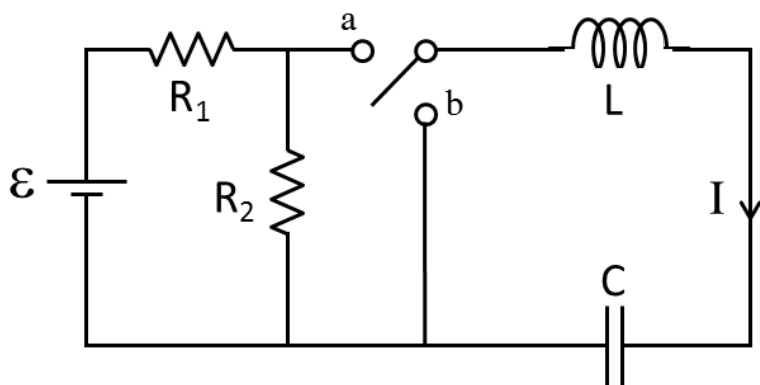
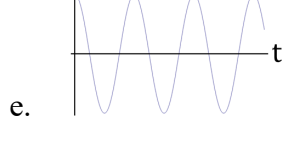
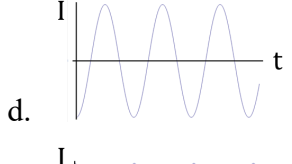
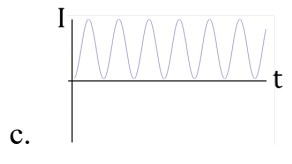
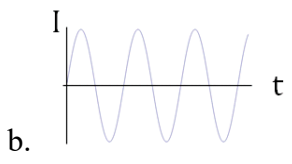
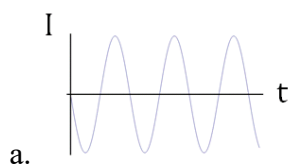


The next three questions pertain to the situation described below.

A circuit consists of a battery with voltage $\epsilon = 15 \text{ V}$, two identical resistors with resistance $R = 10 \Omega$, an inductor with inductance $L=0.015 \text{ H}$, a capacitor with capacitance $C = 0.025 \text{ F}$, and a switch (labeled S) that can be toggled between two positions (a and b) are connected as shown below. The arrow labeled with an “I” defines the direction of positive current. After being in position **a** for a long time, the switch is suddenly moved to position **b**.

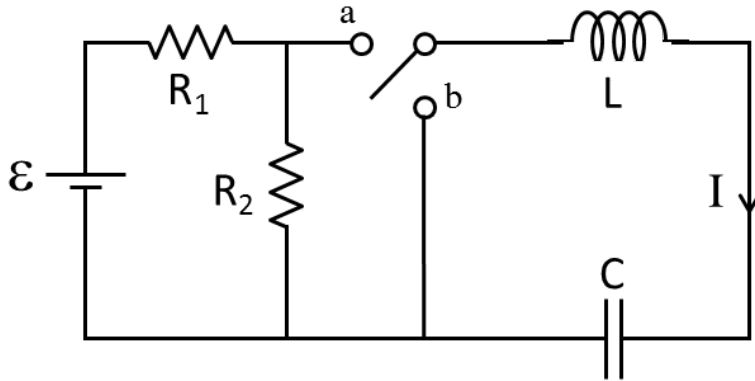


1) Which graph best represents the current through the inductor starting immediately after the switch is moved to position b?



2) Repeated from the previous page

A circuit consists of a battery with voltage $\epsilon = 15 \text{ V}$, two identical resistors with resistance $R = 10 \Omega$, an inductor with inductance $L = 0.015 \text{ H}$, a capacitor with capacitance $C = 0.025 \text{ F}$, and a switch (labeled S) that can be toggled between two positions (a and b) are connected as shown below. The arrow labeled with an "I" defines the direction of positive current. After being in position **a** for a long time, the switch is suddenly moved to position **b**.



What is the maximum amount of energy that is stored in the inductor after the switch is turned to position b?

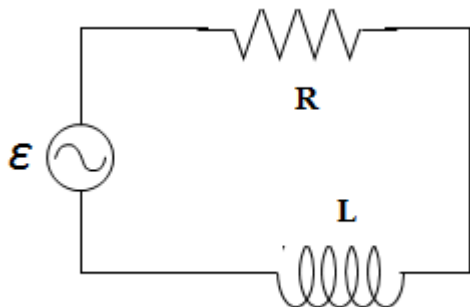
- a. $U_L^{max} = 5.6 \text{ J}$
- b. $U_L^{max} = 1.4 \text{ J}$
- c. $U_L^{max} = 0.35 \text{ J}$
- d. $U_L^{max} = 2.8 \text{ J}$
- e. $U_L^{max} = 0.7 \text{ J}$

3) What is the first time after the switch has been turned to position b that the voltage across the capacitor is zero?

- a. 0.0304 sec
- b. 0.00484 sec
- c. 0.0152 sec
- d. 0.0608 sec
- e. 0.122 sec

The next three questions pertain to the situation described below.

A generator with $\epsilon = \epsilon_0 \sin(\omega t)$ is attached to the RL circuit as shown below.



4) If the reactance of the inductor $X_L = R$, what is the maximum energy U_L^{max} stored in the inductor?

- a. $U_L^{max} = \frac{L}{2} \left(\frac{\epsilon_0}{R} \right)^2$
- b. $U_L^{max} = \frac{L}{4} \left(\frac{\epsilon_0}{R} \right)^2$
- c. $U_L^{max} = \frac{L}{8} \left(\frac{\epsilon_0}{R} \right)^2$

5) If we decrease the generator frequency, the magnitude of the peak voltage across the resistor will

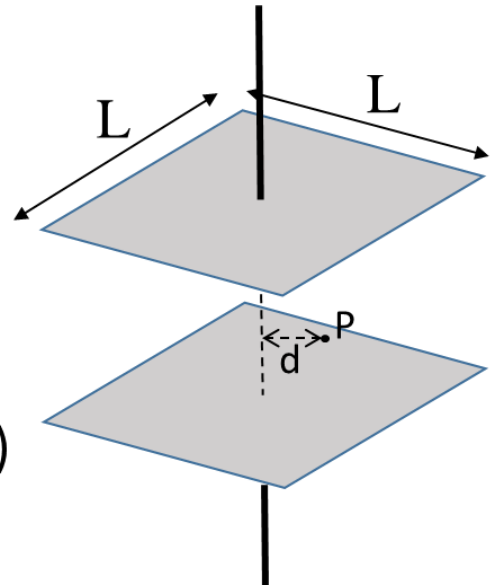
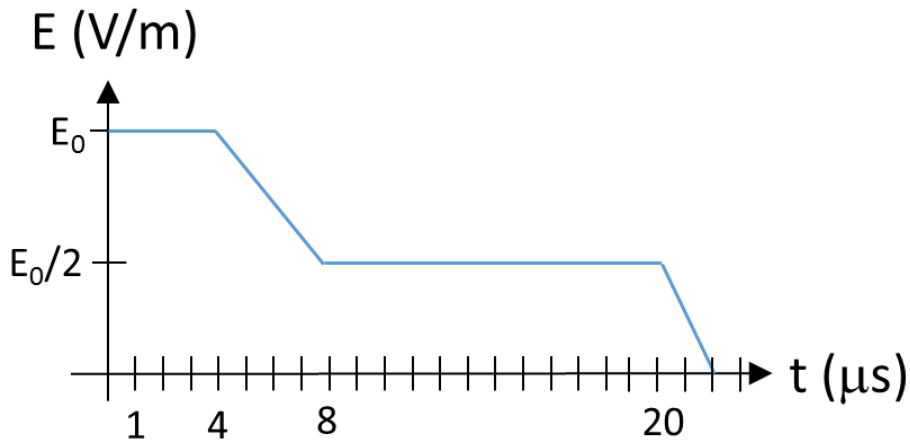
- a. remain the same
- b. increase
- c. decrease

6) The generator frequency remains at its original value and a capacitor is added in series to the circuit. If the capacitor reactance $X_C = R$, how does the maximum current change?

- a. Remains the same
- b. Increases
- c. Decreases

The next two questions pertain to the situation described below.

The electric field in a parallel plate capacitor formed from square plates with sides of length $L = 1.5 \text{ m}$ is changed in time as shown in the graph. The electric field starts at magnitude E_0 . It is uniformly reduced to half of its value between $t=4\mu\text{s}$ and $t=8\mu\text{s}$. It is held constant for $12\mu\text{s}$, and then reduced to 0 V/m in $2\mu\text{s}$.



7) When is the displacement current inside the capacitor the greatest?

- a. $20\mu\text{s} < t < 21\mu\text{s}$
- b. $4\mu\text{s} < t < 8\mu\text{s}$
- c. $0 < t < 4\mu\text{s}$

8) What is the magnitude of the magnetic field at point P (midway between the plates and a distance $d=0.065$ meters from center), when the capacitor is being discharged at a rate of 0.45 C/s ?

- a. $B = 1.38 \times 10^{-6} \text{ T}$
- b. $B = 8.16 \times 10^{-9} \text{ T}$
- c. $B = 2.6 \times 10^{-9} \text{ T}$
- d. $B = 5.13 \times 10^{-8} \text{ T}$
- e. $B = 4.35 \times 10^{-6} \text{ T}$

The next three questions pertain to the situation described below.

The electric field for a plane electromagnetic wave in vacuum is given by

$$\mathbf{E} = 1300(\text{N/C}) \sin(-0.7 \text{ m}^{-1} z + \omega t) \hat{x}.$$

9) What is the frequency of the wave?

a. $f = 3.34 \times 10^7 \text{ Hz}$

b. $f = 2.1 \times 10^8 \text{ Hz}$

c. $f = 7 \times 10^5 \text{ Hz}$

10) What is the magnitude of the magnetic field oscillation?

a. $B = 4.3 \times 10^{-6} \text{ T}$

b. $B = 2.3 \times 10^5 \text{ T}$

c. $B = 1300 \text{ T}$

11) In what direction does the wave propagate?

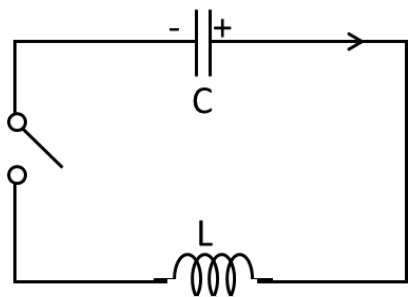
a. +x

b. +z

c. -z

The next three questions pertain to the situation described below.

A capacitor with capacitance $C=0.025\text{ F}$ and an inductor with inductance $L=0.015\text{ H}$ are connected in series with a switch. The capacitor charged is to $100\ \mu\text{C}$ (the right plate is positive). At $t=0$ the switch is closed.



12) What is the maximum current that flows through the circuit after the switch is closed?

- a. $I_{\max} = 0.004\text{ A}$
- b. $I_{\max} = 0.018\text{ A}$
- c. $I_{\max} = 0.0052\text{ A}$

13) Which expression best describes the current through the circuit as a function of time? Let current flowing in the direction of the arrow be defined as positive.

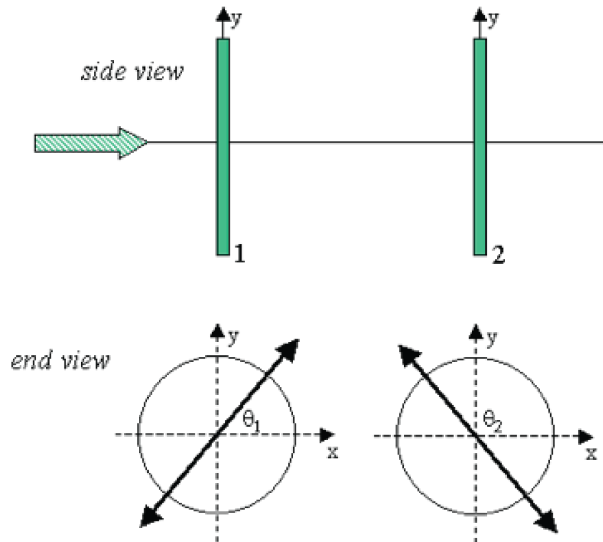
- a. $I(t) = -I_{\max} * \cos(\omega t)$
- b. $I(t) = I_{\max} * \cos(\omega t)$
- c. $I(t) = I_{\max} * \sin(\omega t)$

14) When the charge on the capacitor is $1/2$ its maximum value, what is the magnitude of the current through the inductor?

- a. $I > \frac{1}{2} I_{\max}$
- b. $I < \frac{1}{2} I_{\max}$
- c. $I = \frac{1}{2} I_{\max}$

The next two questions pertain to the situation described below.

A circularly polarized beam of intensity I_0 travels in the positive z-direction and is incident from the left on a series of two linear polarizers as shown. The transmission axis of the two polarizers make angles of $\theta_1 = 62$ degrees and $\theta_2 = 116$ degrees, respectively, with respect to the positive x-axis. The intensity of the beam immediately after the first polarizer is $I_1 = 171 \text{ W/m}^2$.



15) What is the intensity of the incident beam?

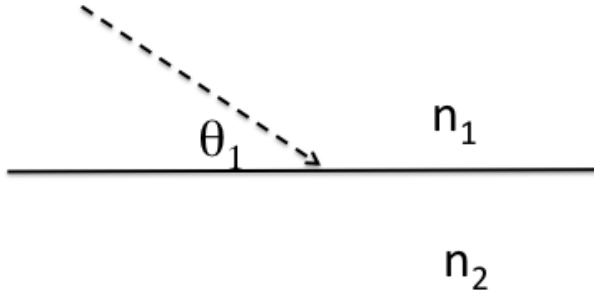
- a. $I_0 = 342 \text{ W / m}^2$
- b. $I_0 = 37.8 \text{ W / m}^2$
- c. $I_0 = 774 \text{ W / m}^2$

16) What is the intensity of the beam immediately after the second polarizer?

- a. $I_2 = 37.8 \text{ W / m}^2$
- b. $I_2 = 32.7 \text{ W / m}^2$
- c. $I_2 = 59.2 \text{ W / m}^2$

The next three questions pertain to the situation described below.

A monochromatic beam of light passes from medium 1 to medium 2 characterized by refractive indices $n_1 = 1.4$ and $n_2 = 1.2$. In medium 1, the beam makes an angle of $\theta_1 = 40$ degrees with the boundary separating medium 1 and medium 2 as shown in the figure.



17) What is the corresponding angle of the beam of light in medium 2, with respect to the boundary?

- a. 33.4 degrees
- b. 48.5 degrees
- c. 26.7 degrees

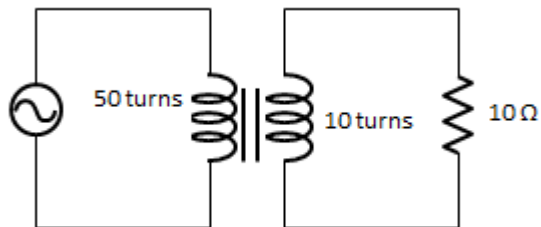
18) Compare the frequency of light in medium 1, to the frequency of light in medium 2.

- a. $f_1 = f_2$
- b. $f_1 > f_2$
- c. $f_1 < f_2$

19) Given the index of refraction for material 1, and the incident angle $\theta_1 = 40$, in order for the beam of light to undergo total internal reflection at the interface between the two surfaces

- a. The index of refraction of material 2 would need to be smaller than 1.2.
- b. It is not possible for light from material 1 incident at the above angle to undergo total internal reflection.
- c. The index of refraction of material 2 would need to be larger than 1.2.

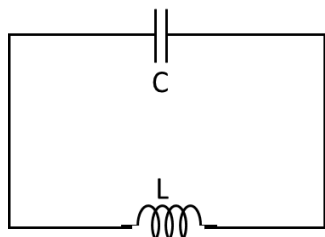
An ideal transformer has 50 turns in the primary coil and 10 turns in the secondary coil. An RMS voltage of 120 V 60Hz AC voltage source is connected to the primary coil. A $10\ \Omega$ resistor is connected to the secondary coil as shown in the figure.



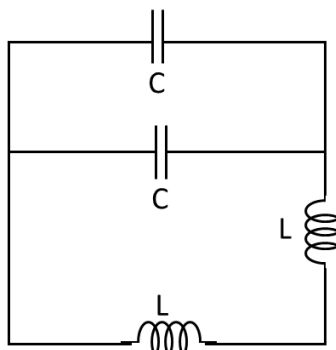
20) What is the average power dissipated in the resistor?

- a. 1440 W
- b. 3.6×10^4 W
- c. 115.2 W
- d. 7.2×10^4 W
- e. 57.6 W

21) Consider the two LC circuits shown below.



Circuit 1



Circuit 2

Compare the resonant frequencies of the two circuits.

- a. $\omega_1 = \omega_2$
- b. $\omega_1 > \omega_2$
- c. $\omega_1 < \omega_2$