**1**

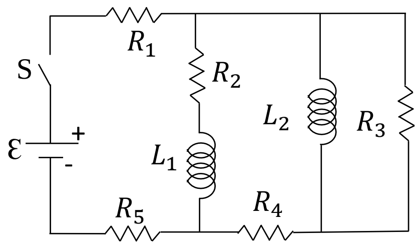
The electric field in a region is given by $\vec{E} = 2x\hat{\imath} + 3y^2\hat{\jmath}$ . Which of the followings is the work done by the electrostatic force to displace the point charge $q = +2.0nC$ between the points from $A(1.0,2.0,0.0)\ (m)$ to $B(3.0,1.0,3.0)(m)$ in nano-Joules?

**A)** 2.0  **B)** -4.0  **C)** -2.0  **D)** 4.0  **E)** 0.0

**2**

Switch S is closed at $t = 0$ in the circuit. Find the current across the resistor $R_4$ at $t = 0$.

$R_1 = 2\ (\Omega)$, $R_2 = 2\ (\Omega)$, $R_3 = 2\ (\Omega)$, $R_4 = 2\ (\Omega)$, $R_5 = 2\ (\Omega)$, $L_1 = 1$ (mH), $L_2 = 2$ (mH), $\varepsilon = 4\ (V)$

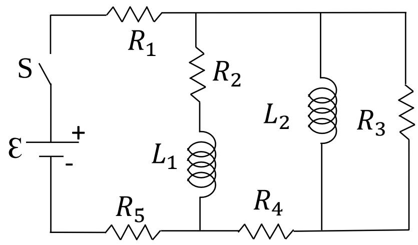



**A)** 0.5 A  **B)** 0.75 A  **C)** 1.0 A  **D)** 1.6 A  **E)** 1.25 A

**3**

Switch S is closed at $t = 0$ in the circuit. Find the current across the resistor $R_3$ at $t = \infty$ in Amperes.

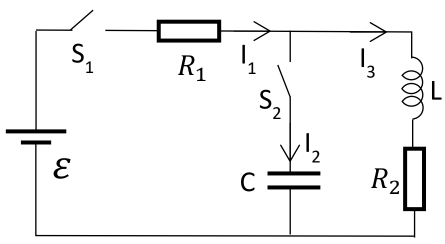
$R_1 = 2\ (\Omega)$, $R_2 = 2\ (\Omega)$, $R_3 = 2\ (\Omega)$, $R_4 = 2\ (\Omega)$, $R_5 = 2\ (\Omega)$, $L_1 = 1$ (mH), $L_2 = 2$ (mH), $\varepsilon = 4\ (V)$




**A)** 0  **B)** 1.5  **C)** 1.0  **D)** 2.3  **E)** 1.8

**4**

The switch $S_1$ is closed at $t = 0$. Find the current $I_1(t)$ in the circuit as a function of time while the switch $S_2$ is open. $R_1 = R$, $R_2 = R$




**A)** $\frac{\varepsilon}{2R}(1 - e^{-\frac{2Rt}{L}})$

**B)** $\frac{\varepsilon}{3R}(1 - e^{-\frac{3Rt}{L}})$

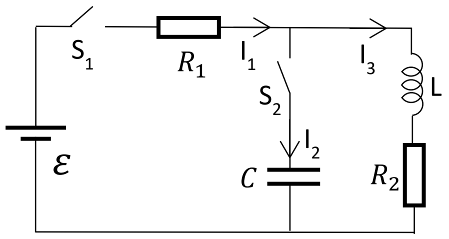
**C)** $\frac{\varepsilon}{R}(1 - e^{-\frac{Rt}{L}})$

**D)** $\frac{2\varepsilon}{3R}(1 - e^{-\frac{3Rt}{2L}})$

**E)** $\frac{\varepsilon}{R}(1 - e^{-\frac{2Rt}{L}})$

**5**

$S_1$ and $S_2$ are closed for a long time. Find the currents $I_3$ and the charge $Q$ on the capacitor at steady state. $R_1 = R$, $R_2 = R$




**A)** $I_3 = \frac{\varepsilon}{2R}$ $\quad Q = \frac{\varepsilon C}{2}$

**B)** $I_3 = \frac{2\varepsilon}{5R}$ $\quad Q = \frac{\varepsilon C}{5}$

**C)** $I_3 = \frac{2\varepsilon}{5R}$ $\quad Q = \frac{4\varepsilon C}{5}$

**D)** $I_3 = \frac{\varepsilon}{4R}$ $\quad Q = \frac{\varepsilon C}{4}$

**E)** $I_3 = \frac{\varepsilon}{2R}$ $\quad Q = \frac{\varepsilon C}{4}$

**6**

In a series RLC circuit $I_{rms} = 0{,}1A$, $\Delta V_{rms} = 60V$, and the current leads the voltage by $\frac{\pi}{4}\ rad$. Calculate the average power $P_{av}$ delivered to the circuit in Watts.

**A)** $3\sqrt{2}$ **B)** $2.5$ **C)** $8\sqrt{3}$ **D)** $15\sqrt{2}$ **E)** $7.5\sqrt{3}$

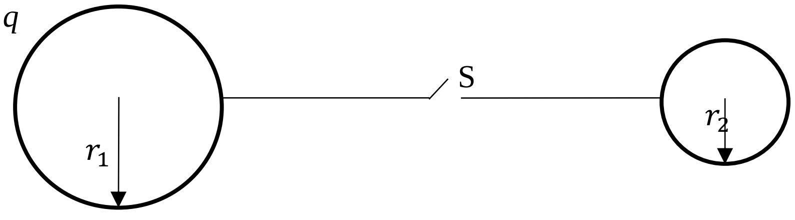
**7**

In a series RLC circuit $I_{rms} = 0{,}1A$, $\Delta V_{rms} = 60V$, and the current leads the voltage by $\frac{\pi}{4}\ rad$. Which of the followings is the resistance of the circuit in ohms?

**A)** $300\sqrt{2}$ **B)** $250\sqrt{2}$ **C)** $200\sqrt{2}$ **D)** $150\sqrt{2}$ **E)** $350\sqrt{2}$

**8**

Two metal spheres in the figure are separated by a distance that is much greater than their radii. They are to be connected by a conducting wire of total resistance R. The sphere of radius $r_2 = a$ is uncharged and the sphere of radius $r_1 = 2a$ has a total charge of $q = +Q$ on it.

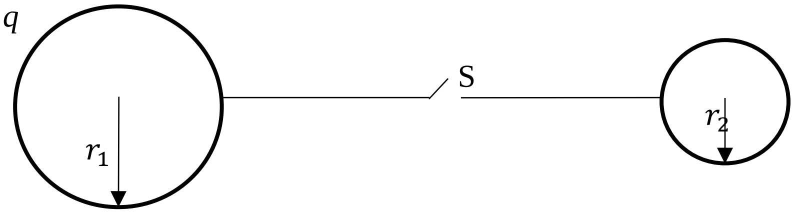



Find the electrostatic potential energy of the two-sphere system before switch S is closed.

**A)** $\frac{Q^2}{16\pi\varepsilon_0 a}$ **B)** $\frac{Q^2}{4\pi\varepsilon_0 a}$ **C)** $\frac{Q^2}{24\pi\varepsilon_0 a}$ **D)** $\frac{Q^2}{6\pi\varepsilon_0 a}$ **E)** $\frac{9Q^2}{16\pi\varepsilon_0 a}$

**9**

Two metal spheres in the figure are separated by a distance that is much greater than their radii. They are to be connected by a conducting wire of total resistance R. The sphere of radius $r_2 = a$ is uncharged and the sphere of radius $r_1 = 2a$ has a total charge of $q = +Q$ on it.

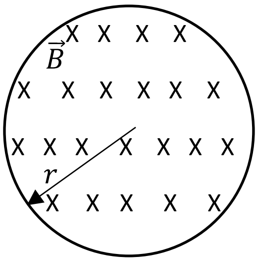



Find the current through the wire immediately after the switch S is closed.

**A)** $\frac{Q}{8\pi\varepsilon_0 aR}$ **B)** $\frac{Q}{4\pi\varepsilon_0 aR}$ **C)** $\frac{5Q}{12\pi\varepsilon_0 aR}$ **D)** $\frac{Q}{2\pi\varepsilon_0 aR}$ **E)** $\frac{Q}{\pi\varepsilon_0 aR}$

**10**

The uniform magnetic field inside the circular conducting wire of radius $r = 0.5\ (m)$ is directed into the page plane and varies with time as $B(t) = at^2 + b\ (T)$ where $a = 2.0\left(\frac{T}{s^2}\right)$ and $b = 4.0(T)$ and time is in second. $\pi = 3$

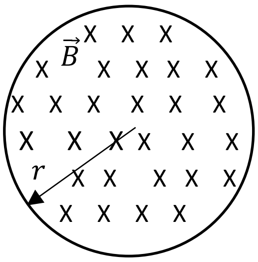



How much electromotive force induce in the circuit $|\varepsilon|$ at $t = 1.0(s)$ in Volts?

**A)** 3.0 **B)** 48 **C)** 360 **D)** 768 **E)** 120

**11**

The uniform magnetic field inside the circular conducting wire of initial radius of $r = a$ is directed into the page plane and is given as $B = 4.0\ (T)$. The radius of the circle decreses at a constant rate of $\frac{dr}{dt} = -0.25\ (\frac{m}{s})$. Wire is always in circular shape.

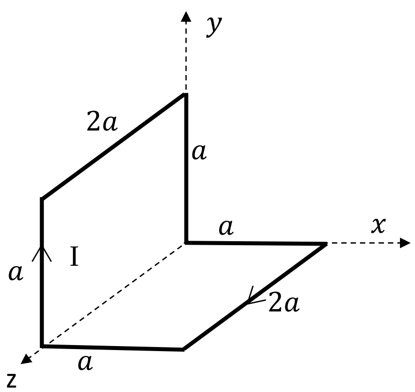



Find the electric field induced at a point at a distance $2a$ from the centre of the circle at $t = 0(s)$ in SI units?

**A)** 0.5 **B)** 1.0 **C)** 0.4 **D)** 0.3 **E)** 0.6

**12**

A closed loop carrying a constant current $I = 2.0(A)$ is in a uniform magnetic field given by $\vec{B} = 2\hat{\imath} - \hat{\jmath} + 2\hat{k}$ as shown in the figure. $a = 0.5\ (m)$ Find the potential energy of the magnetic dipole in Joules.

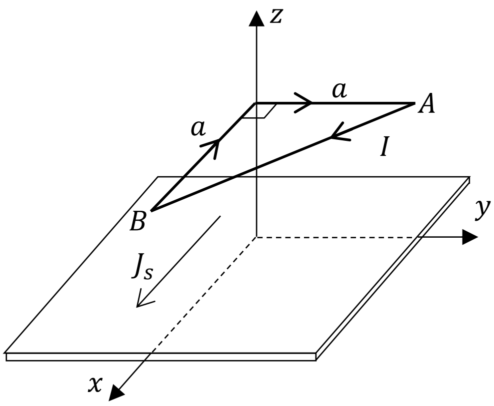



**A)** 1 **B)** 8 **C)** 24 **D)** 36 **E)** 4

**13**

An infinite sheet of current in $z = 0$ plane has uniform current density $\vec{J}_s = J_s\hat{\imath}\left(\frac{A}{m}\right)$. A right triangle current loop is placed parallel to the current sheet so that the right corner is on the z axis as shown in the figure.

Find the magnitude of the force acting on AB segment of the loop due to the current sheet for $J_s = 5.0\left(\frac{A}{m}\right)$, $I = 1.0\ (A)$ and $a = 2.0\ (m)$.

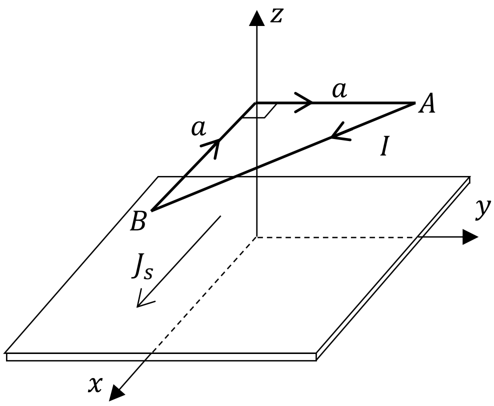



**A)** $5\mu_0$ **B)** $20\mu_0$ **C)** $2\mu_0$ **D)** $30\mu_0$ **E)** $4\mu_0$

**14**

An infinite sheet of current in $z = 0$ plane has uniform current density $\vec{J}_s = J_s\hat{\imath}\left(\frac{A}{m}\right)$. A right triangle current loop is placed parallel to the current sheet so that the right corner is on the z axis as shown in the figure.

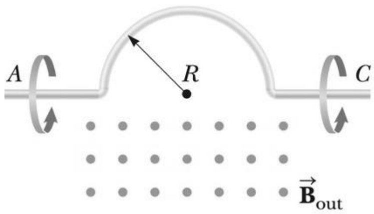
Find the magnitude of the torque acting on the current e loop due to the current sheet for $I = 2.0\ (A)$, $J_s = 2.0\ \left(\frac{A}{m}\right)$ and $a = 1.0\ (m)$




**A)** $\mu_0$ **B)** $40\mu_0$ **C)** $45\mu_0$ **D)** $10\mu_0$ **E)** $12.5\mu_0$

**15**

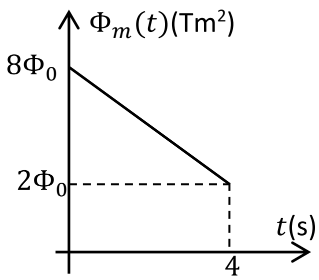
A semicircular conductor of radius $R = 1.0\ (m)$ is rotated about the axis AC at a constant rate of $\omega = 60\ (rad/s)$ angular velocity. A uniform magnetic field of magnitude $B = 2\ (T)$ fills the entire region below the axis and is directed out of the page. Calculate the maximum value of the emf induced between the ends of the conductor in Volts. $(\pi = 3)$




**A)** 180 **B)** 120 **C)** 75 **D)** 90 **E)** 135

**16**

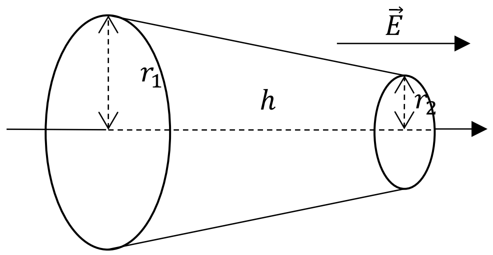
The magnetic flux through a coil changes over time as shown in the figure. The time rate of current flowing the coil is $\frac{dI}{dt} = 3\ \left(\frac{A}{s}\right)$. Which of the following is the inductance of the coil in Henry? Where $\Phi_0 = 2.0\ (Tm^2)$.




**A)** 1 **B)** 1.5 **C)** 2 **D)** 3 **E)** 2.5

**17**

A truncated conical surface of radius $r_1 = 5.0\ (m), r_2 = 3.0\ (m)$ and height $h = 5.0\ (m)$ is placed in a uniform electric field $\vec{E} = 2.0\ \hat{\imath}(\frac{N}{C})$. Find the electric flux through the side surface of the cone in SI units. $(\pi = 3)$




**A)** 96 **B)** 45 **C)** 72 **D)** 27 **E)** 42

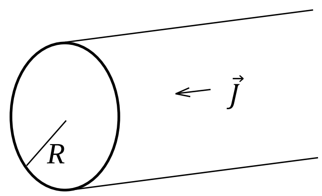
**18**

The voltage across a parallel-plate capacitor with area $A = 2.0\ (\mathrm{cm}^2)$ and separation $d = 0.05\ (cm)$ varies with time t as $V(t) = 5.0 \ln(2t)\ \ (\mathrm{Volt})$. Find the displacement current between the plates at $t = 2.0\ (s)$.

**A)** $\varepsilon_0$ **B)** $\frac{3}{2}\varepsilon_0$ **C)** $5\varepsilon_0$ **D)** $2\varepsilon_0$ **E)** $4\varepsilon_0$

**19**

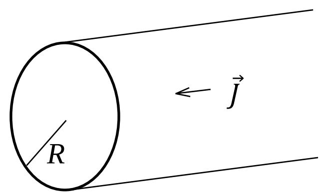
As shown in the figure, a very long cylindrical rod with radius $R = 3.0\ (m)$ is carrying a nonuniform current density $J = \alpha r$. Where $r$ is the radial distance and $\alpha$ is a positive constant. If the magnitude of magnetic field is $B = 0.5\ (T)$ at $r = \frac{3}{2}R$, what is the constant $\alpha$ in SI units? $\pi = 3$




**A)** $\frac{1}{4\mu_0}$ **B)** $\frac{1}{2\mu_0}$ **C)** $\frac{3}{4\mu_0}$ **D)** $\frac{3}{2\mu_0}$ **E)** $\frac{3}{\mu_0}$

**20**

As shown in the figure, a very long cylindrical rod with radius $R = 3.0\ (m)$ is carrying a nonuniform current density $J = \frac{r}{\mu_0}\ (\frac{A}{m^2})$. Where $r$ is the radial distance and $\alpha$ is a positive constant. Find the magnitude of magnetic field at $r = R/2$ in SI units?




**A)** $\frac{3}{4}$ **B)** $\frac{1}{3}$ **C)** $\frac{4}{3}$ **D)** 3 **E)** $\frac{1}{12}$