IG.P5 Mains Electricity and Circuit Wiring Safety

EDEXCEL 4PH1 · Calculator allowed · about 50 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 State the nominal rms voltage supplied by the UK mains electricity supply that household appliances use.

(Total for Question 1 is 1 mark)

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2 State the standard frequency of the UK mains electricity supply and include the unit.

(Total for Question 2 is 1 mark)

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3 Describe two differences between direct current as supplied by a cell or battery and alternating current supplied by the UK mains, naming each type in your answer.

(Total for Question 3 is 2 marks)

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4 State the colour coding of the three wires found in a standard three-core mains cable used in the UK, giving the colour and the name of each wire: live, neutral, earth. Include the earth colour exactly as used in UK wiring.

(Total for Question 4 is 3 marks)

5 Describe the purpose of the earth wire in a mains appliance and how it reduces the risk of electric shock to a user.

(Total for Question 5 is 3 marks)

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6 State the purpose of the neutral wire in a domestic mains circuit and what potential it is close to during normal operation.

(Total for Question 6 is 1 mark)

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7 State the role of the live wire in a mains appliance and the danger it poses if touched while the appliance is switched on.

(Total for Question 7 is 1 mark)

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8 The diagram shows a simple three-pin plug and a length of three-core cable for a domestic appliance. Label the plug pins and the cable cores with the correct names and colours. In your answer label: Live pin and wire, Neutral pin and wire, Earth pin and wire. Also indicate where the fuse is placed in a correctly wired plug.

(Total for Question 8 is 6 marks)

9 A hairdryer is labelled 900 W for power and is designed to be used on UK mains 230 V. Calculate the current the hairdryer draws from the mains and hence suggest a suitable fuse rating for the plug. Show your working and state the unit.

(Total for Question 9 is 2 marks)

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10 A kettle marked 2300 W is used on 230 V mains. Calculate the current it draws and determine the smallest standard fuse rating from the common UK plug ratings 3 A, 5 A and 13 A that should be used. Show the equation, substitution and evaluation. State the unit for the current.

(Total for Question 10 is 3 marks)

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11 Explain how a fuse protects an appliance and a user from danger in the event of a fault that allows excessive current to flow.

(Total for Question 11 is 2 marks)

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12 Describe briefly how a circuit breaker provides protection compared with a fuse, and give one advantage of a circuit breaker over a fuse in domestic use.

(Total for Question 12 is 2 marks)

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13 Explain how double insulation protects a user from electric shock and state an example of an item that might use double insulation instead of an earth wire.

(Total for Question 13 is 3 marks)

14 A toaster has power rating 1500 W and is used on 230 V mains. Calculate the current drawn by the toaster. Then explain why a 3 A fuse would be unsuitable in the plug for this toaster, giving the numerical reason. Show the equation, substitution and evaluate the current; state the unit.

(Total for Question 14 is 3 marks)

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15 A small charger has a label showing 12 V output and 2 A maximum on the low-voltage side. The charger is powered from 230 V mains via an internal transformer and internal fuse in the live input. Explain why the charger still needs an internal fuse on the mains side even though the low-voltage side limit is 2 A, and state what the fuse on the mains side protects against. Give two distinct reasons.

(Total for Question 15 is 4 marks)

Mark scheme · IG.P5 Mains Electricity and Circuit Wiring Safety

Question 1

- **B1** 230 V (or 230 volts) cao
- **Answer: 230 V**

Question 2

- **B1** 50 Hz (50 hertz) cao
- **Answer: 50 Hz**

Question 3

- **B1** DC: current flows in one direction only (from a cell or battery)
- **B1** AC: current changes direction periodically, e.g. 50 times per second for UK mains
- **Answer: DC flows in one direction only; AC reverses direction periodically (50 Hz in UK mains).**

Question 4

- **B1** live is brown
- **B1** neutral is blue
- **B1** earth is green-and-yellow (green with yellow stripe) cao
- **Answer: Live = brown; Neutral = blue; Earth = green-and-yellow**

Question 5

- **B1** provides a low resistance path to earth for fault current if the live conductor touches a metal case
- **B1** this allows large fault current to flow so protective devices operate (fuse blows or circuit breaker trips)
- **B1** metal case is kept at near earth potential, reducing risk of electric shock to a user who touches the case
- **Answer: Earth gives a low-resistance path for fault current so a fuse or breaker operates and the metal case stays near earth potential, reducing shock risk.**

Question 6

- **B1** completes the circuit back to the supply and is close to earth potential (near 0 V) during normal operation
- **Answer: Neutral completes the circuit back to the supply and is close to earth potential (near 0 V) in normal use.**

Question 7

- **B1** carries the alternating voltage from the supply to the appliance and can give a dangerous electric shock if touched while live
- **Answer: Live carries the supply voltage to the appliance and can give a dangerous shock if touched when the appliance is switched on.**

Question 8

- **B1** live pin labelled and live wire colour given as brown
- **B1** neutral pin labelled and neutral wire colour given as blue
- **B1** earth pin labelled and earth wire colour given as green-and-yellow
- **B1** correct position of the fuse inside the live conductor in the plug is shown or stated
- **B1** correct identification of the live, neutral and earth pin positions (live on the right when looking at the pins, neutral on the left, earth top)
- **B1** shows that the cable outer sheath is clamped and that individual cores are connected to the correct pins
- **Answer: Live = brown to live pin (right pin), Neutral = blue to neutral pin (left pin), Earth = green-and-yellow to top pin; fuse is in the live conductor inside the plug; outer sheath clamped.**

Question 9

- **M1** uses I = P / V with P = 900 W and V = 230 V
- **A1** I = 900 / 230 = 3.913... A, therefore suitable fuse rating 5 A cao
- **Answer: I = P / V = 900 / 230 = 3.91 A (about 3.9 A), so use a 5 A fuse.**

Question 10

- **M1** quotes the equation I = P / V and substitutes values I = 2300 / 230
- **A1** evaluates current = 10 A (2300 / 230 = 10.0 A) cao
- **B1** states smallest suitable fuse is 13 A, since 3 A and 5 A are too small and 13 A is the next standard rating above 10 A
- **Answer: I = P / V = 2300 / 230 = 10.0 A, so use a 13 A fuse (3 A and 5 A would blow).**

Question 11

- **B1** wire in the fuse melts when current exceeds its rating, breaking the circuit
- **B1** this stops current flowing so prevents overheating or fire and reduces risk of electric shock
- **Answer: If current exceeds the fuse rating its thin wire melts and breaks the circuit, stopping current flow and preventing overheating, fire or a live casing that could give a shock.**

Question 12

- **B1** circuit breaker trips to open the circuit when current is too high, often using an electromagnet or bimetallic strip
- **B1** advantage: it can be reset rather than replaced, so quicker and more convenient after a fault
- **Answer: A circuit breaker trips to open the circuit when excess current flows, often using electromagnetism or a bimetal strip; it can be reset after a fault instead of replacing it like a fuse.**

Question 13

- **B1** double insulation has two layers of insulation or reinforced insulation so live parts cannot touch external metal parts
- **B1** prevents any fault current reaching the outside casing, so user cannot receive a shock even if internal wiring fails
- **B1** gives a correct example, e.g. a hairdryer with a plastic casing or many handheld power tools and battery chargers
- **Answer: Double insulation uses two layers or reinforced insulation so live parts cannot reach an external metal case; this prevents fault current reaching a user. Example: a hairdryer with a plastic outer case or many handheld power tools.**

Question 14

- **M1** quotes I = P / V and substitutes I = 1500 / 230
- **A1** evaluates current = 6.5217... A, cao, states unit A
- **B1** explains 3 A fuse is unsuitable because 3 A < 6.52 A so it would blow under normal operation; suggests a 13 A fuse is appropriate
- **Answer: I = P / V = 1500 / 230 = 6.52 A (about 6.5 A). A 3 A fuse is unsuitable because 3 A is less than the operating current (6.52 A) so it would blow; use 13 A.**

Question 15

- **B1** internal fuse on mains side protects the charger and wiring from excessive current drawn from the mains due to a fault in the charger, preventing overheating and fire
- **B1** it protects the mains supply and user by disconnecting the high-voltage side if a fault causes a short or overload, limiting damage and reducing shock/fire risk
- **B1** the low-voltage 2 A rating does not limit mains-side current directly because transformation changes voltage and current; a mains fuse ensures faults on either side cannot cause unsafe mains currents
- **B1** explicit statement that the fuse protects against internal short circuits, earth faults or component failures that would otherwise cause excessive heating or fire risk
- **Answer: The mains-side internal fuse stops excessive current from the 230 V supply if the charger develops a fault, protecting the charger and cable from overheating and preventing fire, and it disconnects the mains to reduce shock risk. The 2 A low-voltage limit does not prevent mains-side faults, so a mains fuse is needed to protect against internal shorts, earth faults and overloads.**