Q1.

A string, of length 0.75 m and fixed at both ends, is vibrating in its fundamental mode. The maximum transverse speed and magnitude of maximum transverse acceleration of a point on the string are 4.2 m/s and 840 m/s^2, respectively. What is the speed of waves on the string?

A) 48 m/s
B) 17 m/s
C) 22 m/s
D) 66 m/s
E) 53 m/s

Ans:

$$v = \lambda f \; but \; \lambda = 2 \times L = 2 \times 0.75 = 1.5\, m$$

$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\left|\frac{a_{max}}{u_{max}}\right| = \frac{84.0}{4.2} \times \frac{1}{2\pi} = 31.83\, Hz$$

$$v = \lambda f = 1.5 \times 31.83 = 47.8\, m/s$$

Q2.

A sound wave is travelling in air. The intensity and frequency of the wave are both doubled. What is the ratio of the new pressure amplitude to the initial pressure amplitude?

A) $\sqrt{2}$
B) $1/\sqrt{2}$
C) 1
D) 2
E) 1/2

Ans:

$$P_{max}^2 = 2I\rho v = 2I\rho\lambda f \;\; but \; v = \lambda_1 f_1 = \lambda_2 f_2; \; f_2 = 2f_1 \; then \; \lambda_2 = \frac{\lambda_1}{2}$$

$$P_{1-max}^2 = 2I_1\rho\lambda_1 f_1$$

$$P_{2-max}^2 = 2I_2\rho\cancel{2}\lambda_1\frac{f_1}{\cancel{2}} = 2 \times 2I_1\rho\lambda_1 f_1 = 4I_1\rho\lambda_1 f_1$$

$$\frac{P_{2-max}^2}{P_{1-max}^2} = \frac{\overset{2}{\cancel{4}}\cancel{I_1\rho\lambda_1 f_1}}{\cancel{2}\cancel{I_1\lambda_1 f_1}} = 2 \Rightarrow \frac{P_{2-max}}{P_{1-max}} = \sqrt{2}$$

Q3.

A copper container with a mass of 0.500 kg contains 0.180 kg of water, and both are at a temperature of 20.0 oC. A 0.250 kg block of iron at 85.0 oC is dropped into the container. Find the final equilibrium temperature of the system, assuming no heat loss or gain to the surroundings. [specific heat (J/kg.K): copper = 390, iron = 470]

A) 27.2 ^{o}C
B) 33.1 ^{o}C
C) 52.5 ^{o}C
D) 13.7 ^{o}C
E) 95.3 ^{o}C

Ans:

$$\Delta Q_{+} = \Delta Q_{-}$$

$$(m_{cu} \times c_{cu} + m_{water} \times c_{water})(T_f - 20) = m_{iron} \times c_{iron} \times (85 - T_f)$$

$$T_f = \frac{85 \times m_{iron} \times c_{iron} + (m_{cu} \times c_{cu} + m_{water} \times c_{water}) \times 20}{m_{cu} \times c_{cu} + m_{water} \times c_{water} + m_{iron} \times c_{iron}}$$

$$T_f = \frac{85 \times 0.25 \times 470 + (0.5 \times 390 + 0.18 \times 4190) \times 20}{0.5 \times 390 + 0.18 \times 4190 + 0.25 \times 470} = 27.16℃ = 27.2℃$$

Q4.

An ideal diatomic gas is initially at 27 oC and a pressure of 1.0 atm. It is compressed adiabatically to one fifth of its initial volume. What is the final pressure (in atm) of the gas?

A) 9.5
B) 2.5
C) 5. 0
D) 2.9
E) 15

Ans:

$$P_i V_i^{\gamma} = P_f V_f^{\gamma} \Rightarrow P_f = P_i \left(\frac{V_i}{V_f}\right)^{\gamma} = 1 \left(\frac{5}{1}\right)^{1.4} = 9.5\ atm$$

Q5.

A block of ice of mass 1.00 kg at 0 ^{o}C is heated until it becomes water at 100 ^{o}C. Calculate the entropy change of the ice until it becomes water at 100 ^{o}C.

A) 2.53 kJ/K
B) 1.57 kJ/K
C) 1.22 kJ/K
D) 2.31 kJ/K
E) 1.47 kJ/K

Ans:

$$\Delta S = \frac{m_{ice} \times L_f}{273} + m_{water} \times c_{water} \times ln\left(\frac{373}{273}\right)$$

$$= \frac{1 \times 333 \times 10^3}{273} + 1 \times 4190 \times l_n\left(\frac{373}{273}\right) = 2529.4\, J/K$$

$$\Delta S = 2.53 \times 10^3\, J/K$$

Q6.

Three point charges are arranged as shown in **FIGURE 1**. Charges Q_1 and Q_3 are positive, charge Q_2 is negative, and the magnitudes of Q_1 and Q_2 are equal. What is the direction of the net electrostatic force on Q_3 due to Q_1 and Q_2?

A) Negative y direction
B) Positive y direction
C) Positive x direction
D) Negative x direction
E) The net force on Q3 is zero

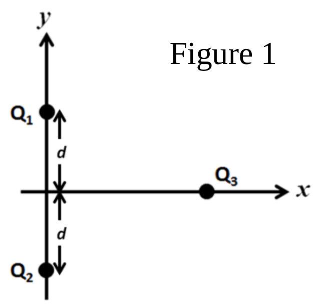


Figure 1

Ans:

A

Q7.

Two point charges, 2.50 μC and – 3.50 μC, are placed on the *x* axis, as shown in **FIGURE 2,** one at the origin and the other at *x* = 0.600 m, respectively. Find the coordinate of a point on the *x* axis where the electric field due to these two charges is zero.

A) – 3.27 m
B) + 3.27 m
C) + 0.280 m
D) + 0.880 m
E) – 0.880 m

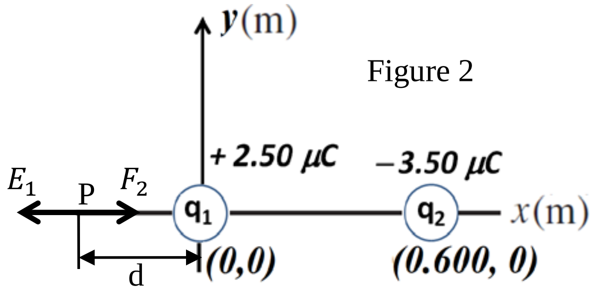


Figure 2

Ans:

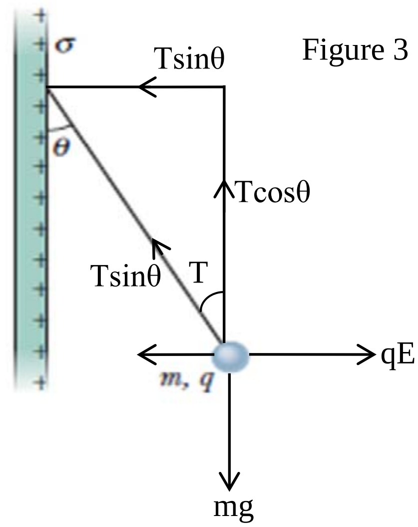
$At\ P\ |E_1| = |E_2|$

$$\left|\frac{kq_1}{d^2}\right| = \left|\frac{kq_2}{(0.6+d)^2}\right| \Rightarrow \frac{\sqrt{|q_1|}}{d} = \frac{\sqrt{|q_2|}}{0.6+d} \Rightarrow \frac{0.6+d}{d} = \sqrt{\frac{|q_2|}{|q_1|}} = \sqrt{\frac{3.5}{2.5}} = 1.18$$

$$\frac{0.6+d}{d} = 1.18 \implies (1.18-1)d = 0.6 \Rightarrow d = \frac{0.6}{0.18} = 3.27\ m = -3.27\ m$$

Q8.

A small sphere with a mass of 4.00 × 10^{-6} kg and carrying a charge of 50.0 nC hangs from a string near a very large, charged insulating sheet, as shown in **FIGURE 3**. The charge density on the surface of the sheet is 2.50 nC/m^2. What is the angle (θ) which the string makes with the vertical?



A) 10.2°
B) 19.8°
C) 70.2°
D) 79.8°
E) 45.2°

Ans:

$$T sin\theta = qE$$

$$T cos\theta = mg$$

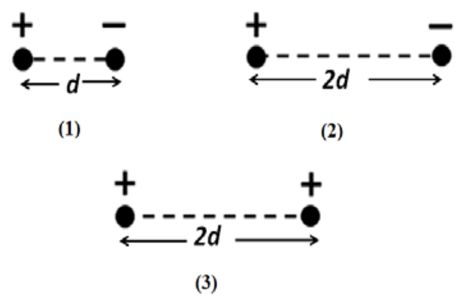
$$Tan\theta = \frac{qE}{mg} = \frac{q \times \frac{\sigma}{2\varepsilon_0}}{mg}$$

$$\theta = \tan^{-1}\left(\frac{q \times \frac{\sigma}{2\varepsilon_0}}{mg}\right) = \tan^{-1}\left(\frac{50 \times 10^{-9} \times 2.50 \times 10^{-9}}{4 \times 10^{-6} \times 9.8 \times 2 \times 8.85 \times 10^{-12}}\right) = 10.2°$$

Q9.

Two point charges, carrying equal magnitude of charge, are arranged in three configurations as shown in **FIGURE 4**. Rank the configurations according to the work done by an external agent to separate the charges to infinity, **greatest** first.

Figure 4



A) 1, 2, 3
B) 3, 1, 2
C) 3, 2, 1
D) 1, 3, 2
E) 2, 3, 1

Ans:

$$W_{ext} = -U_i = -\frac{kq_1q_2}{d}$$

$$W_{1-ext} = +\frac{kq^2}{d};\ W_{2-ext} = +\frac{kq^2}{2d};\ W_{3-ext} = -\frac{kq^2}{2d}$$

Q10.

The electric potential at points in a xy plane is given by V = 1.5 x^2 − 3.5 y^2 (where V is in volts and x and y are in meters). In unit-vector notation, what is the electric field (in V/m) at the point (2.0, 3.0) m?

A) $-6.0\hat{i} + 21\hat{j}$
B) $+6.0\hat{i} - 21\hat{j}$
C) $-6.0\hat{i} - 21\hat{j}$
D) $+6.0\hat{i} + 21\hat{j}$
E) $-21\hat{i} + 6.0\hat{j}$

Ans:

$$\vec{E}\,(2,3) = E_x\vec{\imath} + E_y\vec{\jmath}$$

$$E_x = -\frac{\partial V}{\partial x} = -3x;\ E_y = -\frac{\partial V}{\partial y} = +7y$$

$$E_x\,(x = 2) = -6\,;\ E_y\,(y = 3) = +21$$

$$\vec{E} = E_x\vec{\imath} + E_y\vec{\jmath} = -6\vec{\imath} + 21\vec{\jmath}$$

Q11.

In **FIGURE 5**, potential difference across 5.0 µF capacitor is V_{ab} = 28 V. What is the charge on the 11 µF capacitor?

A) 77 µC
B) 140 µC
C) 63 µC
D) 54 µC
E) 86 µC

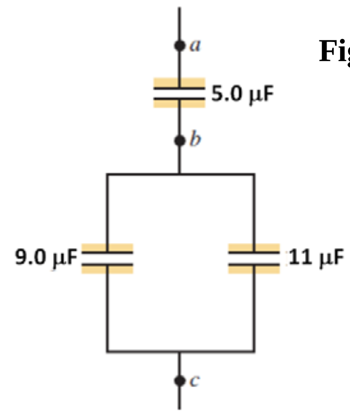


Figure 5

Ans:

$$q_{5\mu F} = C_{5\mu F} \times V = 5 \times 10^{-6} \times 28 = 140\mu F$$

$$C_{9-11} = C_{9\mu F} + C_{11\mu F} = (9 + 11)\mu F = 20\mu F$$

$$V_{11} = \frac{q_{5\mu F}}{C_{9-11}} = \frac{140 \times 10^{-6}}{20 \times 10^{-6}} = 7V$$

$$q_{11} = C_{11} \times V_{11} = 11 \times 10^{-6} \times 7 = 77\mu C$$

Q12.

What is the magnitude of the electric field in a copper wire, of radius 1.02 mm, that is needed to cause a 2.75 A current to flow? Copper has a resistivity of 1.72 × 10^{-8} Ω.m.

A) 0.0145 V/m
B) 0.317 V/m
C) 0.0464 V/m
D) 0.0547 V/m
E) 0.108 V/m

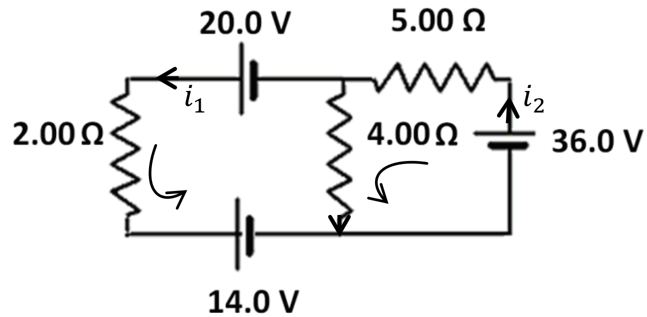
Ans:

$$\frac{R}{l} = \frac{\rho}{A}; \; E = \frac{V}{l} = \frac{iR}{l} = i\left(\frac{\rho}{A}\right) = \frac{i \times \rho}{\pi r^2} = \frac{2.75 \times 1.72 \times 10^{-8}}{\pi \times (1.020 \times 10^{-3})^2} = 0.0145\, V/m$$

Q13.

Find the current through 4.00 Ω resistor in the circuit, shown in **FIGURE 6** (Note that the emfs are ideal).

Figure 6



A) 1.11 A
B) 5.21 A
C) 6.32 A
D) 0.75 A
E) 2.67 A

Ans:

$20 - 2i_1 - 14 + 4i_3 = 0$

$i_1 = 3 + 2i_3 \ \rightarrow (1)$

$36 - 5i_2 - 4i_3 = 0$

$5i_2 = 36 - 4i_3$

$i_2 = 7.2 - 0.8i_3 \ \rightarrow (2)$

$i_2 = i_1 + i_3$

$From\ (2)\ 7.2 - 0.8i_3 = i_2 = i_1 + i_3 \Rightarrow 7.2 - 0.8i_3 = 3 + 2i_3 + i_3 = 3 + 3i_3$

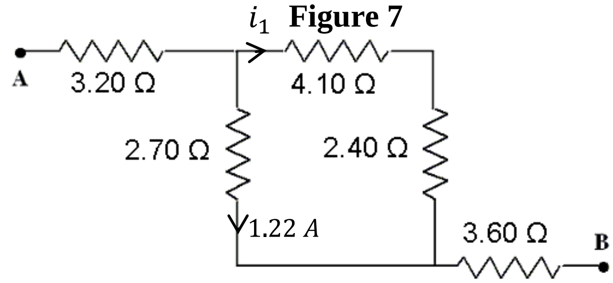
$3i + 0.8i_3 = 7.2 - 3 = 4.2$

$i_3 = \frac{4.2}{3.8} = 1.11\ A$

Q14.

Five resistors are connected as shown in **FIGURE 7**. What is the potential difference $V_A - V_B$, if the current through the 2.70 Ω resistor is 1.22 A?

Figure 7



A) 15.0 V
B) 19.0 V
C) 10.7 V
D) 22.2 V
E) 5.54 V

Ans:

$V_A - V_B = (i_1 + 1.22)R_{eq}$

$i_1 = \frac{2.7 \times 1.22}{6.5} = 0.51\ A$

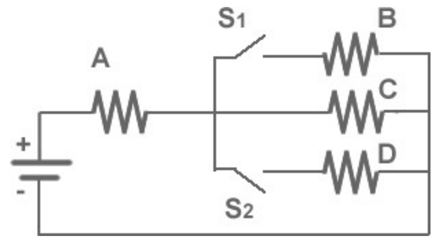
$R_{eq} = 3.20 + \frac{2.70 \times 6.50}{2.70 + 6.50} + 3.60 = 8.71\ \Omega$

$V_A - V_B = (i_1 + 1.22)R_{eq} = (0.51 + 1.22) \times 8.71 = 15.0\ V$

Q15.

In **FIGURE 8,** four identical resistors are connected to an ideal battery. S_1 and S_2 are switches. Which of the following actions would result in the minimum power dissipated in resistor A?

Figure 8



A) keeping both switches open
B) closing S_1 only
C) closing both switches
D) closing S_2 only
E) The answer depends on the value of the emf of the battery

Ans:

$$P_{min} = \frac{V^2}{R_{max}}$$

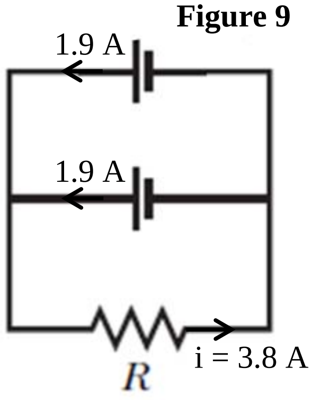
R_{max} *for both swithces open only* !

$$R_{max} = R + R = 2R$$

Q16.

Each of the two real batteries in **FIGURE 9** has an emf of 20.0 V and an internal resistance r = 0.500 Ω. What is the potential difference across each battery if R= 5.00 Ω and the current in resistor R is 3.80 A?

Figure 9



A) 19.1 V
B) 10.1 V
C) 5.50 V
D) 9.55 V
E) 20.0 V

Ans:

$$V = \varepsilon - ir$$

$$= 20 - 1.9 \times 0.5 = 20 - 0.95 = 19.05 = 19.1\ V$$

Q17.

A 200 μF capacitor, that is initially uncharged is connected in series with a 6000 kΩ resistor and an emf source with **ε** = 200 V and negligible resistance. The circuit is closed at t = 0. What is the rate at which electrical energy is being dissipated in the resistor at t = 1.00 s?

A) 1.26 W
B) 2.22 W
C) 0.500 W
D) 3.42 W
E) 5.11 W

Ans:

$$P = i^2(t)\cdot R \;\; ; i(t) = \frac{\varepsilon}{R}e^{-t/RC}$$

$$i(t = 1s) = \frac{200}{6000}e^{-1/(6000\times 200\times 10^{-6})} = \frac{1}{30}e^{(-1/1.2)} = \frac{1}{30}e^{-0.833} = 0.0145\,A$$

30

$$P = i^2(t)\cdot R = (0.0145)^2 \times 6000 = 1.26\,W$$

Q18.

An electron has a velocity of 6.0×10^6 m/s in the positive x direction at a point where the magnetic field has the components B_x = 3.0 T, B_y = 1.5 T, and B_z = 2.0 T. What is the magnitude of the acceleration of the electron at this point? (Ignore gravity)

A) 2.6×10^{18} m/s^2
B) 1.6×10^{18} m/s^2
C) 2.1×10^{18} m/s^2
D) 3.2×10^{18} m/s^2
E) 3.7×10^{18} m/s^2

Ans:

$$\vec{a} = \frac{F_B}{m_e} = \frac{q_e(v \times B)}{m_e} = -1.6 \times 10^{-19}\frac{\left(6.0 \times 10^6 \vec{\imath} \times \left(3\vec{\imath} + 1.5\vec{\jmath} + 2\vec{k}\right)\right)}{9.1 \times 10^{-31}}$$

$$= \frac{-1.6 \times 10^{-19} \times 6 \times 10^6}{9.1 \times 10^{-31}}\left(1.5(\vec{\imath} \times \vec{\jmath}) + 2\left(\vec{\imath} \times \vec{k}\right)\right) = -1.05 \times 10^{18}\left(1.5\vec{k} - 2\vec{\jmath}\right)$$

$$|\vec{a}| = 1.05 \times 10^{18} \times \sqrt{6.25} = 2.6 \times 10^{18}\ m/s^2$$

Q19.

In **FIGURE 10**, current i = 50.0 mA is set up in a loop having two radial lengths and two semicircles of radii a =10.0 cm and b =20.0 cm with a common center P. What is the magnitude of the loop's magnetic dipole moment?

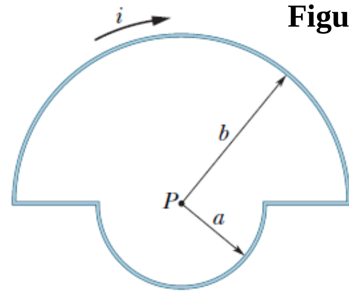


Figure 10

A) 3.93×10^{-3} A.m^2
B) 1.16×10^{-2} A.m^2
C) 5.11×10^{-3} A.m^2
D) 4.22×10^{-3} A.m^2
E) 2.32×10^{-3} A.m^2

Ans:

$$\mu = NiA$$

$$\mu = i\pi\frac{(r_a^2 + r_b^2)}{2}$$

$$= 50\times10^{-3}\pi^2\frac{(0.1^2 + 0.2^2)}{2}$$

$$= 3.93\times10^{-3}\ A\cdot m^2$$

Q20.

A particle ($m = 3.3\times10^{-27}$ kg, $q = 1.6\times10^{-19}$ C) is accelerated from rest through a 10 kV potential difference and then moves perpendicular to a uniform magnetic field with magnitude B = 1.2 T. What is the radius of the resulting circular path?

A) 17 mm
B) 19 mm
C) 20 mm
D) 10 mm
E) 9.0 mm

Ans:

$$F_B = qvB = F_R = \frac{mv^2}{R} \Rightarrow R = \frac{mv}{qB}\ but\ qV = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{\frac{2qV}{m}}$$

$$R = \frac{mv}{qB} = \frac{m}{qB}\times\sqrt{\frac{2qV}{m}}$$

$$= \frac{1}{B}\sqrt{\frac{2mV}{q}} = \frac{1}{1.2}\sqrt{\frac{2\times3.3\times10^{-27}\times10000}{1.6\times10^{-19}}}$$

$$R = 0.017\ m = 17\ mm$$

Q21.

A 5.0 A current is flowing in a 5.0 m long wire which is aligned along the direction of the unit vector $0.60\hat{i} + 0.80\hat{j}$. The wire is placed in a region where the magnetic field is given by $\vec{B} = 0.80\hat{k}$ (T). The magnitude of the magnetic force on the wire is:

A) 20 N
B) 23 N
C) 59 N
D) 17 N
E) 40 N

Ans:

$$\frac{F_B}{l} = i\left(\vec{l} \times \vec{B}\right) \Rightarrow F_B = li\left(\vec{l} \times \vec{B}\right) = 5 \times 5 \times (0.6\vec{i} + 0.8\vec{j}) \times 0.8\vec{k}$$

$$\vec{F}_B = 25\left(0.6 \times 0.8\left(\vec{i} \times \vec{k}\right) + 0.8 \times 0.8\left(\vec{j} \times \vec{k}\right)\right) = 25\left(0.48(-\vec{j}) + 0.64(\vec{i})\right)$$

$$= 25 \times 0.64\,\vec{i} - 25 \times 0.48\,\vec{j} = 16\vec{i} - 12\vec{j}$$

$$|F_B| = \sqrt{16^2 + 12^2} = 20\ N$$

Q22.

An electron moving with a velocity $\vec{v} = 5.0 \times 10^7$ m/s $\hat{i}$ enters a region of space where perpendicular electric and magnetic fields are present. The electric field is $\vec{E} = -1.0\times10^4\ \hat{j}$. What magnetic field will allow the electron to pass through the region, undeflected?

A) $\vec{B} = -\left(2.0\times10^{-4}\text{T}\right)\hat{k}$
B) $\vec{B} = +\left(2.0\times10^{-4}\text{T}\right)\hat{j}$
C) $\vec{B} = -\left(2.0\times10^{-4}\text{T}\right)\hat{i}$
D) $\vec{B} = +\left(2.0\times10^{-4}\text{T}\right)\hat{k}$
E) $\vec{B} = +\left(5.0\times10^{-4}\text{T}\right)\hat{k}$

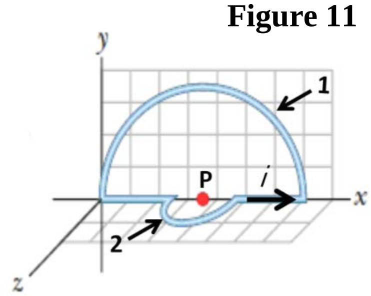
Ans:

A

Q23.

The loop shown in **FIGURE 11** consists of two semicircles 1 and 2 (with the same center) and two radial lengths. The semicircle 1 lies in the xy plane and has a radius of 10.0 cm, and the semicircle 2 lies in the xz plane and has a radius of 4.00 cm. If the current *i* in the loop is 0.500 A, what is magnitude of the magnetic field at point P, located at the center of the loops?

Figure 11



A) 4.23 μT
B) 3.71 μT
C) 1.37 μT
D) 2.92 μT
E) 6.45 μT

Ans:

$$B_{net} = B_2\vec{j} + B_1\vec{k}$$

$$B_1 = \frac{\mu_{0i}}{4R_1} = \frac{4\pi \times 10^{-7} \times 0.5}{4 \times 0.1} = 15.71 \times 10^{-7} T$$

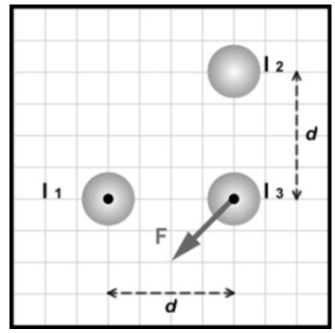
$$B_2 = \frac{\mu_{0i}}{4R_1} = \frac{4\pi \times 10^{-7} \times 0.5}{4 \times 0.04} = 39.27 \times 10^{-7} T$$

$$|B_{net}| = \sqrt{B_1^2 + B_2^2} = \sqrt{(15.71)^2 + (39.27)^2} \times 10^{-7} T = 4.23 \mu T$$

Q24.

FIGURE 12 shows three long, parallel, current-carrying wires carrying equal magnitude of current. The directions of currents I_1 and I_3 are out of page. The arrow labeled **F** represents the magnetic force per unit length acting on current I_3 due to the other two wires and is given by $\mathbf{F} = (-0.220\ \hat{i} - 0.220\ \hat{j})$ (N/m) . What are the magnitude and direction of the current I_2, if the distance d = 1.00 mm?

Figure 12



A) 33.2 A, into the page
B) 33.2 A, out of the page
C) 22.1 A, into the page
D) 22.1A, out of the page
E) 11.4 A, out of the page

Ans:

$$F = -0.22\vec{i} - 0.22\vec{j} = F_{13}\vec{i} - F_{23}\vec{j}$$

$$|F_{23}| = 0.22 = \frac{\mu_0 i^2}{2\pi d} = \frac{\overset{2}{\cancel{4\pi}} \times 10^{-7}}{\cancel{2\pi}} \times \frac{i^2}{d}$$

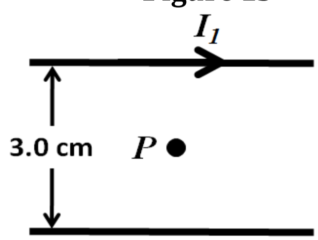
$$i = \sqrt{\frac{0.22 \times d}{2 \times 10^{-7}}} = \sqrt{\frac{0.22 \times 10^{-3}}{2 \times 10^{-7}}} = 33.2 \text{ A into the page}$$

Q25.

Two infinitely long current-carrying wires are parallel to each other, as shown in **FIGURE 13**. The magnetic field at point P, which is midway between them, is 0.12 mT out of the page. If the current I_1 = 12 A, what is magnitude and direction of I_2?

A) 21 A, to the right
B) 21 A, to the left
C) 3.0 A, to the right
D) 3.0 A, to the left
E) 15 A, to the left

Figure 13



Ans:

$$B_{net} = -0.12 \times 10^{-3} T = B_1 + B_2$$

$$B_2 = -0.12 \times 10^{-3} - B_1$$

$$B_1 = \frac{\mu_0 i_1}{2\pi d} = \frac{\overset{2}{\cancel{4}}\cancel{\pi} \times 10^{-7} \times 12}{\cancel{2}\cancel{\pi} \times 0.015} = 16 \times 10^{-5}\, T$$

$$B_2 = 0.12 \times 10^{-3} + 0.16 \times 10^{-3} = 0.28 \times 10^{-3}$$

$$B_{12} = \frac{\mu_0 i_2}{2\pi d} \Rightarrow i_2 = \frac{2\pi d B_2}{\mu_0} = \frac{\cancel{2}\cancel{\pi} d B_2}{\underset{2}{\cancel{4}}\cancel{\pi} \times 10^{-7}}$$

$$i_2 = \frac{dB_2}{2 \times 10^{-7}} = \frac{0.015 \times 0.28 \times 10^{-3}}{2 \times 10^{-7}} = 21A$$

Q26.

Which of the solenoids described below has the **greatest** magnetic field along its axis?

A) a solenoid of length 2L, with 2N turns and a current 2I
B) a solenoid of length L, with N turns and a current I
C) a solenoid of length L, with N/2 turns and a current I
D) a solenoid of length L/2, with N/2 turns and a current I
E) a solenoid of length 2L, with N turns and a current I/2

Ans:

A

Q27.

A cylindrical conductor of radius R = 2.50 cm carries a 2.50 A current along its length. This current is uniformly distributed throughout the cross sectional area of the conductor. Find the distances from the center of the wire (inside and outside the wire) at which the value of magnitude of magnetic field equals half of its maximum value.

A) 1.25 cm, 5.00 cm
B) 1.50 cm, 6.50 cm
C) 1.00 cm, 4.00 cm
D) 1.25 cm, 7.50 cm
E) 1.50 cm, 3.00 cm

Ans:

$$B_{out} = \frac{\mu_0 i}{2\pi R_{com}} = \frac{1}{2}\left(\frac{\mu_0 i}{2\pi R}\right) = \frac{1}{2}B_{max} \Rightarrow \frac{1}{R_{com}} = \frac{1}{2R}$$

$$R_{out} = 2R = 2 \times 2.50 = 5.0\ cm$$

$$B_{in} = \left(\frac{\mu_0 i}{2\pi R^2 R}\right) r = \frac{B_{max}}{2} = \frac{1}{2} \times \frac{\mu_0 i}{2\pi R} \Rightarrow \frac{r}{R} = \frac{1}{2} \Longrightarrow r = \frac{R}{2} = \frac{2.50}{2} = 1.25\ cm$$

B_{in} at r = 1.25 cm, B_{out} at r = 5.00 cm

Q28.

A 20-turn circular coil of radius 5.00 cm is placed in a magnetic field perpendicular to the plane of the coil. The magnitude of the magnetic field varies with time as B(t) = 0.0100 t + 0.0400 t^2, where B is in Tesla and t is in second. Calculate the magnitude of the induced emf in the coil at t = 5.00 s.

A) 64.4 mV
B) 40.4 mV
C) 32.2 mV
D) 23.5 mV
E) 30.5 mV

Ans:

$$\frac{dB}{dt} = 0.01 + 0.08t;\ \frac{dB}{dt}\ (t = 5s) = \ 0.01 + 0.4 = 0.41$$

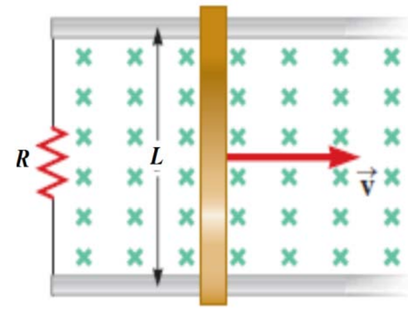
$$|\varepsilon| = N\frac{dB}{dt}A = 20 \times 0.41 \times \pi(0.05)^2 = 0.0644\ \text{V}$$

$$|\varepsilon| = 64.4\ mV$$

Q29.

A conducting bar of length L moves to the right on two frictionless rails, as shown in **FIGURE 14**. A uniform magnetic field, directed into the page, has a magnitude of 0.25 T. Assume $R = 10\ \Omega$, $L = 0.45$ m. At what constant speed should the bar move to produce a 9.0 mA current in the resistor?

Figure 14



A) 0.80 m/s
B) 0.85 m/s
C) 0.75 m/s
D) 0.70 m/s
E) 0.65 m/s

Ans:

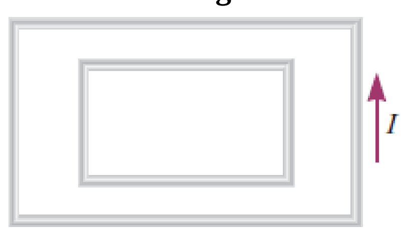
$$|\varepsilon| = BLv = iR$$

$$v = \frac{iR}{BL} = \frac{9 \times 10^{-3} \times 10}{0.25 \times 0.45} = 0.8\ m/s$$

Q30.

Two rectangular loops of wire lie in the same plane as shown in **FIGURE 15**. If the current I in the outer loop is counterclockwise and increases with time, which of the following statements is CORRECT about the current induced in the inner loop?

Figure 15



A) It is clockwise.
B) It is counterclockwise.
C) It is zero.
D) Its direction depends on the dimensions of the loop.
E) Its direction is fluctuating with time.

Ans:

A
