Dangers of electricity

Dangers of high voltage:

- Anyone touching a bare wire or a high voltage terminal will receive a fatal electric shock.
- A current of 20mA (0.02A) is enough to electrocute a person. Also the resistance of a human body=1000Ω. Thus it is dangerous to touch a terminal of about 20V.[Calculated using ohm's law]

Dangers of low voltage:

Low voltage cables can overheat and cause fires. The overheating may happen due to a fault in the low voltage circuit.

Short circuit of low voltage circuits can also cause over-heating.

Short circuit: A low-resistance connection between two points in an electric circuit through which the current tends to flow rather than along the intended path.

This results in excessive current flow in the power source through the 'short,' and may even cause the power source to be destroyed as it might get overheated and catch fire

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Manufacturers ensure that electrical components are safe to use:

- Electrical wires are made of copper as it is a good conductor of electricity. The wires have flexible and hard wearing plastic insulation to prevent snapping.
- Brass terminals are used in plugs, sockets and other electrical fitting as along with being a good conductor of electricity, it is also hard wearing than copper and does not rust easily.
- The cable connecting the device to a socket has an outer layer of insulation surrounding the separate insulated wires inside the cable.
- Plugs and sockets are made from stiff heat resistant plastic materials shaped to hold the wires. The terminals are sealed firmly inside so that they cannot make contact with each other.

Common faults that might develop in electrical devices and circuits are:

- **Wear and tear leading to damaged insulation:**

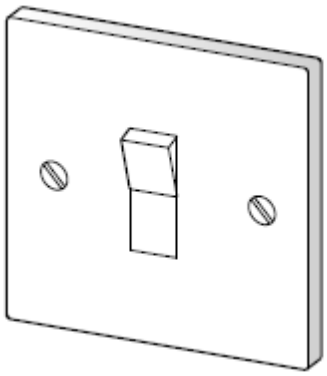
The layer of insulation around a wire or a cable may wear away. The plug or the socket may become chipped or broken exposing a bare wire or terminal in a plug.

- **Overloading a socket:**

A socket with more than one appliance connected to it may become overloaded if too much current flows through it

- **Overheating of cables can melt the insulation.** Thus the wires may become bare. There are also chances of a short circuit.
- **Fitting an incorrect fuse and ignoring manufacturers instructions.**
- **Damp or wet conditions:** Dampness inside a device , socket or a plug can cause short circuit or it could provide a conducting path for the outer surface.
- **Too long cables.** These can cause tripping over. It is also possible that these long cables can get coiled and cause overheating and melting of insulations.

Some precautions to be taken while handling electrical equipment in electrically unsafe conditions:



If such kind of switches are being used in damp and hot conditions:

- **The switch should be set on or off using a long chord of insulated material.**
- **The switch must have an insulating cover on it.**
- **Such switches must be placed outside workrooms with such atmospheric conditions.**

Fuses and circuit breakers:

Fuses and circuit breakers prevent electrical appliances

Fuse:

- A fuse consists of a thin wire that heats up and melts when an excess current flows through it.
- Every fuse has a rating. This is the maximum current that can flow through it without melting its wire
- If the rating is too large then the fuse will not blow when it should and there can be a fire due to overheating. Hence a fuse should be chosen carefully.
- Once a fuse blows out , it needs to be replaced.

The fuse rating:

The fuses in plugs come in various ratings – 3A, 5A or 13A. Each rating is designed to allow enough current to reach a device to allow it to operate normally, but to melt if the current becomes excessive before the device is damaged.

The fuse rating is found by finding the current required by device and rounding up to the next fuse rating.

Suppose for example that a device has a power rating of 800W. We can find the current requirement using the equation[Note that the three pin plug is used in the UK for every electrical device run off the 240V mains supply.]

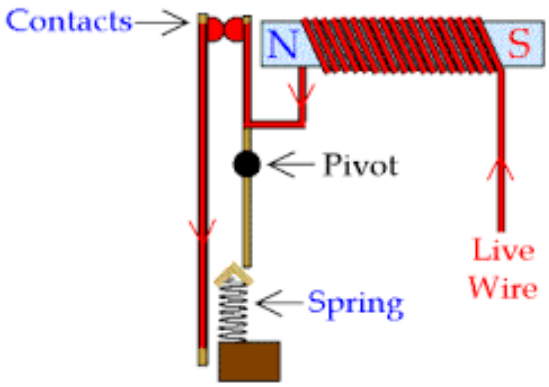
Hence:

$$Current = \frac{Power}{Voltage}$$

$$Current = \frac{Power}{Voltage} = \frac{800}{230} = 3.47A.$$

Then for this appliance we should use a fuse of 5A

Circuit breaker:



- A circuit breaker is an electromagnetically operated switch in series with an electromagnet.

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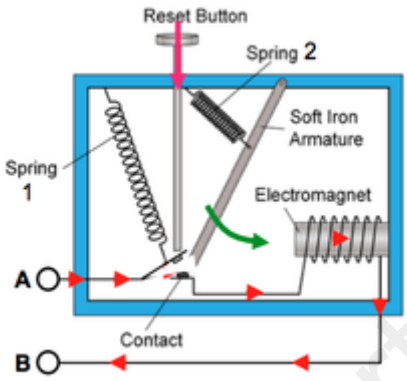

When the current in the live wire exceeds the prescribed limit, the electromagnet pulls the switch open. As a result the rest button pops up and the current is cut off.

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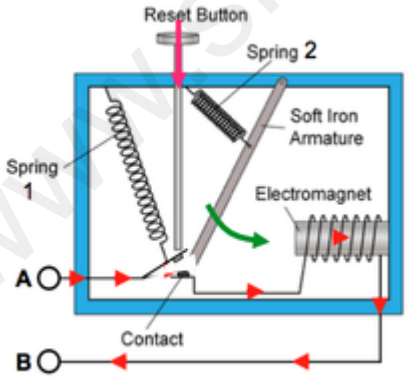
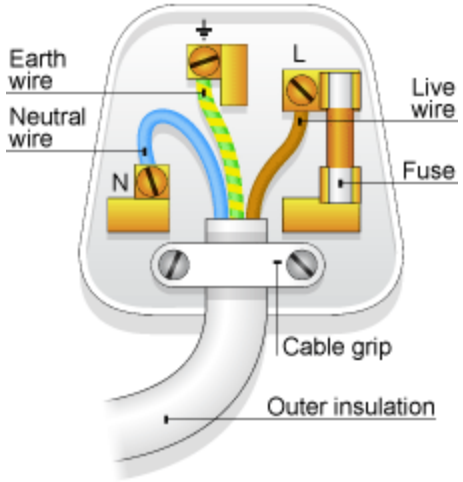


Once the fault that made it is put right, the switch is reset by pressing the reset button .As a result the soft iron armature again establishes contact with the electromagnet and the circuit is complete and the current begins to flow.

Benefits of earthing metal cases:

- Earthing provides additional safety to electrical appliances with metal frames and panels.
- Three pin plugs:



- Three pin plugs contain an additional cable called as the earth wire. This wire carries the excess current to the earth thus making the appliance and its user safe.
- The earth pin is longer which ensures that the appliance is first earthed while being plugged into the socket

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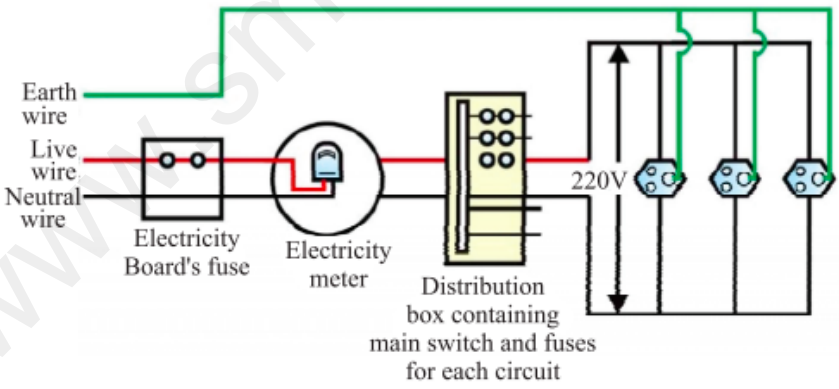
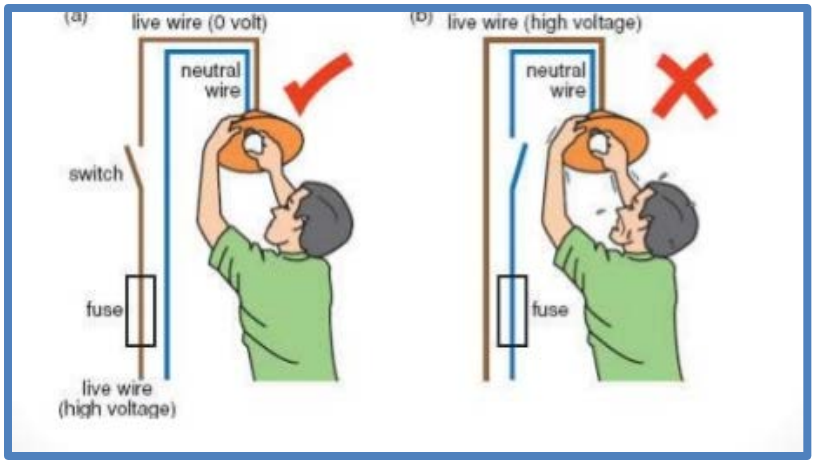
The circuit wiring from the distribution board also includes an earth wire in addition to the live and neutral wire. The earth wire is connected to the ground outside the building.

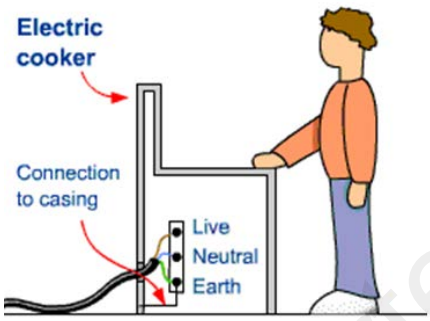


Fuse in the live wire of electrical appliances:



The fuse should be present in the live wire, so that the circuit is broken when excess current flows through it and prevents electrical shocks.

To prevent electrocution, the earth wire is connected to the casing of appliances.



If the live wire snaps and touches the casing, the casing will become alive. So anyone touching the casing would be electrocuted.

The earth wire however will provide a path for the flow of electricity from the appliance to the ground. So anyone touching the appliance will not be electrocuted.

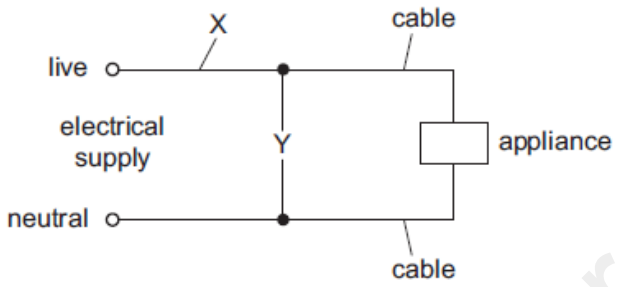
Will the excess current blow the fuse?

Yes: The extra current will blow the fuse if it exceeds the fuse rating and switch off the appliance, keeping the user safe.

No: If however the current is not large enough to blow off the fuse, the appliance will still become unsafe as the excess current will lead to overheating of the device and a possible fire.

APPLICATION BASED QUESTIONS:

32 Either a fuse or a circuit-breaker can be used to protect electrical cables from large currents that could cause overheating.



If a fuse is used, in which position in the circuit should it be connected, and if a circuit-breaker is used, in which position should it be connected?

0625/11/M/J/09

	position of fuse	position of circuit-breaker
A	X	X
B	X	Y
C	Y	X
D	Y	Y

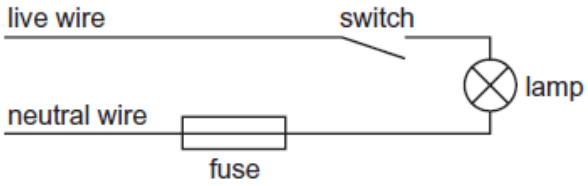
33 The current in a lamp at full brightness is 0.25 A. The flexible cable to the lamp is designed for currents up to 5.0 A, so it can safely carry the 0.25 A taken by the lamp.

Which fuse should be inserted in the plug at the other end of the flexible cable?

A 0.2 A **B** 1.0 A **C** 5.0 A **D** 10.0 A

32 Which diagram shows the correct positions for both the switch and the fuse?

A



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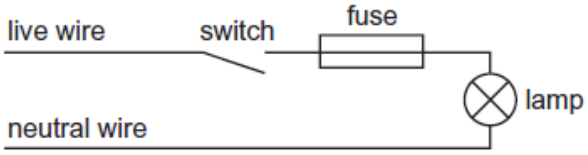

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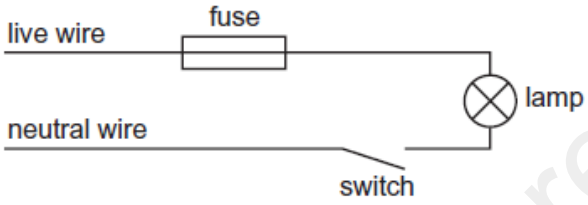

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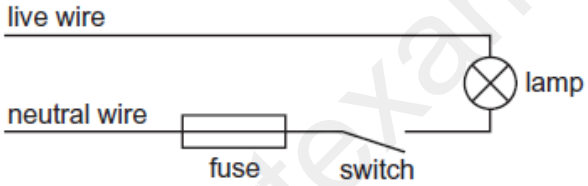
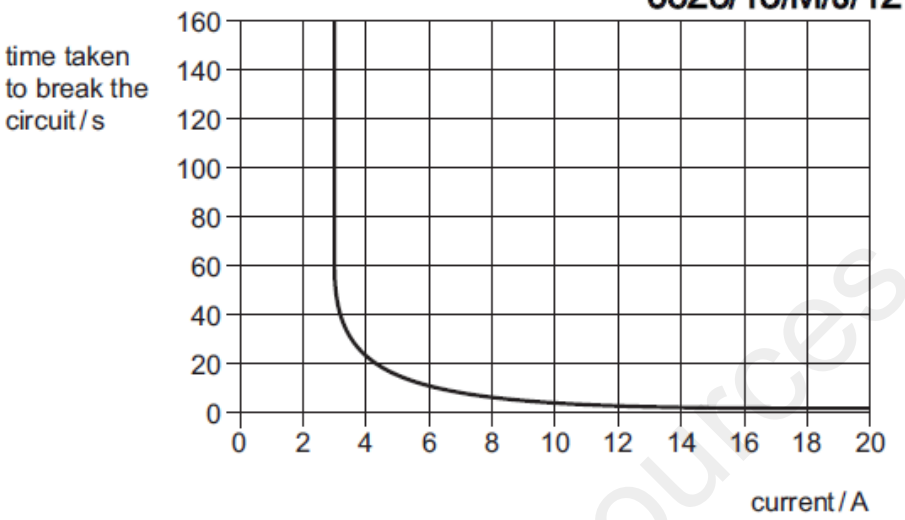


31 A circuit-breaker is designed to protect a circuit which usually carries a current of 2 A.

The time taken to break the circuit depends on the current, as shown in the graph.



What happens when the current in the circuit is 2 A and what happens when the current 18 A?

	when the current is 2 A	when the current is 18 A
A	the circuit breaks in less than 5 seconds	the circuit breaks in less than 5 seconds
B	the circuit breaks in less than 5 seconds	the circuit does not break
C	the circuit does not break	the circuit breaks in less than 5 seconds
D	the circuit does not break	the circuit does not break

5 The manufacturer's label on an electric heater is as shown in Fig. 5.1. M/J/11-P31

C.I.E. Electrical Company
Suitable for use on 110 V, 60 Hz supply
1 kW/2 kW
This appliance must be earthed when in use

Fig. 5.1

(a) State what electrical quantity is represented by

(i) 110V, ...

(ii) 60 Hz, ...

(iii) 1 kW. ..... [1]

(b) **(i)** Which part of the electric heater must be earthed?

.....[1]

(ii) Explain what the hazard might be if the heater is not earthed.

.....

.....

.....[2]

(c) The heater has two 110V heating elements, with two switches, so that either one or both elements may be switched on.

In the space below, draw a circuit diagram showing how the heating elements and switches are connected to the mains supply.
Use the symbol ⊣⊏⊐⊐⊐⊢ for each heating element.