IG.P6 Current, Potential Difference, Resistance and Electrical Power

Total Marks

EDEXCEL 4PH1 · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 In the context of simple electric circuits, define electric current and name the charge carrier in a metal conductor.

(Total for Question 1 is 1 mark)

2 State the unit of potential difference used when measuring across a component in a circuit, and give its symbol.

(Total for Question 2 is 1 mark)

3 State the rule for electric current in a series circuit, naming the relevant parts of the circuit.

(Total for Question 3 is 1 mark)

4 State the rule for potential difference across components connected in parallel, naming the branch context.

(Total for Question 4 is 1 mark)

5 A fixed resistor in a circuit has a potential difference of 12 V across it and a current of 0.30 A through it. Calculate the resistance of the resistor using V = IR, showing the equation, substitution and final answer with unit.

(Total for Question 5 is 3 marks)

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6 Two resistors of 10 ohm and 20 ohm are connected in series across a 9 V battery. Calculate (a) the total resistance of the pair and (b) the current from the battery. Show equation, substitution and final answers with units for both parts.

(Total for Question 6 is 3 marks)

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7 A 12 V supply is connected to two resistors in parallel: branch A has 24 ohm, branch B has 12 ohm. Calculate the current through branch B and the total current drawn from the supply. Show equation, substitution and answers with units.

(Total for Question 7 is 3 marks)

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8 At a junction in a parallel circuit three branch currents are measured: 0.20 A, 0.35 A and an unknown third branch current. If the total current leaving the battery is 0.80 A, determine the third branch current and state the rule used at the junction.

(Total for Question 8 is 2 marks)

9 A component has 0.40 A flowing through it when 3.0 V is applied. Calculate the resistance of the component using V = IR. Show equation, substitution and final answer with unit.

(Total for Question 9 is 3 marks)

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10 A small motor draws a current of 2.0 A from a 6.0 V supply. Calculate the electrical power delivered to the motor using P = IV. Show equation, substitution and final answer with unit.

(Total for Question 10 is 3 marks)

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11 A heater is a 15 ohm resistor carrying 3.0 A. Calculate the electrical power dissipated in the heater using $P = I^2 R$. Show equation, substitution and final answer with unit.

(Total for Question 11 is 3 marks)

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12 An electric kettle is rated at 2.4 kW and is used for 20 minutes. Calculate (a) the energy used in kWh and (b) the cost if electricity is charged at 28 pence per kWh. Show all working, units and final answers.

(Total for Question 12 is 4 marks)

13 A circuit contains a 6 ohm resistor in series with two parallel resistors of 12 ohm and 24 ohm. The combination is connected to a 12 V supply. Calculate the total current drawn from the supply and the current through the 24 ohm resistor. Show equations, substitutions and answers with units.

(Total for Question 13 is 4 marks)

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14 Sketch the I-V characteristic on the axes for a fixed resistor and for a filament lamp, both labelled, and then explain why the filament lamp curve has its particular shape as current and voltage increase in the lamp.

(Total for Question 14 is 6 marks)

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15 A filament lamp draws 0.50 A when 2.0 V is applied and 1.50 A when 6.0 V is applied. Determine the resistance of the filament at the lower voltage and at the higher voltage, showing equation, substitution and final answers with units, and explain briefly why the resistances are different.

(Total for Question 15 is 3 marks)

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16 A resistor in a circuit carries 0.25 A when connected across a 9 V supply. Calculate the potential difference across the resistor if its resistance is doubled, giving the equation, substitution and the final answer with unit.

(Total for Question 16 is 3 marks)

Mark scheme · IG.P6 Current, Potential Difference, Resistance and Electrical Power

Question 1

- **B1** electric current is the flow of electric charge (through a conductor)
- **Answer: The flow of electric charge; charge carriers in a metal are electrons**

Question 2

- **B1** volt, symbol V
- **Answer: Volt, symbol V**

Question 3

- **B1** current is the same/same value at all points/components in a series circuit
- **Answer: The current is the same through every component and at every point in a series circuit**

Question 4

- **B1** the potential difference across each parallel branch is the same
- **Answer: The potential difference across each branch in a parallel circuit is the same**

Question 5

- **M1** writes V = I R or rearranges to R = V / I
- **M1** substitutes R = 12 / 0.30
- **A1** R = 40 ohm cao
- **Answer: 40 ohm**

Question 6

- **M1** for (a) adds series resistances R_total = 10 + 20
- **M1** for (b) uses I = V / R_total with V = 9 V and R_total = 30 ohm
- **A1** gives R_total = 30 ohm and I = 0.30 A cao
- **Answer: R_total = 30 ohm; I = 0.30 A**

Question 7

- **M1** uses I = V / R for branch B: I_B = 12 / 12
- **M1** finds I_A = 12 / 24 and adds currents for total I_total = I_A + I_B
- **A1** I_B = 1.0 A and I_total = 1.5 A cao
- **Answer: Current through B = 1.0 A; total current = 1.5 A**

Question 8

- **M1** uses conservation: I_total = sum of branch currents and forms I_third = 0.80 - 0.20 - 0.35
- **A1** gives I_third = 0.25 A and states current splits at junction so sum of branches equals total (cao)
- **Answer: Third branch current = 0.25 A; at a junction current splits so sum of branch currents equals total**

Question 9

- **M1** uses R = V / I and substitutes R = 3.0 / 0.40
- **M1** performs the division
- **A1** R = 7.5 ohm cao
- **Answer: 7.5 ohm**

Question 10

- **M1** uses P = I V and substitutes P = 2.0 x 6.0
- **M1** performs multiplication
- **A1** P = 12 W cao
- **Answer: 12 W**

Question 11

- **M1** uses $P = I^2 R$ and substitutes $P = (3.0)^2 \times 15$
- **M1** performs the calculation (9 x 15)
- **A1** P = 135 W cao
- **Answer: 135 W**

Question 12

- **M1** converts time to hours: 20 minutes = 20/60 = 1/3 hour and forms energy = power x time = 2.4 kW x 1/3 h
- **M1** calculates energy = 0.8 kWh
- **M1** calculates cost = 0.8 x 28 pence = 22.4 pence
- **A1** gives energy = 0.8 kWh and cost = 22.4 pence (or 22 pence to appropriate rounding) cao
- **Answer: Energy = 0.8 kWh; cost = 22.4 pence**

Question 13

- **M1** finds equivalent of parallel pair: 1/Rp = 1/12 + 1/24 so Rp = 8 ohm or uses $R_p = (12*24)/(12+24)$
- **M1** finds total R_total = 6 + 8 = 14 ohm
- **M1** uses I_total = V / R_total = 12 / 14
- **A1** gives I_total = 0.857 A (awrt 0.86 A) and current through 24 ohm as I_{24} = V_branch / 24 = 6.857 / 24 = 0.286 A (awrt 0.29 A) cao
- **Answer: Total current = 0.857 A (about 0.86 A); current through 24 ohm = 0.286 A (about 0.29 A)**

Question 14

- **B1** sketches straight line through origin for fixed resistor (I proportional to V) labelled 'fixed resistor' or 'ohmic conductor'
- **B1** sketches a curve for filament lamp that is shallower at higher V (non-linear), labelled 'filament lamp'
- **B1** states that filament resistance increases as current increases
- **B1** explains that current heating raises the filament temperature
- **B1** explains that higher temperature causes greater resistance due to increased vibrations of metal ions reducing electron flow
- **B1** links the increasing resistance to the curve bending so that I increases less for each increment of V at higher voltages

Question 15

- **M1** uses R = V / I for both cases and substitutes R1 = 2.0 / 0.50 and R2 = 6.0 / 1.50
- **M1** calculates R1 = 4.0 ohm and R2 = 4.0 ohm or performs both divisions
- **A1** states that resistances differ in general because filament heats up as current increases, increasing resistance; if calculations give same numerical value, note measurement rounding or that these points happen to give same ratio cao
- **Answer: R at 2.0 V = 4.0 ohm; R at 6.0 V = 4.0 ohm; resistances generally increase with temperature because filament heating increases resistance**

Question 16

- **M1** finds original R = V / I = 9 / 0.25 = 36 ohm and then doubled R_{new} = 72 ohm
- **M1** uses $V_{new} = I \times R_{new}$ with I = 0.25 A
- **A1** gives V_{new} = 18 V cao
- **Answer: 18 V**