Q1.
A transverse sinusoidal wave travelling on a stretched string is described by the equation:

$$y\,(x,t) = y_m \sin\,(3.0x - 6.0t),$$

where x and y are in meters and t is in seconds. If the linear mass density of the string is 0.0025 kg/m, what is the magnitude of the tension in the string?

A) 0.010 N
B) 0.050 N
C) 0.0063 N
D) 0.0013 N
E) 0.075 N

Q2.
The average power output of a sound point source is 1.5 mW. What is the sound level at a distance of 3.0 m from the source?

A) 71 dB
B) 76 dB
C) 81 dB
D) 86 dB
E) 90 dB

Q3.
An ideal gas is initially under a pressure of 2.4×10^4 Pa, and has a volume of 0.20 m^3. It undergoes an isothermal process in which its pressure reduces to half its original value. How much heat is absorbed or lost by the gas?

A) + 3.3 kJ
B) − 3.3 kJ
C) − 9.5 kJ
D) + 9.5 kJ
E) zero

Q4.
The heat lost by 300 grams of a metal as it cools by 50.0 °C raises the temperature of 300 grams of water by 10.0 ^{o}C. The specific heat of water is 4190 J/kg · K. The specific heat of the metal is:

A) 838 J/kg.K
B) 209 J/kg.K
C) 419 J.kg.K
D) 135 J.kg.K
E) 946 J.kg.K

Q5.
Both the pressure and volume of an ideal monatomic gas are doubled. The ratio of the new internal energy to the old internal energy is:

A) 4
B) 2

C) 1
D) 1/2
E) 1/4

Q6.
A heat engine with an efficiency of 0.40 generates 1500 W of power. How much heat is expelled to the low-temperature reservoir each hour?

A) 8.1×10^6 J
B) 3.2×10^6 J
C) 5.4×10^6 J
D) 14×10^6 J
E) 2.7×10^6 J

Q7.
A proton and an electron are released from rest from the same point in a uniform electric field? Which of the following statements is CORRECT?

A) They will experience the same magnitude of the electric force.
B) They will travel in the same direction.
C) They will experience the same acceleration.
D) They will travel equal distances in equal times.
E) The distance between them will remain constant.

Q8.
A point charge q_1 = 4.0 nC is located on the x axis at x = 2.0 m, and a second point charge q_2 = – 6.0 nC is located on the y axis at y = 1.0 m. What is the magnitude of the total electric flux due to these two point charges through a spherical surface centered at the origin and with a radius of 1.5 m?

A) 0.68 kNm^2/C
B) 0.45 kN m^2/C
C) 1.1 kN m^2/C
D) 0.23 kN m^2/C
E) zero

Q9.
A uniform electric field has a magnitude of 300 N/C, and is directed to the right as shown in **Figure 1**. Points A and B are a distance of 5.0 m apart and lie on a line that is parallel to the electric field. What is the change in the electric potential energy of a proton as it moves from A to B?

Fig#

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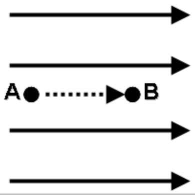

A) -2.4×10^{-16} J
B) $+2.4 \times 10^{-16}$ J
C) $+9.6 \times 10^{-18}$ J
D) -9.6×10^{-16} J
E) $+4.8 \times 10^{-16}$ J

Q10.
Two identical point charges with q = + 5.00 μC are placed at opposite corners of a square. The length of each side of the square is 0.200 m. A point charge q_o = – 2.00 μC is placed at one of the empty corners as shown in **Figure 2**. How much work is done on q_o by the electric force when q_o is moved to the other empty corner?

Fig#

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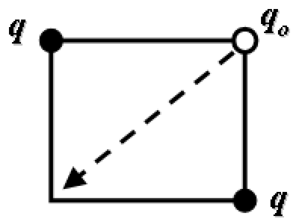

A) Zero
B) 0.795 J
C) 0.450 J
D) 0.900 J
E) 0.345 J

Q11.
In **Figure 3**, the capacitors are identical, and each has a capacitance C. The equivalent capacitance of the combination is

Fig#

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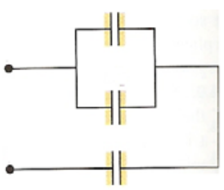

A) 2C/3
B) 3C/2
C) C/3
D) 3C

E) $C^2/3$

Q12.
The resistivity of silver is 1.5×10^{-8} Ω.m, and that of aluminum is 2.8×10^{-8} Ω.m. Two wires, one made of silver and the other made of aluminum, have the same dimensions and are connected to the same battery. What is the ratio of the current passing in the silver wire to that passing in the aluminum wire?

A) 1.9
B) 0.53
C) 1.0
D) 3.5
E) 0.29

Q13.
For the circuit shown in **Figure 4**, which equation is correct for loop 2?

Fig#

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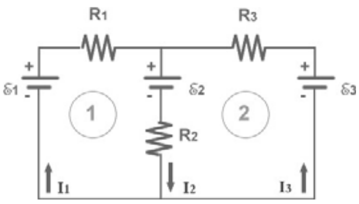

A) $E_2 + R_3I_3 - E_3 + R_2I_2 = 0$
B) $E_2 + R_3I_3 + E_3 - R_2I_2 = 0$
C) $E_2 - R_3I_3 - E_3 - R_2I_2 = 0.$
D) $E_2 + R_3I_3 + E_3 + R_2I_2 = 0$
E) $-E_2 + R_3I_3 - E_3 + R_2I_2 = 0$

Q14.
Initially, for the circuit shown in **Figure 5**, the switch S is open and the capacitor is uncharged. The switch S is closed at time $t = 0$. At what time will the current be half its initial value?

Fig#

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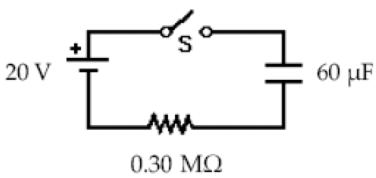

A) 12.5 s
B) 18.0 s
C) 9.00 s

D) 6.50 s
E) 13.5 s

Q15.
The circuit in **Figure 6** shows three identical resistors connected to a battery and an ammeter. The current measured by the ammeter is I_o. If resistor R_2 is removed, the current measured by the ammeter will be

Fig#

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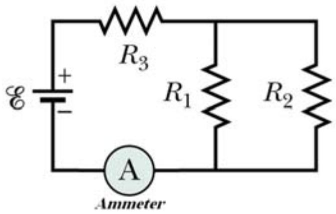

A) $3I_o$ /4.
B) I_o /4.
C) the same.
D) $4I_o$ /3.
E) 4 I_o.

Q16.
In the circuit shown in **Figure 7**, ε_1 = 28 V, ε_2 = 42 V, R_1 = 2.0 Ω, R_2 = 5.0 Ω, R_3 = 1.0 Ω, and I_1 = 7.5 A. Calculate the potential difference $V_A - V_B$.

Fig#

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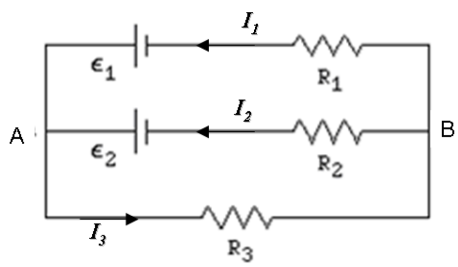

A) + 13 V
B) – 13 V
C) + 21 V
D) – 21 V
E) + 38 V

Q17.
In the circuit shown in **Figure 8**, what power is dissipated in the 4-Ω resistor?

Fig#

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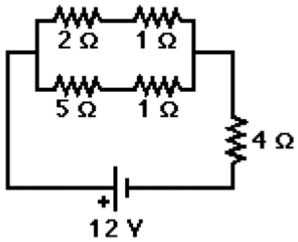


A) 16 W
B) 8.0 W
C) 24 W
D) 12 W
E) 20 W

Q18.
An electron is moving in the xy plane, with velocity **v** = (5.0×10^5) **i** + (4.0×10^5) **j** (m/s). A magnetic field of magnitude 0.80 T is in the positive *x* direction. The magnitude of the magnetic force on the electron is:

A) 5.1×10^{-14} N
B) 2.6×10^{-14} N
C) 6.4×10^{-14} N
D) 3.2×10^{-13} N
E) 0

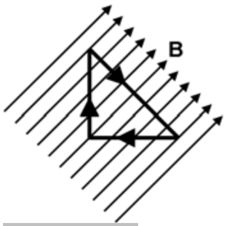
Q19.
A particle with a charge of + 4.8×10^{-19} C is moving with constant velocity in a region where a uniform electric field with a magnitude of 5.0×10^4 V/m is perpendicular to a uniform magnetic field of magnitude 1.6 T. What is the speed of the particle?

A) 3.1×10^4 m/s
B) 1.6×10^4 m/s
C) 4.0×10^4 m/s
D) 32 m/s
E) zero

Q20.
A loop of wire carrying a current of 2.0A is in the shape of a right triangle with two equal sides = 15 cm long (see **Figure 9**). A 0.70 T uniform magnetic field is perpendicular to the hypotenuse. The magnetic force on **either** of the two equal sides has a magnitude of:

Fig#

#:



A) 0.15 N
B) 0.11 N
C) zero
D) 0.21 N
E) 0.30 N

Q21.
A square loop of wire having side length of 2.0 cm is perpendicular to a magnetic field of magnitude 2.0 T. The loop carries a current of 6.0 A. Calculate the magnitude of the torque acting on the loop.

A) Zero
B) 1.0×10^{-3} N.m
C) 3.6×10^{-3} N.m
D) 2.4×10^{-3} N.m
E) 4.8×10^{-3} N.m

Q22.
In a uniform magnetic field, a charged performs uniform circular motion. The particle has charge 2.5 μC and mass 3.0×10^{-9} kg and completes 7 revolutions in one second. What is the magnitude of the magnetic field?

A) 53 mT
B) 5.8 mT
C) 36 mT
D) 8.4 mT
E) 11 mT

Q23.
An infinitely long wire carrying current *I* is bent at a right angle as shown in **Figure 10**. What is the magnetic field at point P that is a distance *y* from the corner of the wire?

Fig#

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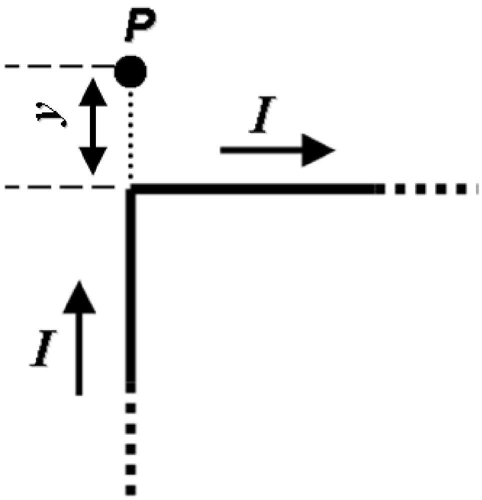

A) $\dfrac{\mu_o I}{4\pi y}$ out of the page

B) $\dfrac{\mu_o I}{4\pi y}$ into the page

C) $\dfrac{\mu_o I}{\pi y}$ into the page

D) $\dfrac{\mu_o I}{\pi y}$ out of the page

E) $\dfrac{\mu_o I}{2\pi y}$ into the page

Q24.
Figure 11 shows two current segments. The lower segment carries current I_1 = 0.50 A, and includes a circular arc of radius 5.0 cm. The upper segment carries current I_2 = 0.90 A, and includes a circular arc of radius 4.0 cm. Both arcs are centered at point P. What is magnitude of the magnetic field at P?

Fig#

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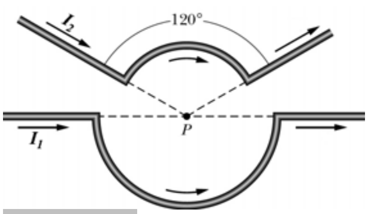

A) 1.6 μT
B) 7.8 μT
C) 3.1 μT
D) 4.7 μT
E) 6.2 μT

Q25.

A cylindrical conductor of radius R = 2.5 cm carries a current I = 2.5 A along its length. This current is uniformly distributed throughout the cross section of the conductor. What is the magnitude of the magnetic field at $r = R/2$, where r is the radial distance measured from the axis of the wire?

A) 10 μT
B) 8.0 μT
C) 20 μT
D) 4.0 μT
E) 2.0 μT

Q26.
A solenoid that is 9.5 m long has a winding of 12,000 turns. It carries a current of 3.6 A. What is the magnitude of the magnetic field inside the solenoid?

A) 5.7 mT
B) 8.2 mT
C) 3.4 mT
D) 1.8 mT
E) 9.8 mT

Q27.
Wires A, B, and C carry equal currents in the directions shown in **Figure 12**. What is the direction of the net magnetic force on wire C due to wires A and B?

Fig#

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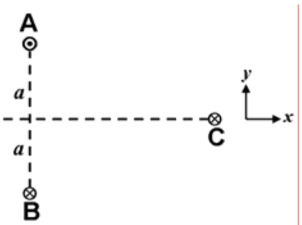

A) Negative y direction
B) Positive x direction
C) Negative x direction
D) Positive y direction
E) Positive z direction

Q28.
A uniform magnetic field passes through two areas, A_1 and A_2. The angles between the magnetic field and the normals of areas A_1 and A_2 are 30° and 60°, respectively. If the magnetic flux through the two areas is the same, what is the ratio A_1/A_2?

A) 0.58
B) 0.82
C) 1.0
D) 1.2
E) 1.7

Q29.

A circular coil of wire has 25 turns and has a radius of 0.075 m. The coil is located in a variable magnetic field whose behavior is shown on the graph of **Figure 13**. At all times, the magnetic field is directed perpendicular to the plane of a loop. What is the magnitude of the emf induced in the coil in the time interval from t = 5.0 s to 7.5 s?

Fig#

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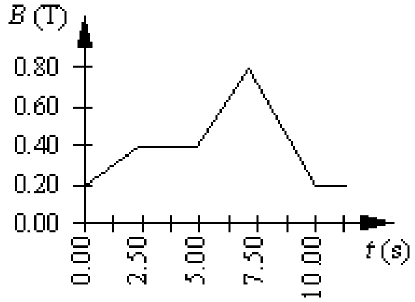

A) 71 mV
B) 49 mV
C) 92 mV
D) 37 mV
E) 18 mV

Q30.

Two conducting loops carry equal currents I in the same direction as shown in **Figure 14**. If the current in the upper loop drops to zero, what will happen to the current in the lower loop?

Fig#

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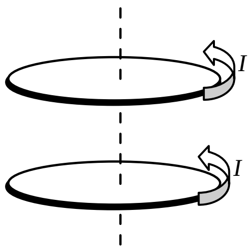

A) The current will increase.
B) The current will not change.
C) The current will drop to zero.
D) The current will reverse its direction.
E) The current will decrease.

$v = \sqrt{\frac{\tau}{\mu}}$, $v = \lambda f$ $\quad v = \sqrt{\frac{B}{\rho}}$

$S = S_m \cos(kx - \omega t)$

$I = \frac{\text{Power}}{\text{Area}}$

$y = y_m \sin(kx - \omega t - \varphi)$

$P = \frac{1}{2}\mu\omega^2 y_m^2 v$

$\Delta P = \Delta P_m \sin(kx - \omega t)$

$\Delta P_m = \rho v \omega S_m$

$I = \frac{1}{2}\rho(\omega S_m)^2 v$

$\beta = 10 \log \frac{I}{I_0}$, $I_0 = 10^{-12}\,\text{W/m}^2$

$f' = f\left(\frac{v \pm v_D}{v \mp v_s}\right)$

$y = \left(2y_m \cos\frac{\varphi}{2}\right)\sin\left(kx - \omega t - \frac{\varphi}{2}\right)$

$\Delta L = \frac{\lambda}{2\pi}\varphi$

$\Delta L = n\frac{\lambda}{2}$ $\quad n = 0,1,2,3,\ldots \quad \ldots$

$\Delta L = m\lambda$

$\Delta L = \left(m + \frac{1}{2}\right)\lambda$

$f_n = \frac{nv}{2L}$, $\quad n = 1,2,3,\ldots$

$f_n = \frac{nv}{4L}$, $\quad n = 1,3,5,\ldots$

$y = 2y_m \sin(kx)\cos(\omega t)$

$\alpha = \frac{\Delta L}{L}\frac{1}{\Delta T}$, $PV = nRT = NkT$

$n = \frac{m}{M} = \frac{N}{N_A}$, $\beta = \frac{1}{V}\frac{\Delta V}{\Delta T}$

$Q = mL$, $\quad W = \int P dV$,

$P = \frac{2}{3}\frac{N}{V}\left(\frac{1}{2}m\vec{v}^2\right)$, $C_p - C_v = R$

$Q = m\,c\,\Delta T$,

$\Delta E_{int} = Q - W$, $\Delta E_{int} = nc_v\Delta T$

$v_{rms} = \sqrt{\frac{3RT}{M}}$, $\frac{1}{2}m\vec{v}^2 = \frac{3}{2}k_B T$,

$P_{cond} = \frac{Q}{t} = \kappa A\,\frac{T_H - T_C}{L}$

$Q = n\,c_p\,\Delta T$, $\quad Q = n\,c_v\,\Delta T$

$PV^\gamma = \text{constant}$, $\quad TV^{\gamma-1} = \text{constant}$

$T_F = \frac{9}{5}T_c + 32$, $\quad T_K = T_c + 273$

$W = Q_H - Q_L$, $\quad \varepsilon = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$

$\frac{Q_L}{Q_H} = \frac{T_L}{T_H}$, $K = \frac{Q_L}{W}$, $\quad \Delta S = \int\frac{dQ_r}{T}$

$F = \frac{kq_1q_2}{r^2}$, $\quad F = q_0 E$, $\quad \vec{\tau} = \vec{p}\times\vec{E}$

$\varphi = \int_{\text{Surface}} \vec{E}\cdot d\vec{A}$, $\quad E = \frac{kq}{r^2}$, $U = \vec{p}\cdot\vec{E}$

$E = \frac{kQ}{R^3}r$ $\quad$, $\quad E = \frac{2k\lambda}{r}$

$\varphi_c = \oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$

$E = \frac{\sigma}{2\varepsilon_o}$, $\quad E = \frac{\sigma}{\varepsilon_o}$, $V = \frac{kQ}{r}$,

$\Delta V = V_B - V_A = -\int_A^B \vec{E}\cdot d\vec{S} = \frac{\Delta U}{q_0}$,

$E_x = -\frac{\partial V}{\partial x}$, $E_y = -\frac{\partial V}{\partial y}$, $E_z = -\frac{\partial V}{\partial z}$

$U = \frac{kq_1q_2}{r_{12}}$, $C = \frac{Q}{V}$, $\quad C_o = \frac{\varepsilon_0 A}{d}$

$C = 4\pi\varepsilon_o\frac{ab}{b-a}$, $U = \frac{1}{2}CV^2$

$u = \frac{1}{2}\varepsilon_o E^2$, $C = \kappa C_0$,

$E = \frac{E_0}{\kappa}$, $V = \frac{V_o}{\kappa}$, $I = \frac{dQ}{dt}$,

$I = JA$, $R = \frac{V}{I} = \rho\frac{L}{A}$

$\rho = \rho_0[1 + \alpha(T - T_0)]$, $\quad P = IV$

$q(t) = C\varepsilon[1 - e^{-t/RC}]$,

$q(t) = q_o\,e^{-t/RC}$

$\tau = N\,i\,AB\sin\theta$, $\vec{\tau} = \vec{\mu}\times\vec{B}$

$\vec{F} = q(\vec{v}\times\vec{B})$, $\quad \vec{F} = i(\vec{L}\times\vec{B})$

$F_{ba} = \frac{\mu_o L i_a i_b}{2\pi d}$, $d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\,d\vec{s}\times\vec{r}}{r^3}$,

$\oint \vec{B}\cdot d\vec{s} = \mu_0\,i_{enc}$, $U = -\vec{\mu}\cdot\vec{B}$

$B = \frac{\mu_0\,i}{4\pi R}\varphi$, $\quad B = \frac{\mu_0\,i}{2\pi r}$,

$B_s = \mu_0\,n\,i$, $\varphi_B = \int_{\text{Surface}} \vec{B}\cdot d\vec{A}$

$\varepsilon = -\frac{d\varphi_B}{dt}$, $\quad \varepsilon = BLv$

$v = v_o + at$

$x - x_o = v_o t + \frac{1}{2}at^2$

$v^2 = v_o^2 + 2a(x - x_o)$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N.m^2$

$k = 9.0 \times 10^9\ N.m^2/C^2$

$q_e = -1.6 \times 10^{-19}\ C$

$m_e = 9.11 \times 10^{-31}\ kg$

$m_p = 1.67 \times 10^{-27}\ kg$

$1\ eV = 1.6 \times 10^{-19}\ J$

$\mu_0 = 4\pi \times 10^{-7}\ Wb/A.\ m$

$k_B = 1.38 \times 10^{-23}\ J/K$

$N_A = 6.02 \times 10^{23}$ molecues/mole

$1\ atm = 1.013 \times 10^5\ N/m^2$

$R = 8.31$ J/mol. K

$g = 9.8\ m/s^2$, 1 cal = 4.186 J,

for water:

$c = 4180\ \frac{J}{kg.K}$

$L_F = 333\ \frac{kJ}{kg}$, $\quad L_V = 2256\ \frac{kJ}{kg}$