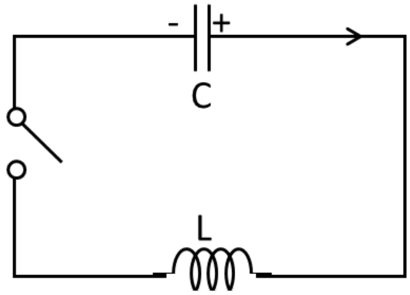
The next three questions pertain to the situation described below.

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



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

a. I_{max} = 0.008 A
b. I_{max} = 0.014 A
c. I_{max} = 0.05 A
d. I_{max} = 0.063 A
e. I_{max} = 0.004 A

2) 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.

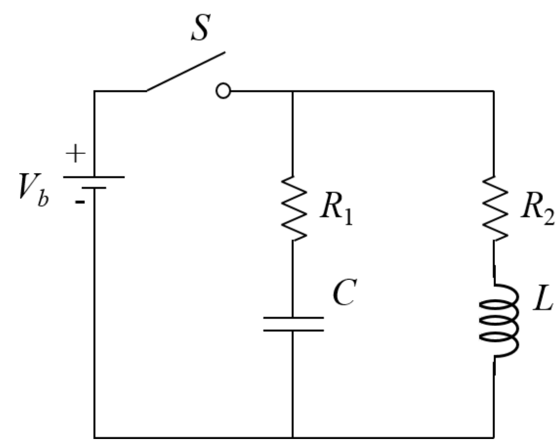
a. $I(t) = I_{max} * cos(\omega t)$
b. $I(t) = I_{max} * sin(\omega t)$
c. $I(t) = -I_{max} * cos(\omega t)$

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

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

The next two questions pertain to the situation described below.

A circuit is composed of a battery with voltage $V_b = 6$ V, two resistors $R_1 = 40\ \Omega$ and $R_2 = 24\ \Omega$, a capacitor $C = 34$ nF, an inductor $L = 56$ mH and a switch S. The switch has been open for a long time; at $t = 0$ s, it is closed.



4) What is the current through the battery at $t = 0$, just after the switch is closed?

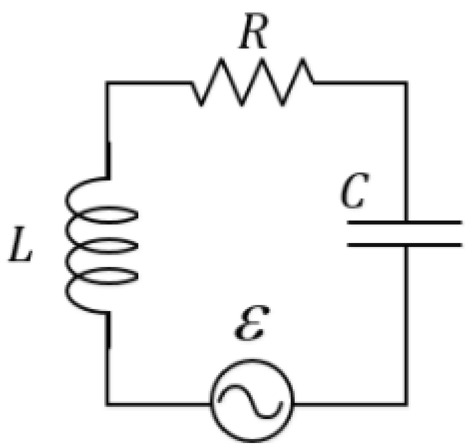
a. $I_b = 0.0938$ A
b. $I_b = 0.15$ A
c. $I_b = 0.4$ A
d. $I_b = 0$ A
e. $I_b = 0.25$ A

5) What is V_C, the voltage across the capacitor, after the switch has been closed for a long time?

a. $V_C = 3.75$ V
b. $V_C = 0$ V
c. $V_C = 6$ V

The next four questions pertain to the situation described below.

An AC generator provides power for the circuit shown below. The generator voltage is described by $\mathcal{E}(t) = \mathcal{E}_{max}\sin(\omega t)$ where $\mathcal{E} = 120$ V. Here, $L = 660$ mH, $C = 180\ \mu$F, $R = 110\ \Omega$, and $\omega = 40$ rad/sec.



6) What is the phase angle between the generator and the current? (Generator leads if postive)

a. $\phi =$ -13 degrees
b. $\phi =$ 56 degrees
c. $\phi =$ 0.98 degrees
d. $\phi =$ -0.79 degrees
e. $\phi =$ -46 degrees

7) This circuit is being driven at:

a. its resonant frequency
b. a frequency above its resonant frequency
c. a frequency below its resonant frequency

8) At time $t = t_1$, the current in the circuit is zero. What is the magnitude of the voltage across the capacitor at this time?

a. $|V_C| =$ 0.0079 V
b. $|V_C| =$ 0.0055 V
c. $|V_C| =$ 20 V
d. $|V_C| =$ 0.029 V
e. $|V_C| =$ 110 V

9) At resonance, the average power delivered by the AC generator is

a. $\langle P\rangle =$ 45.8 W
b. $\langle P\rangle =$ 65.5 W
c. $\langle P\rangle =$ 131 W

The next three questions pertain to the situation described below.

Microwaves in a home microwave oven can be modeled as a linearly polarized plane wave in vacuum with a magnetic field given by $\vec{B} = B_0 \sin(ky + \omega t)\hat{x}$. Here, $B_0 =$ 0.24 mT and $\omega = 1.8 \times 10^{10}$ rad/sec.

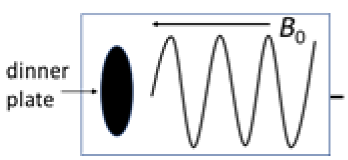
10) What is the wavelength?

a. $\lambda = 1.67$ cm
b. $\lambda = 10.5$ cm
c. $\lambda = 1.7 \times 10^{17}$ cm

11) The associated electric field is given by:

a. $\vec{E} = -B_0 c \sin(ky + \omega t)\hat{y}$
b. $\vec{E} = -B_0 c \sin(ky - \omega t)\hat{z}$
c. $\vec{E} = B_0 c \sin(ky + \omega t)\hat{z}$
d. $\vec{E} = B_0 c \sin(ky - \omega t)\hat{y}$
e. $\vec{E} = -B_0 c \sin(ky + \omega t)\hat{z}$

12) A round dinner plate of radius r = 10 cm is placed in the microwave oven in an orientation perpendicular to the direction of propagation, as shown. Find the average power the plate can absorb. (Assume the plate area is smaller than the wave itself, and the plate absorbs all the energy impinging on it).

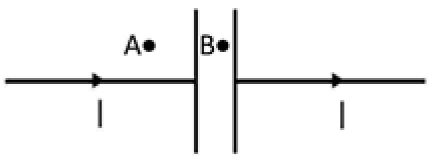


a. $\langle P \rangle = 1.36 \times 10^5$ W
b. $\langle P \rangle = 7.64 \times 10^{-11}$ W
c. $\langle P \rangle = 2.16 \times 10^5$ W
d. $\langle P \rangle = 2.4 \times 10^{-12}$ W
e. $\langle P \rangle = 6.88 \times 10^6$ W

13) A newly designed analog radio is found to require unusually precise fine tuning of the frequency dial to pick up a certain radio station. To create a less-sensitive dial, the radio engineer should

a. decrease the Q (quality factor) of the radio circuit.
b. decrease the resistance of the radio circuit.
c. increase the Q (quality factor) of the radio circuit.

14) A current I is flowing to a capacitor with circular plates of radius 11.7 cm. Point A is a distance 6 cm from the current-carrying wire, while point B is a distance 6 cm from the midway of the capacitor plates, as shown below. Compare the magnetic fields at point A and point B:

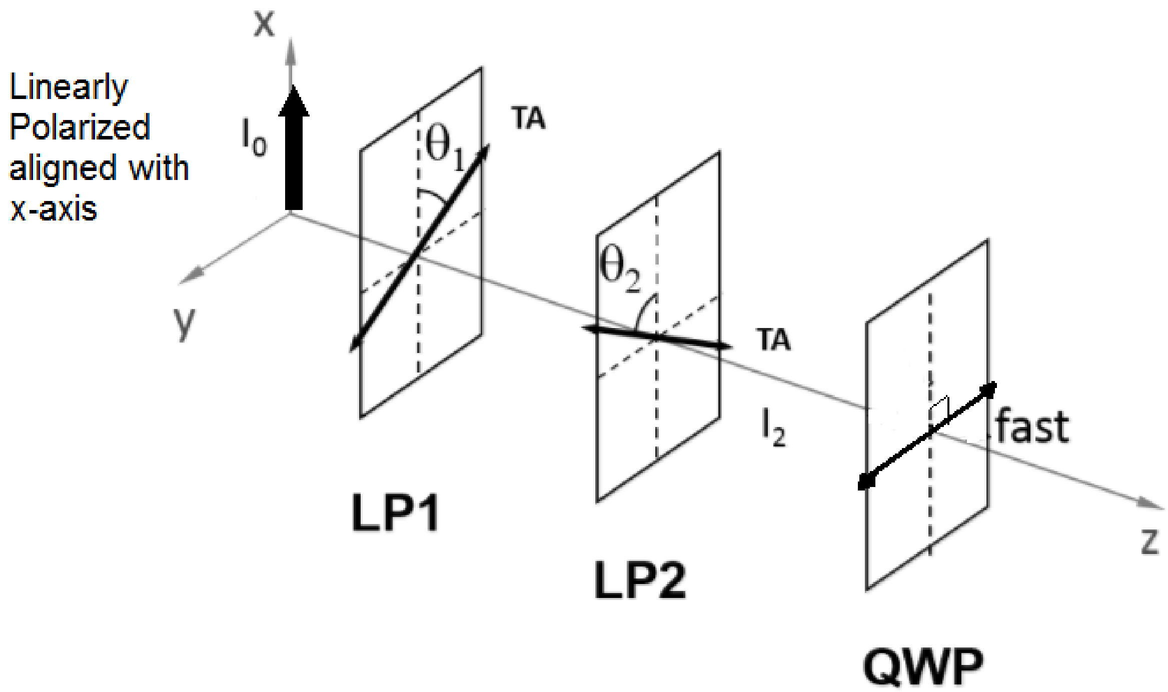


a. $B_B > B_A$
b. $B_A = B_B$
c. $B_A > B_B$

15) A far away galaxy approaches Earth at a velocity $v = 0.62\ c$ and emits light at a wavelength 368 nm. What frequency does an observer on Earth measure? (c is the speed of light)

a. $f = 2.72 \times 10^6$ Hz
b. $f = 8.15 \times 10^{14}$ Hz
c. $f = 471$ Hz
d. $f = 3.95 \times 10^{14}$ Hz
e. $f = 1.68 \times 10^{15}$ Hz

The next three questions pertain to the situation described below.



Linearly polarized light that is oriented along the x-axis and has intensity I_0 is incident on a linear polarizer (LP1) with transmission axis oriented at an angle θ_1=15° clockwise with respect to the *x* axis. The light then passes through a second linear polarizer (LP2) with transmission axis oriented at an angle θ_2 = 45° counterclockwise relative to the *x* axis as shown before passing through a quarter wave plate. The fast axis of the quarter wave plate is aligned with the y-axis.

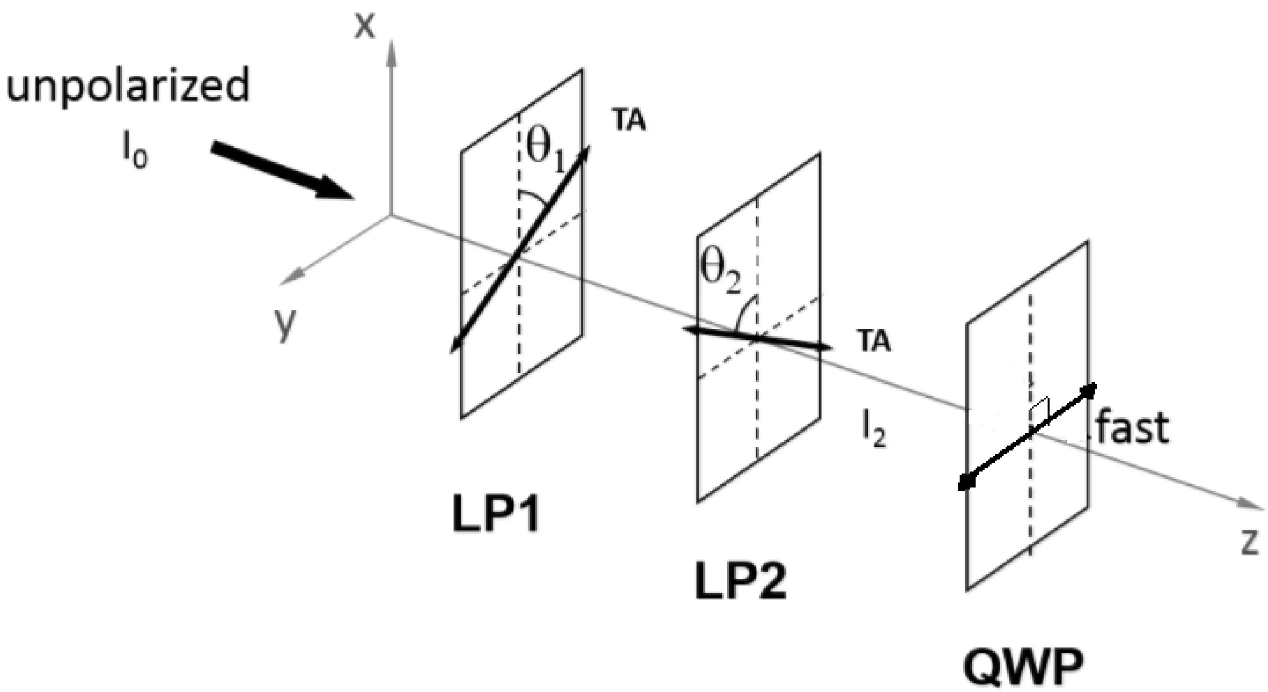
16) What is the intensity of the light after the second linear polarizer (LP2) but before the quarter wave plate?

a. $I_2 = 0.467\ I_0$
b. $I_2 = 0.75\ I_0$
c. $I_2 = 0.25\ I_0$
d. $I_2 = 0.233\ I_0$
e. $I_2 = 0.7\ I_0$

17) What is the polarization after the light passes through the quarter wave plate?

a. Left circularly polarized
b. Right circularly polarized
c. Linearly polarized along θ_2

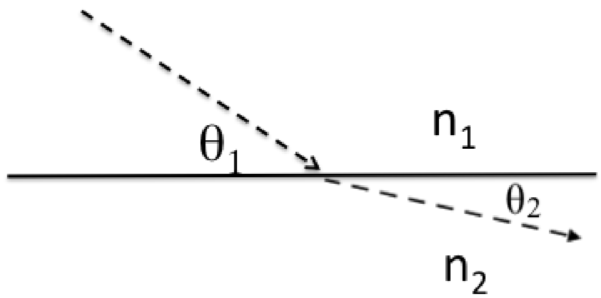
18) Keeping the linear polarizers and quarter wave plate exactly the same, the incident light is now changed to be unpolarized as shown below. What is the intensity of light measured after the quarter wave plate(I_{QWP})?



a. $I_{QWP} = 0.467\ I_0$
b. $I_{QWP} = 0.5\ I_0$
c. $I_{QWP} = 0.125\ I_0$
d. $I_{QWP} = 0.233\ I_0$
e. $I_{QWP} = 0.0583\ I_0$

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 = 1.55 and n_2=1.35. In medium 1, the beam makes an angle of θ_1 = 39 degrees with the boundary separating medium 1 and medium 2 as shown in the figure.



19) What is the corresponding angle of the beam of light θ_2 in medium 2?

a. 47.4 degrees
b. 63.2 degrees
c. 15.6 degrees
d. 46.3 degrees
e. 26.8 degrees

20) Compare the speed of light v_1 in medium 1, to the speed of light v_2 in medium 2.

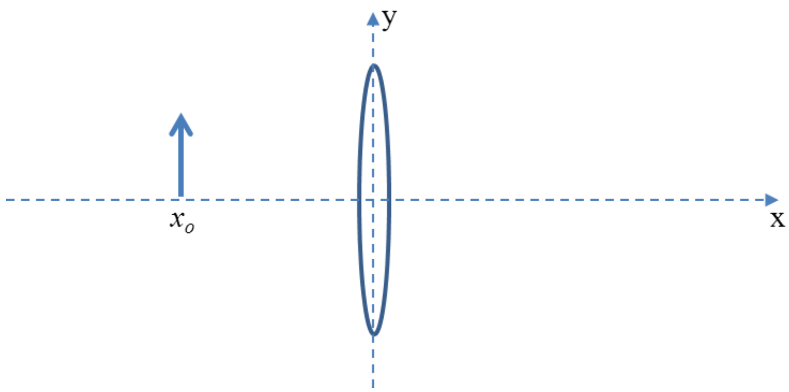
a. $v_1 < v_2$
b. $v_1 > v_2$
c. $v_1 = v_2$

21) Given the index of refraction for material 1, and the incident angle θ_1 = 39 degrees, 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 larger than 1.35.
b. The index of refraction of material 2 would need to be smaller than 1.35.
c. It is not possible for light from material 1 incident at the above angle to undergo total internal reflection.

The next three questions pertain to the situation described below.

A converging lens, made of glass with index of refraction $n = 1.5$, has a focal length $f = 0.26$ m. The lens is positioned at $x = 0$, as shown below.



22) At what position, x_0, to the left of the lens should an object be placed so that the resulting image has a magnification $M = 2.7$?

a. $x_0 = -0.164$ m
b. $x_0 = -0.702$ m
c. $x_0 = -0.356$ m
d. $x_0 = -0.0963$ m
e. $x_0 = -0.26$ m

23) The resulting image is

a. virtual and upright
b. real and inverted
c. real and upright

24) If the entire apparatus was placed inside an aquarium filled with water (n=1.3), in order to produce an image with the same magnification $M = 2.7$, the object should be moved

a. closer to the lens.
b. further from the lens.
c. at the same location as when the system was in air.