Problem 1

GPN2-L06

GP2-L26 P01: A beam contains 2.0×10^8 doubly charged positive ions per cubic centimeter, all of which are moving north with a speed of 1.0×10^5 m/s. What are the (a)magnitude and direction of the current density $\vec{J}$? (b)If the corss-sectional area is 20 cm^2, what is the total current? (02小題)

(a)magnitude of $\vec{J}$, $|\vec{J}|$=_____ A/m^2

01: **ANS:=6.4**

(b)current, i=_____ A

02: **ANS:=0.256**

Solution:

$$J = (2 \times 10^{14})(3.2 \times 10^{-19})(1.0 \times 10^5) = 6.4$$

$$i = JA = 6.4 \times (0.2)^2 = 0.256$$

Problem 2

How long does it take electrons to get from a car battery to the starting motor? Assume the current is 300 A and the electrons travel through a copper wire with cross-sectional area 0.21 cm^2 and length 0.85 m. The number of charge carriers per unit volume is 8.49×10^{28} m^{-3}. (01小題)

_____ s

03: **ANS:=8.1E2**

We use $v_d = J/ne = i/Ane$. Thus,

$$t = \frac{L}{v_d} = \frac{L}{i/Ane} = \frac{LAne}{i} = \frac{(0.85\,\text{m})\left(0.21\times10^{-14}\,\text{m}^2\right)\left(8.47\times10^{28}/\text{m}^3\right)\left(1.60\times10^{-19}\,\text{C}\right)}{300\,\text{A}}$$

$$= 8.1\times10^{2}\,\text{s} = 13\,\text{min}.$$

Problem 3

The magnitude $J(r)$ of the current density in a certain cylindrical wire is given as a function of radial distance from the center of the wire's cross section as $J(r) = Br$, where r is in meters, J is in amperes per square meter, and $B = 2.00 \times 10^5$ A/m^3. This function applies out to the wire's radius of 2.00 mm. How much current is contained within the width of a thin ring concentric with the wire if the ring has a radial width of 10.0 μm and is at a radial distance of 1.20 mm? (01小題)

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i=_____ A

04: **ANS:=1.81E-5**

Solution:

$$i = \int J dA = \int Br(2\pi r)dr \simeq Br(2\pi r)\Delta r = 2\pi B r^2 \Delta r = 18.1\mu\text{A}.$$

Problem 4

What is the resistivity of a wire of 1.0 mm diameter, 2.0 m length, and 50 mΩ resistance? (01小題)

_____ Ω ·m

05: **ANS:=2.0E-8**

The resistance of the wire is given by $R = \rho L / A$, where ρ is the resistivity of the material, L is the length of the wire, and A is its cross-sectional area. In this case,

$$A = \pi r^2 = \pi\left(0.50\times10^{-3}\ \text{m}\right)^2 = 7.85\times10^{-7}\ \text{m}^2.$$

Thus,

$$\rho = \frac{RA}{L} = \frac{\left(50\times10^{-3}\,\Omega\right)\left(7.85\times10^{-7}\,\text{m}^2\right)}{2.0\,\text{m}} = 2.0\times10^{-8}\,\Omega\cdot\text{m}.$$

Problem 5

Two conductors are made of the same material and have the same length. Conductor A is a solid wire of diameter 1.0 mm. Conductor B is a hollow tube of outside diameter 2.0 mm and inside diameter 1.0 mm. What is the resistance ratio R_A/R_B, measured between their ends? (01小題)

R_A / R_B=_____

06: **ANS:=3.0**

The resistance of conductor A is given by

$$R_A = \frac{\rho L}{\pi r_A^2},$$

where r_A is the radius of the conductor. If r_o is the outside diameter of conductor B and r_I is its inside diameter, then its cross-sectional area is $\pi(r_o^2 - r_I^2)$, and its resistance is

$$R_B = \frac{\rho L}{\pi\left(r_o^2 - r_i^2\right)}.$$

The ratio is

$$\frac{R_A}{R_B} = \frac{r_o^2 - r_i^2}{r_A^2} = \frac{(1.0\,\text{mm})^2 - (0.50\,\text{mm})^2}{(0.50\,\text{mm})^2} = 3.0.$$

Problem 6

A potential difference of 3.00 nV is set up across a 2.00 cm length of copper wire that has a radius of 2.00 mm. How much charge drifts through a cross section in 3.00 ms? (01小題)

_____ C

07: **ANS:=3.35E-7**

First we find the resistance of the copper wire to be

$$R=\frac{\rho L}{A}=\frac{\left(1.69\times10^{-8}\ \Omega\cdot\mathrm{m}\right)\left(0.020\ \mathrm{m}\right)}{\pi(2.0\times10^{-3}\ \mathrm{m})^{2}}=2.69\times10^{-5}\ \Omega .$$

With potential difference $V=3.00\ \mathrm{nV}$, the current flowing through the wire is

$$i=\frac{V}{R}=\frac{3.00\times10^{-9}\mathrm{V}}{2.69\times10^{-5}\Omega}=1.115\times10^{-4}\mathrm{A} .$$

Therefore, in 3.00 ms, the amount of charge drifting through a cross section is

$$\Delta Q=i\Delta t=(1.115\times10^{-4}\mathrm{A})(3.00\times10^{-3}\ \mathrm{s})=3.35\times10^{-7}\mathrm{C} .$$

Problem 7

An electrical cable consists of 125 strands of fine wire, each having 2.65 $\mu\,\Omega$ resistance.The same potential difference is applied between the ends of all the strands and results in a total current of 0.750 A. (a) What is the current in each strand? (b) What is the applied potential difference? (c) What is the resistance of the cable? (03小題)

(a) _____ A

08: **ANS:=6E-3**

(b) _____ V

09: **ANS:=1.59E-8**

(c) _____ Ω

10: **ANS:=2.12E-8**

(a) The current in each strand is $i = 0.750\ \text{A}/125 = 6.00 \times 10^{-3}\ \text{A}$.

(b) The potential difference is $V = iR = (6.00 \times 10^{-3}\ \text{A})\,(2.65 \times 10^{-6}\ \Omega) = 1.59 \times 10^{-8}\ \text{V}$.

(c) The resistance is $R_{\text{total}} = 2.65 \times 10^{-6}\ \Omega/125 = 2.12 \times 10^{-8}\ \Omega$.

Problem 8

A 1250 W radiant heater is constructed to operate at 115 V. (a) What is the current in the heater when the unit is operating? (b) What is the resistance of the heating coil? (c) How much thermal energy is produced in 1.0 h? (03小題)

(a) _____ A

11: **ANS:=10.9**

(b) _____ Ω

12: **ANS:=10.6**

(c) _____ J

13: **ANS:=4.50E6**

(a) The power dissipated, the current in the heater, and the potential difference across the heater are related by $P = iV$. Therefore,

$$i = \frac{P}{V} = \frac{1250\ \text{W}}{115\ \text{V}} = 10.9\ \text{A}.$$

(b) Ohm's law states $V = iR$, where R is the resistance of the heater. Thus,

$$R = \frac{V}{i} = \frac{115\ \text{V}}{10.9\ \text{A}} = 10.6\ \Omega.$$

(c) The thermal energy E generated by the heater in time $t = 1.0\ \text{h} = 3600\ \text{s}$ is

$$E = Pt = (1250\,\text{W})(3600\,\text{s}) = 4.50\times10^{6}\ \text{J}.$$

Problem 9

A 120 V potential difference is applied to a space heater that dissipates 500 W during operation. (a) What is its resistance during operation? (b) At what rate do electrons flow through any cross section of the heater element? (02小題)

(a) _____ Ω

14: **ANS:=10.9**

(b) _____ 1/s

15: **ANS:=2.60E19**

(a) From $P = V^2/R$ we find $R = V^2/P = (120\ \text{V})^2/500\ \text{W} = 28.8\ \Omega$.

(b) Since $i = P/V$, the rate of electron transport is

$$\frac{i}{e} = \frac{P}{eV} = \frac{500\ \text{W}}{(1.60\times10^{-19}\ \text{C})(120\ \text{V})} = 2.60\times10^{19}\ /\ \text{s}.$$

__D__ 16 可嘗試次數= 1 分數= 2 電流是測量： (A)使得電荷移動通過一個點的力量 (B)電荷移動通過一個點的阻力 (C)移動電荷通過一個點的能量 (D)每單位時間通過一個點的電荷量 (E)電荷移動通過一個點的速度

__E__ 17 可嘗試次數= 1 分數= 2 一個60瓦的燈泡載有0.5安培的電流。在一小時內通過它的總電量為：Q = _____ C (A)120 (B)3600 (C)300 (D)2400 (E)1800

__B__ 18 可嘗試次數= 1 分數= 2 一個10歐姆的電阻具有恆定電流。如果1200庫倫的電荷在4分鐘內流過，電流的值是多少？i= ____ A (A)3.0 (B)5 (C)11 (D)15 (E)20

__B__ 19 可嘗試次數= 1 分數= 2 由不同材料製成的兩根導線具有相同的均勻電流密度。只在 (A)它們的長度是相同的 (B)它們的橫截面積是相同的 (C)它們的長度和橫截面積都相同 (D)它們之間的電位差是相同的 (E)它們的電場是相同的

__B__ 20 可嘗試次數= 1 分數= 2 在攜帶電流的導體中，我們預計電子漂移速度為： (A)比平均電子速度大得多 (B)遠低於平均電子速度 (C)大約與平均電子速度相同 (D)低於低溫時的電子速度並且高於高溫時的電子速度 (E)低於高溫時的電子速度並且低於低溫時的電子速度

__B__ 21 可嘗試次數= 1 分數= 2 長度為150 m，半徑為0.15 mm的導線載有均勻電流密度為 $2.8 \times 10^7 A/m^2$的電流。電流i = ____ A (A)0.63 (B)2.0 (C)5.9 (D)296 (E)400

Solution:

$(2.8 \times 10^7 A/m^2) * (\pi(0.15mm)^2) = 2A$

__C__ 22 可嘗試次數= 1 分數= 2 沒有施加電位差時，導體中的電流為零，因為： (A)電子不移動 (B)電子運動速度不夠快 (C)對於具有給定速度的每個電子，都有另一個具有相等幅度和相反方向的速度 (D)相同數量的電子和質子一起移動 (E)否則歐姆定律無效

__B__ 23 可嘗試次數= 1 分數= 2 電流密度所滿足的公式? (A)nq^2v_d (B)nqv_d (C)n^2qv_d (D)nv_d/q (E)qv_d/n

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__B__ 24 可嘗試次數= 1 分數= 2 傳導電流的導體其電阻的公式? (A)ρlA (B)$\rho\frac{l}{A}$ (C)$\rho\frac{A}{l}$ (D)$\rho\frac{l^2}{A}$ (E)$\rho\frac{n}{A}$

__A__ 25 可嘗試次數= 1 分數= 2　特定的X射線管在80 kV的電壓下需要7 mA的電流。能量耗散率（以瓦特計）為：
(A)560　(B)5600　(C)26　(D)11.4　(E)87.5

__E__ 26 可嘗試次數= 1 分數= 2　使用6V電源將0.3A的電流通過燈2分鐘。 這種燈在2分鐘內消耗的能量為：E = ____ J
(A)1.8　(B)12　(C)20　(D)36　(E)216

__D__ 27 可嘗試次數= 1 分數= 2　某個電阻接到3 V電位差時的消耗功率為0.5 W， 當連接到1 V電位差時，該電阻消耗功率為____ W？ (A)0.5　(B)0.167　(C)1.5　(D)0.056　(E)以上皆非

__C__ 28 可嘗試次數= 1 分數= 2　電熨斗標記為“120伏，600瓦”。 在正常使用中，其中的電流是多少安培： (A)2
(B)4　(C)5　(D)7.2　(E)0.2

Solution:

$$\frac{600W}{120V} = 5A$$

__A__ 29 可嘗試次數= 1 分數= 2　下列哪一個公式是導體的漂移速度必須滿足的公式？ (A)$v_d = \frac{e\tau E}{m}$　(B)$v_d = \frac{ne^2\tau}{m}$　(C)$v_d = \frac{en^2E}{m}$　(D)$v_d = \frac{n\tau E}{m}$　(E)$v_d = \frac{m\tau E}{e}$　(F)$v_d = \frac{me\tau E}{n}$

__B__ 30 可嘗試次數= 1 分數= 2　導體的電導率滿足的公式？ (A)$\sigma = \frac{ne\tau}{m}$　(B)$\sigma = \frac{ne^2\tau}{m}$　(C)$\sigma = \frac{m}{ne^2\tau}$　(D)$\sigma = \frac{me^2\tau}{n}$　(E)$\sigma = \frac{ne^2E}{m}$