

2.5 Domestic uses and safety

Name: _____ Class: _____ Date: _____

Total: 21 marks**KEY WORDS** alternating • direct

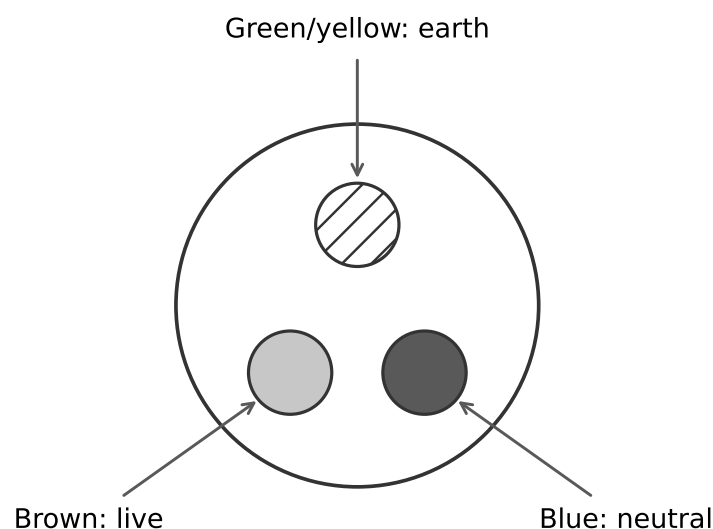
Objective

State the UK mains values, tell alternating from direct potential difference, name the three wires with colours and jobs, and explain the live-wire dangers. Original questions for spec statement 4.2.3.

1 Key knowledge and worked examples

Fact	Value
UK mains potential difference	about 230 V
frequency	50 Hz
type	alternating (ac) – the pd repeatedly changes direction

A **direct (dc)** potential difference drives current one way only (batteries). In the sinusoidal UK mains model, 50 Hz means 50 complete cycles each second, with two polarity changes per cycle; it does not mean only 50 reversals each second.



Brown live, blue neutral, green/yellow earth.

Wire	Colour	Job	Potential
live	brown	carries the alternating pd from the supply	about 230 V relative to earth
neutral	blue	completes the circuit	at or close to 0 V
earth	green and yellow stripes	safety wire – stops the appliance becoming live	0 V; carries current only in a fault

The two dangers you must explain:

- **A live wire can be dangerous even when the switch is open.** The supply-side live wiring remains at about 230 V relative to earth. A person providing a conducting path from that point to earth can receive a shock. This does not imply that a lamp terminal after a correctly wired open live switch must also remain live.
- **A live-to-earth connection can be dangerous.** A low-resistance fault path can carry a very large current. A current through a person can be dangerous even when it is below the appliance fuse rating; do not assume a fuse protects every person touching live wiring.

A suitably rated fuse melts when a sufficiently large excess current heats its wire. It is connected in the **live** wire so that operation breaks the live supply. For a live-to-metal-case fault with a sound low-resistance protective-earth path, the large fault current can melt the fuse and disconnect the supply.

2 Practice

2.1 State the frequency and potential difference of the UK mains supply. [2]

2.2 Explain the difference between direct and alternating potential difference. [2]

2.3 Name the colours of the insulation on the live, neutral and earth wires, and state the job of each wire. [6]

3 Exam-style questions

3.1 A student plugs a metal-cased heater into the mains.

(a) State which wire the fuse is connected in, and why this position is the safe one. [2]

(b) A fault connects the live wire to the metal case. Explain how the earth wire and the fuse protect the user. [3]

3.2 A student says, “Opening a switch in the live wire makes every part of the live wiring harmless.” Explain why supply-side live wiring can still be dangerous, using the idea of potential difference. [2]

3.3 The table describes an ideal single-phase circuit. In the fault, the neutral return breaks between a lamp and the supply; the load-side neutral remains connected to live through the lamp. There is no other return path. All neutral readings below refer to that load-side neutral terminal.

Situation	Live-to-neutral pd	Live-to-earth pd	Neutral-to-earth pd
normal	230 V	230 V	0 V
fault: neutral broken	0 V	230 V	230 V

(a) Using the table, state the potential of the neutral wire relative to earth in normal operation. [1]

(b) In the fault, a lamp connected between live and neutral does not light, but touching its *neutral* terminal is now dangerous. Explain both observations. [3]

Solutions

2.1 Frequency 50 Hz; potential difference about 230 V.

2.2 Direct pd drives current in one direction only; alternating pd repeatedly reverses direction (the current repeatedly changes direction).

2.3 Live: brown – carries the alternating pd from the supply. Neutral: blue – completes the circuit, at or near 0 V. Earth: green and yellow stripes – safety wire at 0 V that carries current only in a fault, stopping the case becoming live.

3.1 (a) The fuse sits in the live wire: breaking the live side disconnects the appliance from the 230 V source, so no fault current can be supplied. (b) The earth wire gives the fault current a low-resistance path to earth; a very large current flows live $\rightarrow$ case $\rightarrow$ earth; the large current melts the fuse, breaking the live supply and making the case safe.

3.2 The supply-side live wiring is still connected to the source and remains at about 230 V relative to earth; a person providing a conducting path from that live point to earth can carry a dangerous current and receive a shock. The claim concerns supply-side wiring, not an assertion that the lamp terminal after a correctly wired open switch remains live.

3.3 (a) 0 V (at or close to earth potential). (b) With the neutral broken, the neutral-side wiring is connected to the live through the lamp, so both lamp terminals are at about 230 V relative to earth with approximately zero pd across the lamp; no normal load current flows (the circuit is incomplete, so the lamp cannot light); a person touching the neutral terminal now provides the missing path to earth; current flows through them and they receive a shock – the table's 230 V neutral-to-earth reading is the warning.