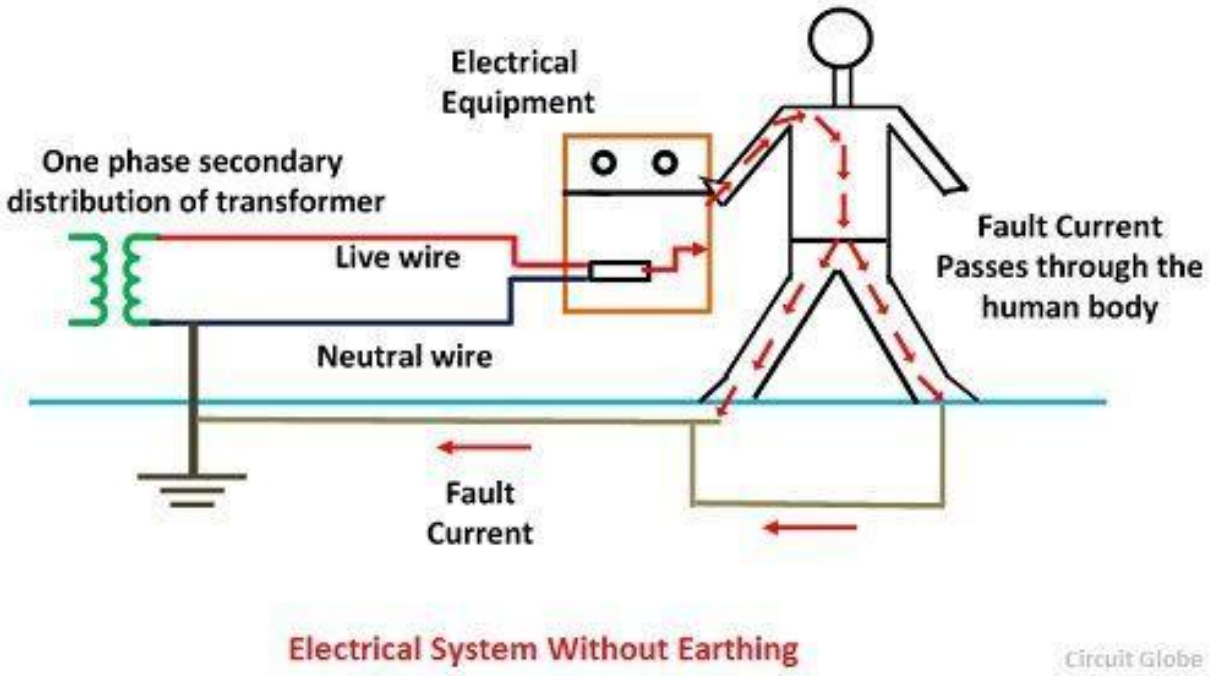
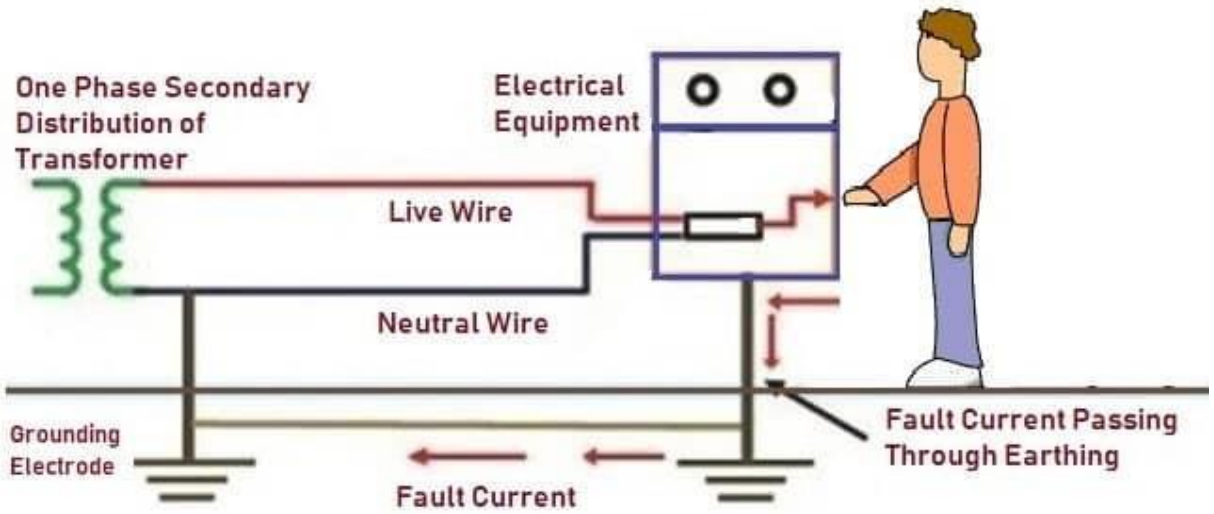
Safety devices

1) The Earth-wire

When the metal casing become live due to a fault, the earth wire provides low resistance path to the ground.





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Fuses

- Fuses in plugs are made in standard ratings. The most common are 3 A, 5 A and 13 A. The fuse should be rated at a slightly higher current than the device needs:

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Fuses

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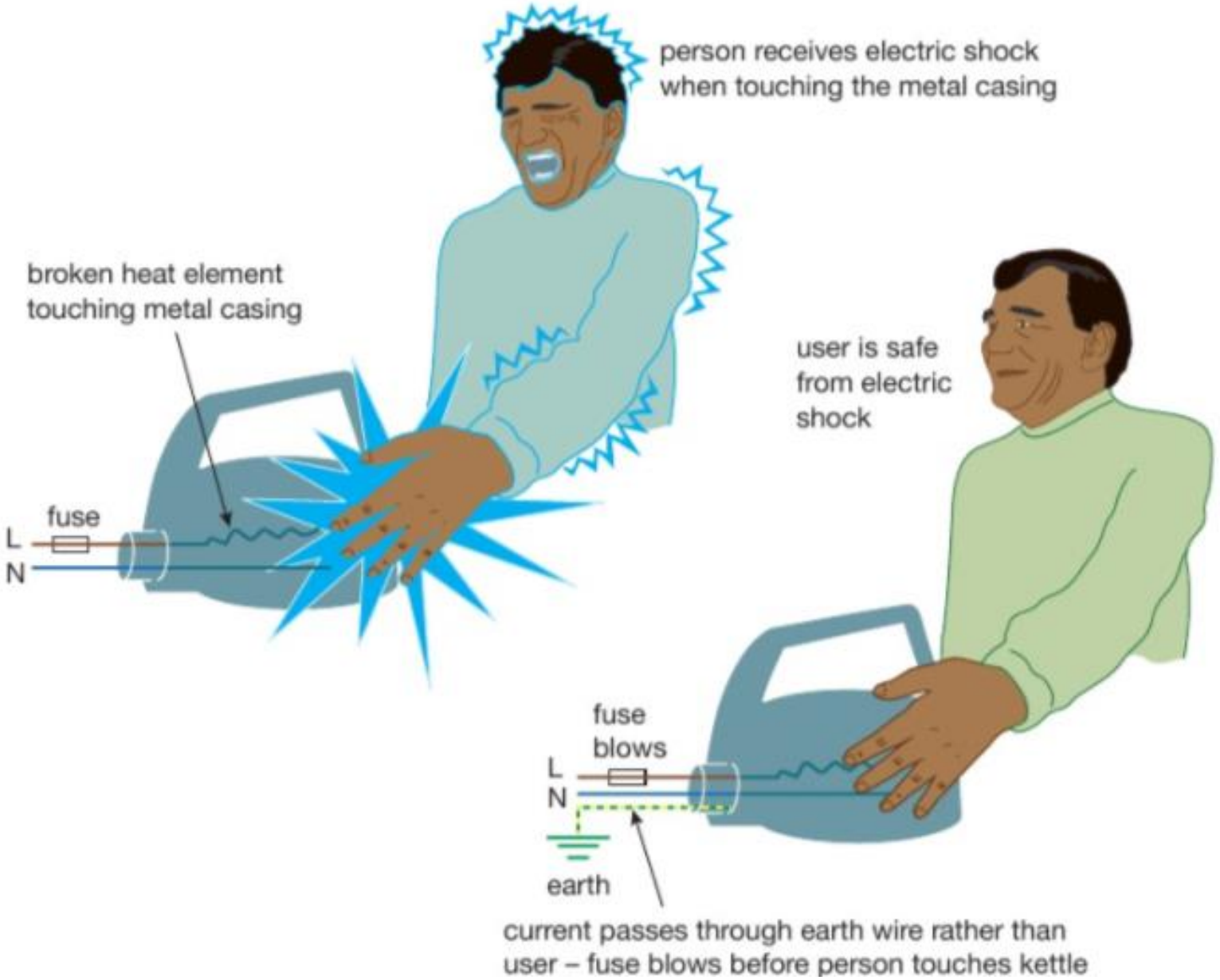
- The fuse breaks the circuit if a fault in an appliance causes too much current to flow.
- This protects the wiring and the appliance if something goes wrong.
- The fuse contains a piece of wire that melts easily.
- If the current going through the fuse is too great, the wire heats up until it melts and breaks the circuit.


person receives electric shock
when touching the metal casing
broken heat element
touching metal casing
fuse
L
N
user is safe
from electric
shock
fuse
blows
L
N
earth
current passes through earth wire rather than
user – fuse blows before person touches kettle

Double insulation

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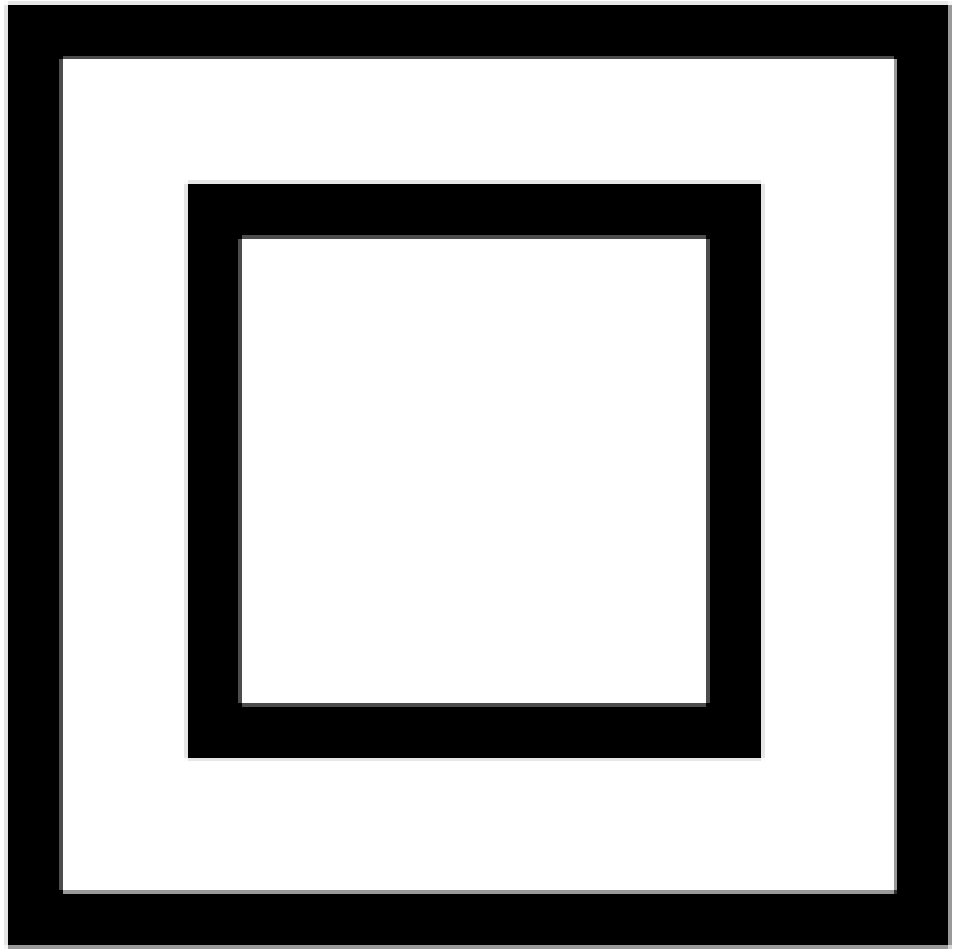

Double insulation

- Some appliances - such as vacuum cleaners, and electric drills - do **not** have an earth wire(uses only 2 pin plugs)
- They have plastic casings, or they have been designed so that the live wire cannot touch the casing.
- As a result, the casing cannot give an electric shock, even if the wires inside become loose.
- These appliances have double insulation.

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Switches

- Switches in main circuits should always be placed in the live wire so that when the switch is open no electrical energy can reach the appliance.

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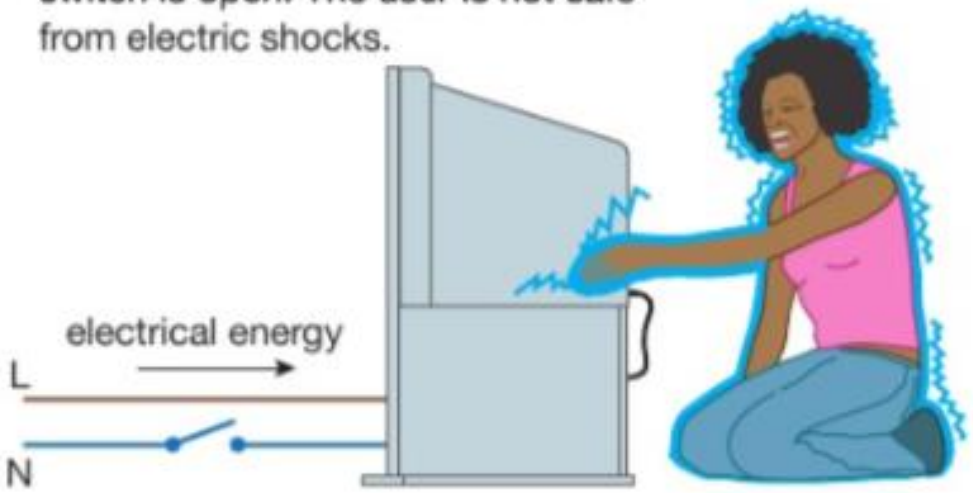
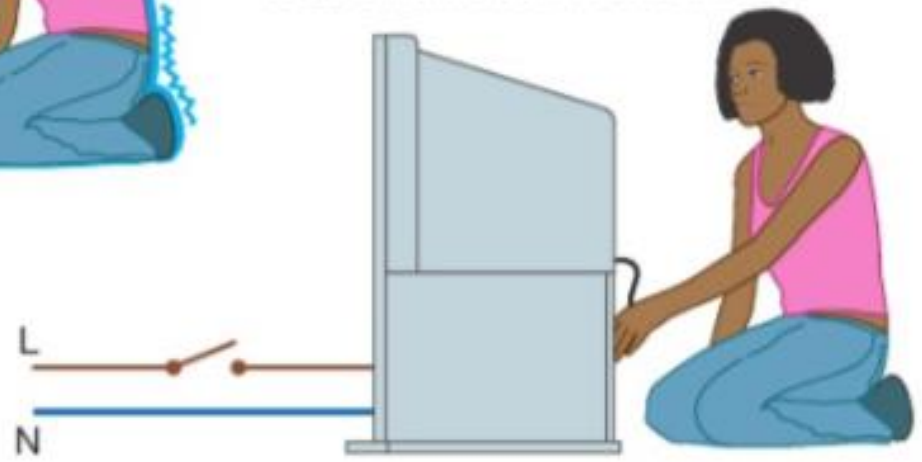
When the switch is connected into the neutral wire electrical energy can reach the faulty appliance even when the switch is open. The user is not safe from electric shocks.



With the switch open and connected into the live wire the electrical energy cannot reach the appliance. The user is safe from electric shock.



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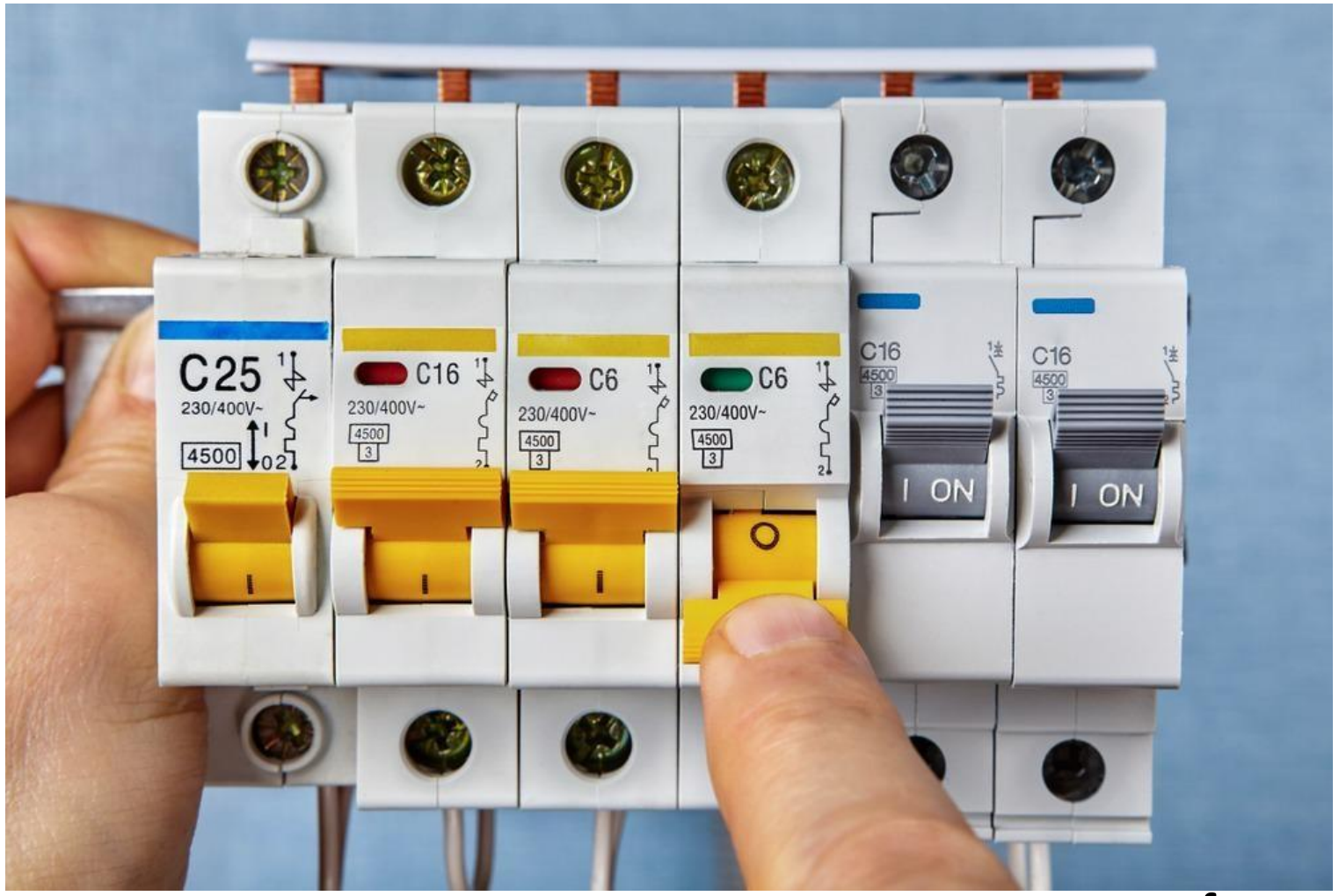
Circuit breakers.



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Circuit breakers

- These are automatically operated electrical switches that protect electrical circuits from overloading or short circuiting.
- They detect faults and then stop the flow of electricity. Small circuit breakers protect individual household appliances, whereas larger ones can protect high voltage circuits supplying electricity to entire cities.
- Advantage over fuses: Fuses must be replaced every time when they stop a large current. Because the wire melts. But circuit breakers can be reset by pressing a button. Circuit breakers work instantly, and they are very sensitive compared with fuses.

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The heating effect of current.

The heating effect of current

- The metal wires get heated(due to the resistance) when current passing through them.
- If the metal wire(heating element) have a high resistance more heat can be generated.
- This heating effect is used in some appliances such as electric cookers, filament lamps and heaters.

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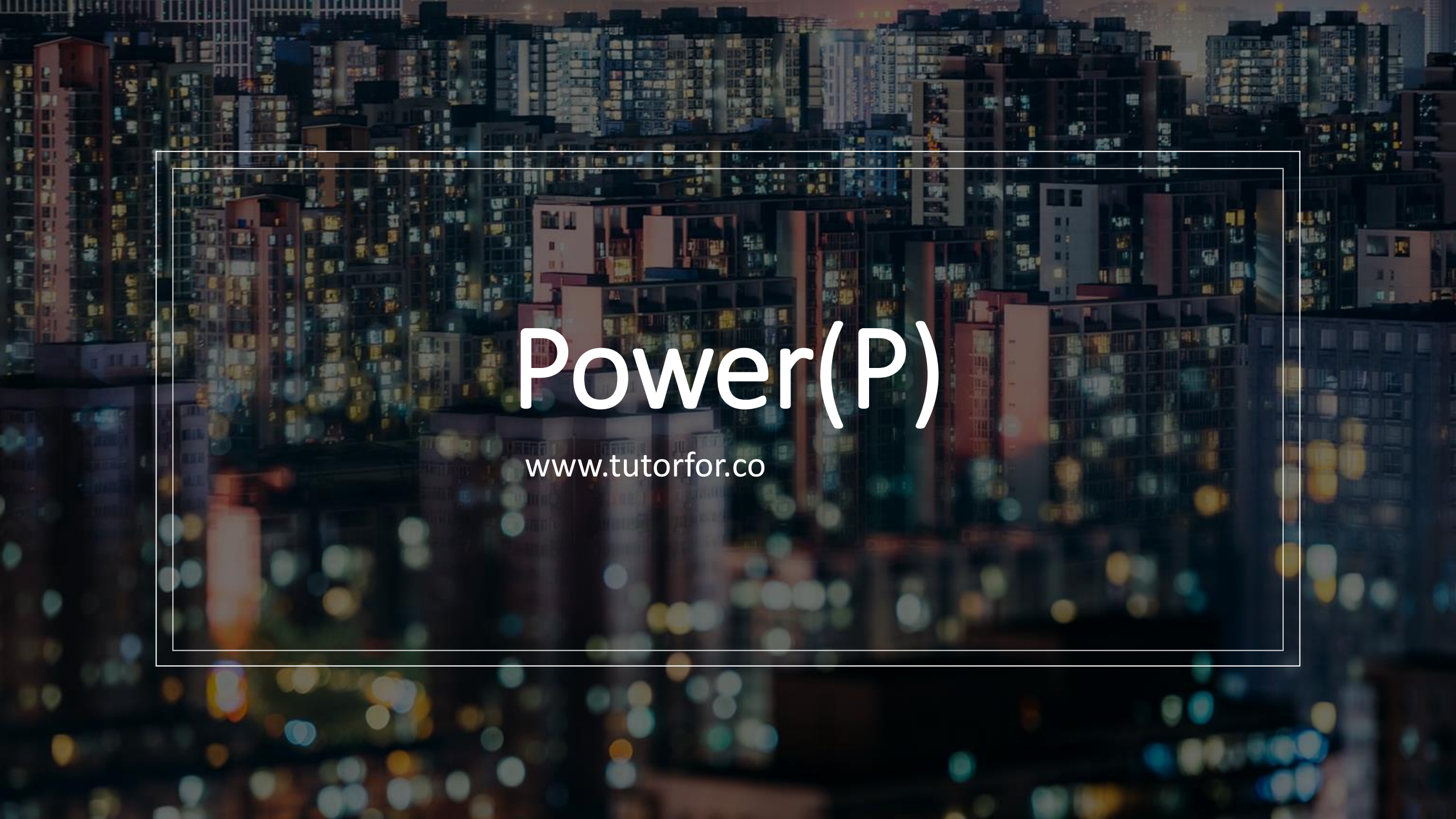
Power(P)
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Power(P)

- The rate of energy transfer is called the power.

$$\text{Power} = \frac{Energy}{Time}$$

$$P = \frac{E}{t}$$

- **SI unit of energy is joule(J).**
- **1 W = 1 J/s**

- The SI unit of power is watt(W).
- The power is a scalar quantity.

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Electrical Power(P)

- Electrical power can be calculated by the product of voltage and current.

Power = Voltage × Current

P = VI

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Concept learning questions

The mains voltage is 230 V. When an electric heater is connected to the mains, a current of 434.8 mA passing through the heater. Calculate the power of the heater.

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Concept learning questions

The power of an electric kettle is 1 kW. Find the current passing through the kettle when it is connected to mains supply(230 V).

Select the suitable fuse for the plug of the kettle.

a) 3 A

b) 5 A

c) 13 A

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Energy transfer

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Energy transfer (E)

$\text{Power} = \frac{Energy}{Time}$ → Energy = Power × time

$P = \frac{E}{t}$ → E = P × t

P= VI → E = (VI) × t

Electric energy transfer = voltage × current × time

$$E = V \times I \times t$$

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Concept learning question

- A 100 W heater is connected to the mains for 15 min. Find the amount of energy transfer.

E= 90 kJ

- The current through a bulb is 250 mA. It is switched on for 20 min. Find the amount of energy transfer.(V= 12 V)

E = VIt = 12 x 0.25 x (20 x60) = 3600 J = 3.6 kJ

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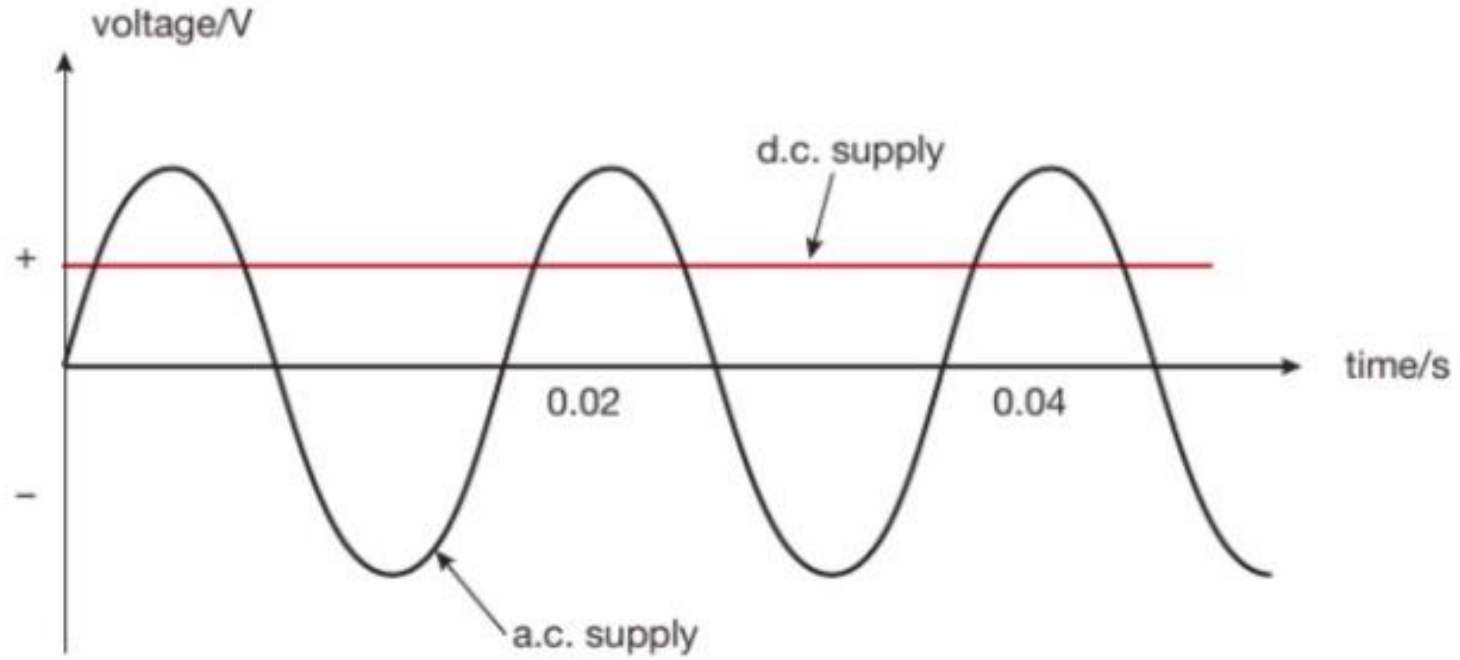
AC & DC

Alternating current(AC) and direct current(DC)



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Alternating current.

The voltage and current continuously changes with the time.

The current generated in the power stations is alternating current. Therefore, the mains supply in our houses is a source of alternating current.

Direct current.

The voltage and current are constant with the time.

The batteries are source of direct current.

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