AQA

A Level

A Level Physics

ELECTRICAL CIRCUITS: Electrical Quantities

Name:

M M E

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Total Marks: /30

1. This question is about the variation of quantities such as current, voltage and resistance in simple electrical circuits containing a variety of standard components.

Total for Question 1: 11

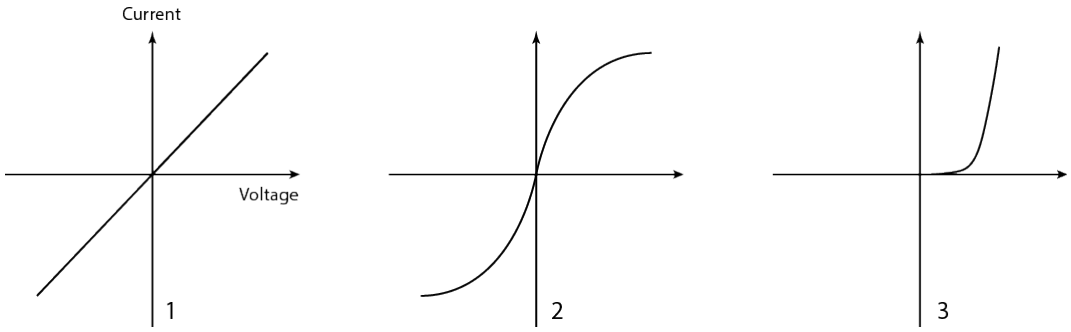

Figure 1: I-V characteristics for three different circuit components.

(a) State Ohm's Law. [1]

(b) Assign one of the following components to each of the characteristic graphs in Figure 1: filament lamp, semiconductor diode, resistor. [3]

(c) Why have these been plotted on graphs of current against potential difference rather than current against electromotive force? [1]

(d) For the diode, state the value of the resistance when a backward bias is applied. [1]

(e) Sketch the following graphs: [2]

i. Resistance against temperature for an ntc thermistor.

ii. Current against voltage for an ntc thermistor.

(f) The current in a filament is 8 A. In the time during which Patrick is using the lamp, 8×10^{22} electrons pass through a given point in the circuit. For how long has he been using the lamp? [3]

2. James unexpectedly finds an electrical circuit in his physics classroom. Immediately he starts recording the current. He notes that it decreases linearly from 10 A to zero over a time period of 30 s.

Total for Question 2: 5

(a) Plot a graph of current against time. [2]

(b) Calculate the charge that is transferred in this time. [2]

(c) If James had also been able to record a graph of charge (vertical axis) against time (horizontal axis), which of the following accurately describes what he would have seen? [1]

i. Linear increase.

ii. Non-linear increase.

iii. Linear decrease.

3. Frances is exploring the electrical properties of a piece of wire. She observes that:
(a) for a given current, doubling the length, L, of the wire doubles the potential difference (P.D.) and the resistance, R.
(b) for a given P.D., doubling the wire's diameter, d, causes R to decrease by a factor of 4.

Total for Question 3: 11

(a) On the basis of Frances' observations, which of these relationships is true: [3]

i. $R \propto A$ and $R \propto L$

ii. $R \propto 1/A$ and $R \propto 1/L$

iii. $R \propto 1/A$ and $R \propto L$

iv. $R \propto d^2$ and $R \propto L$

(b) Use this to define resistivity, ρ, in terms of d, R and L. [2]

(c) Figure 2 is a characteristic graph for a circuit component. Calculate the resistivity at the point for which the curves tangent has been drawn given that the component is cylindrical, has a length of 8 cm and has a radius of 1.5×10^{-5} m. [3]

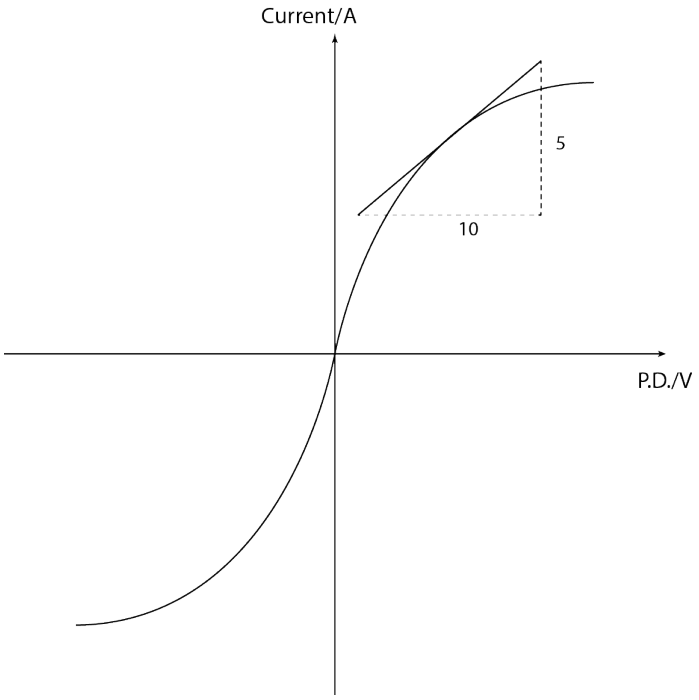

Figure 2: Characteristic graph for a particular circuit component.

(d) Explain how, using the characteristic, it is possible to deduce that, for this component, resistivity increases with temperature. [3]

4. This question is about superconductors.

Total for Question 4: 3

(a) A superconductor is a material whose resistance... [1]

i. ... increases to ∞ below a specific critical temperature.

ii. ... decreases to zero above a specific critical temperature.

iii. ... decreases to zero below a specific critical temperature.

(b) At present the highest known critical temperature is approximately -130°C. Give two examples that illustrate why a superconductor with a room temperature critical temperature would be particularly useful. [2]