

# PHYS143

## Physics for Engineers

### Tutorial - Chapter 27

#### Question 1

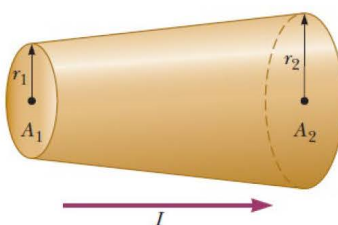
A metal wire has a resistance of  $10.0\ \Omega$  at a temperature of  $20.0^\circ\text{C}$ . If the same wire has a resistance of  $10.6\ \Omega$  at  $90.0^\circ\text{C}$ , what is the resistance of this wire when its temperature is  $-20.0^\circ\text{C}$ ?

#### Question 2

A 200-km-long high-voltage transmission line 2.00 cm in diameter carries a steady current of 1 000 A. If the conductor is copper with a free charge density of  $8.50 \times 10^{28}$  electrons per cubic meter, how many years does it take one electron to travel the full length of the cable?

#### Question 3

The Figure represents a section of a conductor of nonuniform diameter carrying a current of  $I = 5.00$  A. The radius of cross-section  $A_1$  is  $r_1 = 0.400$  cm. (a) What is the magnitude of the current density across  $A_1$ ? The radius  $r_2$  at  $A_2$  is larger than the radius  $r_1$  at  $A_1$ . (b) Is the current at  $A_2$  larger, smaller, or the same? (c) Is the current density at  $A_2$  larger, smaller, or the same? Assume  $A_2 = 4A_1$ . Specify the (d) radius, (e) current, and (f) current density at  $A_2$ .



#### Question 4

The electron beam emerging from a certain high energy electron accelerator has a circular cross section of radius 1.00 mm. (a) The beam current is  $8.00\ \mu\text{A}$ . Find the current density in the beam assuming it is uniform throughout. (b) The speed of the electrons is so close to the speed of light that their speed can be taken as 300 Mm/s with negligible error. Find the electron density in the beam. (c) Over what time interval does Avogadro's number of electrons emerge from the accelerator? Avogadro's number =  $6.02 \times 10^{23}\ e/mol$ .

#### Question 5

A 0.900-V potential difference is maintained across a 1.50-m length of tungsten wire that has a cross sectional area of  $0.600\ \text{mm}^2$ . What is the current in the wire? ( $\rho = 5.60 \times 10^{-8}\ \Omega \cdot m$ )

#### Question 6

An aluminum wire with a diameter of 0.100 mm has a uniform electric field of 0.200 V/m imposed along its entire length. The temperature of the wire is  $50.0^\circ\text{C}$ . Assume one free electron per atom. (a) Determine the resistivity of aluminum at this temperature. (b) What is the current density in the wire? (c) What is the total current in the wire? (d) What potential difference must exist between the ends of a 2.00-m length of the wire to produce the stated electric field? ( $\alpha = 3.9 \times 10^{-3}\ ^\circ\text{C}^{-1}$ ,  $\rho_0 = 2.82 \times 10^{-8}\ \Omega \cdot m$  at  $T_0 = 20\ ^\circ\text{C}$ ).



### Question 7

A coil of Nichrome wire is 25.0 m long. The wire has a diameter of 0.400 mm and is at 20.0°C. If it carries a current of 0.500 A, what are (a) the magnitude of the electric field in the wire and (b) the power delivered to it? (c) What If? If the temperature is increased to 340°C and the potential difference across the wire remains constant, what is the power delivered? ( $\rho = 1.50 \times 10^{-6} \Omega \cdot m$ ,  $\alpha = 0.4 \times 10^{-3} \text{ } ^\circ\text{C}^{-1}$ )