

State Examination Commission – Physics Higher Level, 2011

Question 12c

List the factors that affect the heat produced in a current-carrying conductor. (7)

An electric cable consists of a single strand of insulated copper wire. The wire is of uniform cross-sectional area and is designed to carry a current of 20 A. To preserve the insulation, the maximum rate at which heat may be produced in the wire is 2.7 W per metre length.

Calculate

(i) the maximum resistance per metre of the wire

(ii) the minimum diameter of the wire.

(21)
(resistivity of copper = $1.7 \times 10^{-8} \text{ m}$)

List the factors that affect the heat produced in a current-carrying conductor. (7)

Resistance and current squared

An electric cable consists of a single strand of insulated copper wire. The wire is of uniform cross-sectional area and is designed to carry a current of 20 A. To preserve the insulation, the maximum rate at which heat may be produced in the wire is 2.7 W per metre length.

Calculate

(i) the maximum resistance per metre of the wire

$$P = RI^2 \Rightarrow R = P/I^2 = 2.7/20^2 = 0.00675 \Omega$$

(ii) the minimum diameter of the wire.

(21)

$$\begin{aligned} \rho &= R\pi d^2/4l \\ \Rightarrow d^2 &= 4\rho l/R\pi = (4 \times 1.7 \times 10^{-8} \times 1)/(0.00675 \times 3.14) = 3.2 \times 10^{-6} \\ \Rightarrow d &= 1.8 \times 10^{-3} \text{ m (1.8 mm)} \end{aligned}$$