Mains electricity

6.2.3.2 · Physics · revision notes

How appliances are connected to the mains with three-core cable: the colour, job and potential of the live, neutral and earth wires, and why the live wire is dangerous. Expect 1-mark recall of colours and 2 to 3 mark 'explain' questions about safety.

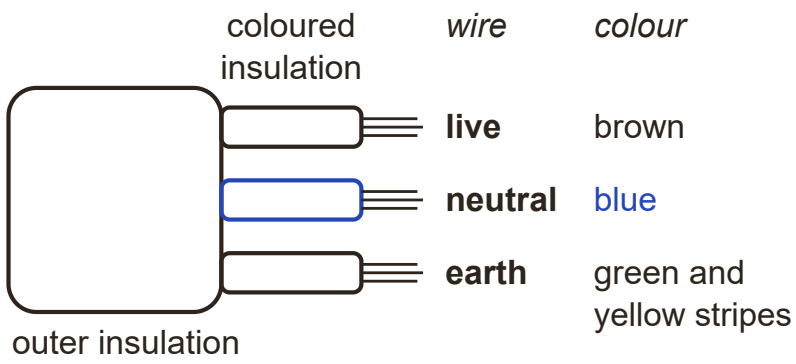
Key facts

- Live: brown, about 230 V, carries the alternating pd from the supply
- Earth: green and yellow stripes, 0 V, safety wire
- Touching the live wire: 230 V across your body → current through you → shock
- Neutral: blue, at or close to 0 V, completes the circuit
- The earth wire only carries a current if there is a fault
- The live wire can be dangerous even when a switch is open

Notes

Three-core cable

- Most electrical appliances are connected to the mains using **three-core cable**: three wires, each covered in colour-coded insulation.
- **Live** wire: **brown**. **Neutral** wire: **blue**. **Earth** wire: **green and yellow stripes**.

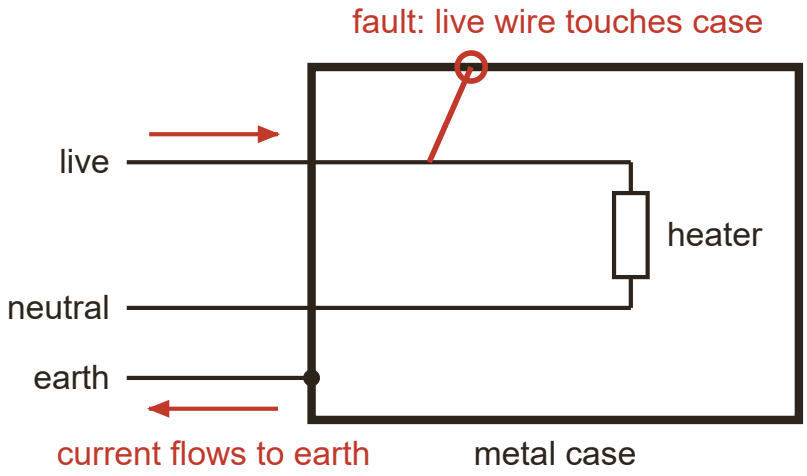


Three-core cable: live (brown), neutral (blue), earth (green and yellow).

- The colours make each wire easy to identify.

What each wire does

- The **live** wire carries the alternating potential difference from the supply. The pd between the live wire and earth is about **230 V**.
- The **neutral** wire completes the circuit. It is at, or close to, earth potential (**0 V**).
- The **earth** wire is a **safety wire** that stops the appliance becoming live. It is at 0 V and only carries a current if there is a **fault**.
- Example: if a loose live wire touches the metal case of an earthed appliance, the current flows through the earth wire instead of through a person who touches the case.



Earthing: in a fault the current goes down the earth wire, not through you.

Why the live wire is dangerous

- Your body is at earth potential (0 V). If you touch the live wire, there is a pd of about 230 V across your body, so a current flows through you to earth. This is an **electric shock**, which can kill.
- A live wire can be dangerous **even when a switch is open**. The switch breaks the circuit through the appliance, but the live wire is still connected to the supply and is still at about 230 V.
- **Any connection between the live wire and earth is dangerous.** There is a pd of about 230 V across the connection, so a current flows through it. If the connection is a person, the current flows through their body. If the connection has a low resistance, the current is very large and can heat the wires enough to start a fire.

How to answer each type of question

Recall the colours and jobs of the wires

1 mark each | Grade 3

1. Learn the three colours: brown, blue, green and yellow stripes.
2. Match each wire to its job: carries the pd (live), completes the circuit (neutral), safety (earth).

Example. (a) Give the colour of the insulation on the neutral wire.
(b) Give the colour of the insulation on the earth wire.
(c) Name the wire that carries the alternating potential difference from the supply.

Model answer.

(a) Blue (1)
(b) Green and yellow stripes (1)
(c) The live wire (1)

Explain how the earth wire makes an appliance safer

2 marks | Grade 5

1. Describe the fault: the live wire touches the metal case.
2. Say that the earth wire stops the case becoming live (keeps it at 0 V).
3. Say that the current flows through the earth wire, not through the person.

Example. A toaster has a metal case. The case is connected to the earth wire.
Explain how the earth wire makes the toaster safer to use.

Model answer. If there is a fault and the live wire touches the metal case, the earth wire stops the case becoming live / keeps the case at 0 V (1). The current flows through the earth wire instead of through a person who touches the case (1).

Explain why a person could get an electric shock

3 marks | Grade 5

1. Say that the live wire is at about 230 V (even with the switch open, it is still connected to the supply).
2. Say that the person is at earth potential (0 V), so there is a large pd across their body.
3. Say that a current flows through the person to earth.

Example. A light switch is off (open). A person touches a damaged part of the live wire that leads to the switch, while standing on the ground.
Explain why the person could get an electric shock.

Model answer. The live wire is still connected to the supply, so it is still at about 230 V even though the switch is open (1). The person is at earth potential / 0 V, so there is a large potential difference across their body (1). A current flows through the person to earth, which causes the shock (1).

Don’t lose marks

- Saying the neutral wire carries no current. It carries current in normal use; it is the earth wire that only carries a current when there is a fault.
- Saying the neutral or the earth wire is at 230 V.
- Saying the earth wire 'protects the appliance'. It protects the user by stopping the case becoming live.
- Thinking that a wire is safe because the switch is off: the live wire can still be at 230 V.
- Writing just 'green' for the earth wire instead of 'green and yellow stripes'.

More tips

Memory tricks

- Colours: brown = live (brown 'burns', it is the dangerous one); blue = neutral (cool and calm, near 0 V); green and yellow = earth (think of green grass on the earth).
- Potentials: live about 230 V, neutral about 0 V, earth 0 V. Only the live wire is at a high potential.
- A shock needs a pd across you. You are at 0 V, so the danger is anything at a high potential: the live wire.

Exam technique

- In shock questions, give both potentials: the live wire at about 230 V and the body at 0 V, so there is a large pd and a current through the body.
- Use the key words 'fault', 'becoming live' and 'earth potential'.
- If a question describes a fuse or a circuit breaker, use the information it gives you in your answer.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Recall the colours of the three wires**
Live is brown, neutral is blue, earth is green and yellow stripes.

Grade 4 — **State the job of each wire**
Live carries the alternating pd from the supply, neutral completes the circuit, earth is a safety wire.

Grade 5 — **State the potential of each wire**
Live is about 230 V (compared with earth); neutral is at or close to 0 V; earth is at 0 V.

Grade 5 — **Explain how the earth wire keeps you safe**
It stops the appliance becoming live and only carries a current if there is a fault.

Grade 5 — **Explain why touching the live wire is dangerous**
Your body is at 0 V, so there is a large pd across you and a current flows through you.

Grade 5 — **Explain dangers even when a switch is open**
The live wire is still connected to the supply, so it is still at about 230 V.

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