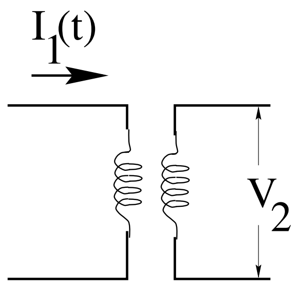
1. The current in a 90 mH inductor is given by $I = (t^2 - 6t)$ (with I in Amps and t in seconds). The emf produced by the inductor is zero when $t =$

   a) 6 s b) 0 s c) 3 s d) 2 s e) $-6s$

2. Two coils are close to each other, with one connected to a current source which produces a current of $I_1(t) = 3t^2 + 5$ amps, where t is expressed in seconds. If the mutual inductance of the two coils is 10 mH, what is the voltage V_2 across the second inductor at time $t = 3$ seconds?



   a) 0.32 V
   b) 0.18 V
   c) 0.23 V
   d) 0.36 V
   e) 7.2 V

3. A 2.0 volt battery is suddenly connected across a series LR combination of a 1.0 Ω resistor and a 10 mH inductor. How long does it take for the current to build up to 1.5 A?

   a) 13.9 ms
   b) 2.88 ms
   c) 1.39 ms
   d) 1.25 ms
   e) 6.02 ms

4. A coil of resistance 8Ω and self inductive 4 H is connected across a constant potential difference of 100 V. Let t = 0 be the time of connection, at which time I = 0. Which statement below most accurately describes the subsequent behavior?

   a) The current increases at an initial rate of 25 A/s to a value at $t \to \infty$ of I = 12.5 A.
   b) The current increases at an initial rate of 12.5 A/s, increasing to a rate of 25 A/s at $t \to \infty$.
   c) The initial rate of current increase is zero, but the current eventually reaches a value at $t \to \infty$ of 12.5 A.
   d) The current increases at an initial rate of 50 A/s.
   e) The current increases to a final value of 25 A.

5. An LC (series) circuit contains a $1pF$ capacitor in series with an inductor. It resonates at $101.5MHz$. What is the value of the inductance in the circuit?

   a) 2.46μH
   b) 97.1μ H
   c) 2.46mH
   d) $2.46 \times 10^6 H$
   e) 1.56kH

6. A capacitor is given a charge Q_0 and then connected to an inductor to form an LC circuit. How much charge is on the capacitor when the energy is shared equally between the inductor and the capacitor?

   a) Zero
   b) Q_0
   c) $Q_0/4$
   d) $Q_0/2$
   e) $Q_0/\sqrt{2}$

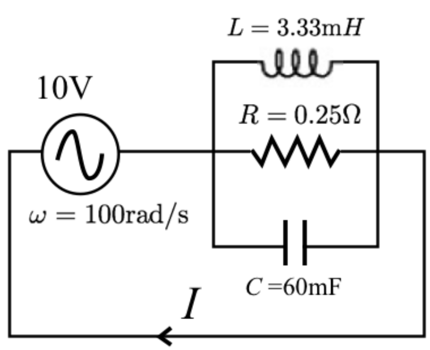
7. A series RLC circuit has elements $R = 30\Omega$, $L = 10^{-3}$ H, and $C = 10^{-7}$ F. The maximum current during the cycle is $I_{max} = 2$ A when the circuit is connected to an EMF oscillating at the resonant frequency. The maximum EMF **across the inductor** is

a) 282 V
b) 200 V
c) 100 V
d) 141 V
e) 60 V

8. A 300 mH inductor is connected across an AC voltage source of $(170\text{V})\sin(377t)$. What is the maximum current flowing through the inductor?

a) 1.5 A
b) 0.67 A
c) 19.2 kA
d) 0.13 A
e) 567 A

9. A parallel ac circuit containing a resistor with $R = 0.25\Omega$, an inductor with $L = 3.33$mH and a capacitor with $C = 60$mF connected to an AC voltage supply with voltage amplitude 10V and angular frequency of 100rad/s as shown in the figure. What is the amplitude of the current through the parallel circuit?

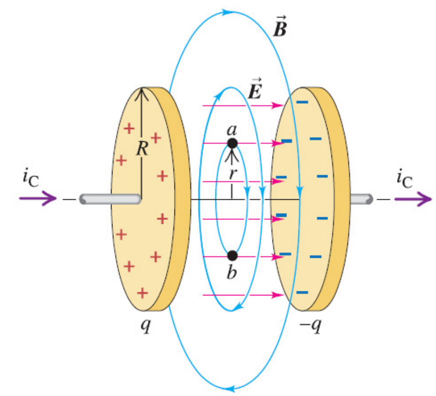


a) 50A
b) 33.3A
c) 3A
d) 50A
e) 35.4A

10. A transformer connected to an AC line with an rms voltage of 120 V supplies an rms voltage of 12 V to a portable electronic device. The load resistance in the secondary is 4.00 Ω. What resistance R connected directly across the source line (which has a voltage of 120 V) would draw the same power as the transformer?

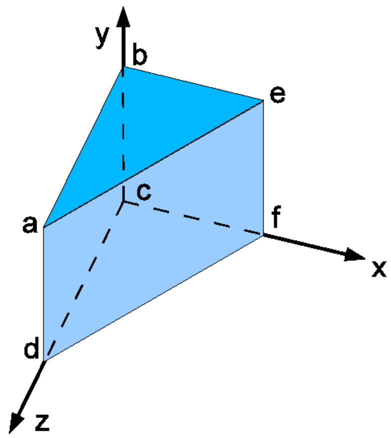
a) $R = 40\ \Omega$
b) $R = 400\ \Omega$
c) $R = 4\ \Omega$
d) $R = 100\ \Omega$
e) $R = 4 \times 10^{-2}\ \Omega$

11. A current $i_C = 10$ A charges a capacitor of radius R = 10 cm, as shown in the figure. What is the induced magnetic field B at its outer rim?



a) 2×10^{-5} T
b) 2×10^{2} T
c) 10^{5} T
d) 15.9 T
e) 1.13×10^{6} T

12. The magnetic field in a certain region is 0.10 T and its direction is that of the +z axis in the figure. Through which of the surfaces of this triangular block is the magnetic flux zero?



a) Surfaces abe and cdf only
b) None of the surfaces
c) Only through all five of the surfaces together
d) Surfaces abcd, abe and cdf and all five of the surfaces together
e) All of the individual surfaces

13. If the wavelength of an electromagnetic wave is 5.5×10^{-7} m, its *angular* frequency is:

a) 1.1×10^{16} rad/sec
b) 6.8×10^{15} rad/sec
c) 3.4×10^{15} rad/sec
d) 1.7×10^{15} rad/sec
e) 5.4×10^{14} rad/sec

14. The electric field in an electromagnetic wave is given by $\vec{E} = E_0\hat{\imath}\sin(\mathbf{kz} - \omega\mathbf{t})$. The associated magnetic field is given by $\vec{B}=$

a) $B_0\hat{\imath}\cos(\mathbf{kz} - \omega\mathbf{t})$
b) $B_0\hat{\mathbf{k}}\cos(\mathbf{kx} - \omega\mathbf{t})$
c) $B_0\hat{\jmath}\cos(kz - \omega t)$
d) $B_0\hat{\imath}\sin(\mathbf{kx} - \omega\mathbf{t})$
e) $B_0\hat{\jmath}\sin(kz - \omega t)$

15. The electric field of a sinusoidal electromagnetic wave obeys the following equation:

$$E = (4.0\ \text{V/m})\cos[(2.0 \times 10^2\ (\text{rad/m}))x + (6.0 \times 10^{10}\ (\text{rad/s}))t]$$

What is the wavelength λ of this wave?

a) $\lambda = \pi \times 10^{-2}$ m
b) $\lambda = 2\pi \times 10^{-2}$ m
c) $\lambda = 200$ m
d) $\lambda = (\pi/4) \times 10^{-10}$ m
e) $\lambda = 8 \times 10^{10}$ m

16. An electromagnetic wave has a magnetic field of form $\mathbf{B} = B_0\sin(\omega t + kz)\hat{\mathbf{x}}$. What direction is the Poynting vector?

a) $+y$-direction
b) $-y$-direction
c) $+z$-direction
d) $-z$-direction
e) $+x$-direction

17. A sinusoidal electromagnetic wave has an electric field amplitude of 6×10^{-2} V/m at a distance L from the antenna. What is the intensity I of the wave?

a) $I = \epsilon_0 c \times 36 \times 10^{-4}$ Wb/m^2
b) $I = \epsilon_0 c L^2 \times 36 \times 10^{-4}$ Wb/m^2
c) $I = \epsilon_0 c L^2 \times 18 \times 10^{-4}$ Wb/m^2
d) $I = \epsilon_0 c \times 18 \times 10^{-4}$ Wb/m^2
e) $I = 18 \times 10^{-4}$ Wb/m^2

18. Two astronauts, Neil and Sally, try the following experiment. A piece of paper that is perfectly reflecting on one side and perfectly absorbing on the other is at rest in a vacuum. Simultaneously, Neil shines a 20W laser normal to the center of the reflecting side and Sally shines a different power laser normal to the center of the absorbing side. They observe the paper remains at rest and conclude that the power of Sally's laser is:

a) 20 W b) 10 W c) 5 W d) 40 W
e) 80 W

19. When two linear polarizers are stacked together with their transmission axis aligned, the transmitted intensity is I_1. If a third polarizer is inserted between the two, with its transmission axis rotated 60° from the first polarizer, the transmitted intensity is then:

a) I_1 b) $\frac{I_1}{2}$ c) $\frac{I_1}{4}$ d) $\frac{I_1}{8}$ e) $\frac{I_1}{16}$

20. In an electromagnetic wave with electric field $\vec{E}$ and magnetic field $\vec{B}$ at a given point in space,

a) $\vec{E}$ and $\vec{B}$ oscillate out of phase so that the energy density at that point alternates between $\vec{E}$ and $\vec{B}$, with the total constant.
b) $\vec{E}$ and $\vec{B}$ oscillate in phase, with the $\vec{E}$ pointing in the direction of the propagation of the wave.
c) $\vec{E}$ and $\vec{B}$ are proportional to each other in magnitude, but are perpendicular to each other.
d) $\vec{E}$ lags behind $\vec{B}$ by 90° because it is the changing magnetic flux which produces the electric field.
e) $\vec{E}$ is constant while $\vec{B}$ oscillates at the frequency of the wave.

REFERENCE PAGE: Useful Information

c = speed of light = 3.00×10^8 m/s
$q_e = -e$ = charge on an electron = -1.602×10^{-19} Coulombs
$q_p = +e$ = charge on a proton = $+1.602 \times 10^{-19}$ Coulombs
m_e = electron mass = 9.11×10^{-31} kg
m_p = proton mass = 1.67×10^{-27} kg
$k = 9 \times 10^9$ N m^2/C^2
$\epsilon_0 = 8.85 \times 10^{-12}$ C^2/(Nm^2)
$\mu_0 = 4\pi \times 10^{-7}$ N/A^2
$g = 9.80$ m/s^2
1 $eV = 1.602 \times 10^{-19}$ J
1 mC = 10^{-3} C   1 μC = 10^{-6} C
1 nC = 10^{-9} C   1 pC = 10^{-12} C