Physics 207 – Comprehensive Exam

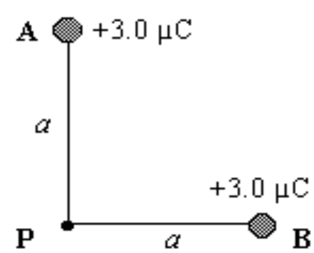
Sections (207-212, 543-583) – December 3rd, 2021

1. [7 pts] The plates of a parallel plate capacitor each have an area of 0.40 m^2 and are separated by a distance of 0.02 m. They are charged until the potential difference between the plates is 3000 V. The charged capacitor is then isolated. Determine the magnitude of the electric field between the capacitor plates.

   A) 60 V/m
   B) 120 V/m
   C) 1.0×10^5 V/m
   D) 1.5×10^5 V/m
   E) 2.5×10^5 V/m
   F) 3.0×10^5 V/m

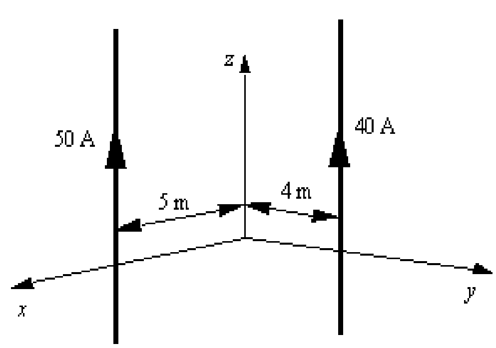
2. [7 pts] Two positive charges are located at points **A** and **B** as shown with $a = 2.0$ m. The electric potential at the point **P** in the figure is

   A) 1.35×10^4 V
   B) 1.89×10^4 V
   C) 2.30×10^4 V
   D) 2.70×10^4 V
   E) 3.68×10^4 V
   F) 3.94×10^4 V



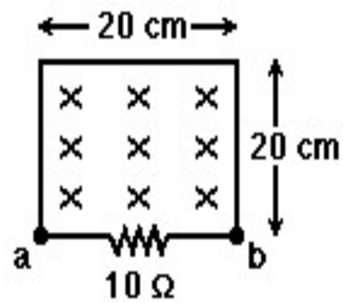
3. [7 pts] The drawing shows two long, thin wires that carry currents in the positive *z* direction. Both wires are parallel to the *z* axis. The 50-A wire is in the *x*-*z* plane and is 5 m from the *z* axis. The 40-A wire is in the *y*-*z* plane and is 4 m from the *z* axis. The magnitude and direction of the magnetic field at the origin is

   A) zero
   B) 2.8×10^{-6} T, in the direction of $+\hat{x} + \hat{y}$
   C) 2.8×10^{-6} T, in the direction of $+\hat{x} - \hat{y}$
   D) 2.0×10^{-6} T, in the direction of $+\hat{x} + \hat{y}$
   E) 2.0×10^{-6} T, in the direction of $+\hat{x} - \hat{y}$
   F) 4.0×10^{-6} T, in the direction of $+\hat{x} + \hat{y}$



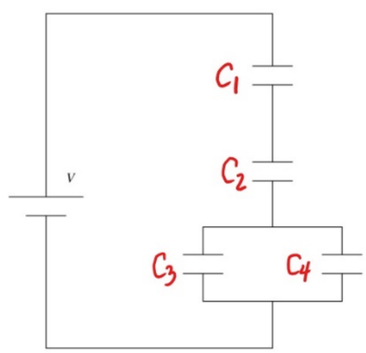
4. [7 pts] In Figure, a wire and a 10 ohm resistor are used to form a circuit in the shape of a square, 20 cm by 20 cm. A uniform but non-steady magnetic field is directed into the plane of the circuit. The magnitude of the magnetic field is decreasing at a fixed rate from 2.70 T to 0.90 T in a time interval of 96 ms. During this time interval the average induced current and its direction through the resistor are closest to

A) 45 mA, from a to b
B) 45 mA, from b to a
C) 75 mA, from a to b
D) 75 mA, from b to a
E) 110 mA, from a to b
F) 110 mA, from b to a



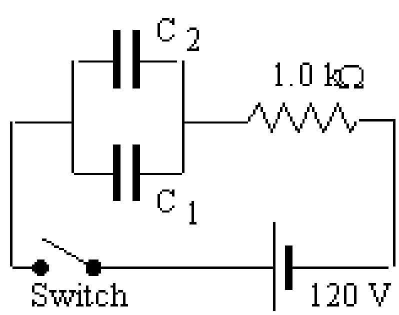
5. [7 pts] Four capacitors are arranged in the circuit shown in the figure. The capacitors have the values C_1=25.5 μF, C_2=45.5 μF, C_3=50.5 μF, and C_4=40.5 μF.
What is the equivalent capacitance of the circuit?

A) 13.9 μF
B) 93.5 μF
C) 162 μF
D) 91 μF
E) 71 μF
F) 10.5 μF

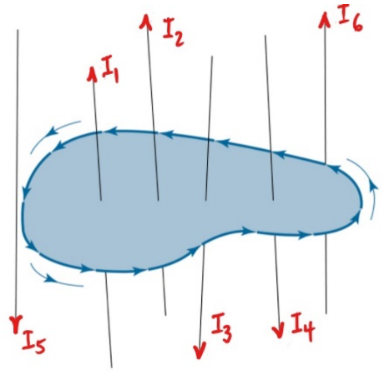


6. [7 pts] An RC circuit consists of a resistor with resistance 1.0 kΩ, a 120-V battery, and two capacitors, C_1 and C_2, with capacitances of 20 μF and 60 μF, respectively. Initially, the capacitors are uncharged and the switch is closed at $t = 0$.
What is the current through the resistor <u>*a long time*</u> after the switch is closed?

A) 0.60 A
B) 0.30 A
C) 0.24 A
D) 0.48 A
E) 0.15 A
F) 0.00 A

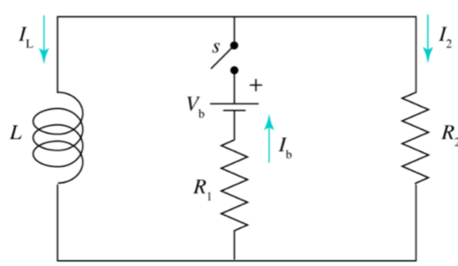


7. [7 pts] Find the value of the line integral of the magnetic field around a closed curve in the presence of six electric currents as shown in the figure: with I_1=3.73 A, I_2=7.19 A, I_3=1.49 A, I_4=4.31 A, I_5=3.77 A and I_6=6.11 A



A) 26.6 μ_0
B) 16.7 μ_0
C) 7.46 μ_0
D) 5.12 μ_0
E) -5.12 μ_0
F) -7.46 μ_0

8. [7 pts] In the circuit shown, L=4.00 H, V_b=24.0 V, R_1=80 Ω and R_2=40 Ω. After switch S has been closed for a long time, the current I_b through the battery and the current I_L through the inductor are respectively



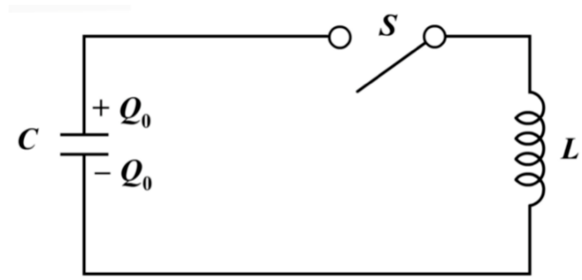
A) I_b =0 I_L =0
B) I_b =0.3 A I_L =0
C) I_b =0.2 A I_L =0
D) I_b =0.3 A I_L =0.3 A
E) I_b =0.2 A I_L =0.2 A
F) I_b =0.5 A I_L =0.3 A

9. [7 pts] An oscillating voltage of fixed amplitude is applied across a circuit element. If the frequency of this voltage is increased, the amplitude of the current will:

A) increase if the circuit element is either an inductor or a capacitor.
B) decrease if the circuit element is either an inductor or a capacitor.
C) remains the same for either an inductor or a capacitor.
D) increase if the circuit element is an inductor, but decrease if the circuit element is a capacitor.
E) decrease if the circuit element is an inductor, but increase if the circuit element is a capacitor.

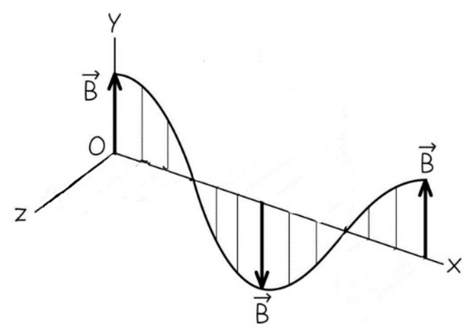
10. [7 pts] In the circuit below the capacitance is C=40.0 mF and the inductance is L=65.0 H. The capacitor is fully charged when the switch S is closed. Calculate the time needed for the energy initially stored in the capacitor to be completely transferred to the inductor.

A) 10.13 s
B) 5.06 s
C) 2.53 s
D) 1.26 s
E) 0.63 s
F) 0.32 s



11. [7 pts] An electromagnetic plane wave is propagating in free space toward the negative x direction. The magnetic field is as shown. A possible description of the electric field is:

A) $\vec{E} = E_0 cos(kx + \omega t)\ \hat{x}$
B) $\vec{E} = E_0 cos(kx - \omega t)\ \hat{x}$
C) $\vec{E} = E_0 sin(kx + \omega t)\ \hat{z}$
D) $\vec{E} = E_0 sin(kx - \omega t)\ \hat{z}$
E) $\vec{E} = E_0 cos(kx + \omega t)\ \hat{z}$
F) $\vec{E} = E_0 cos(kx - \omega t)\ \hat{z}$

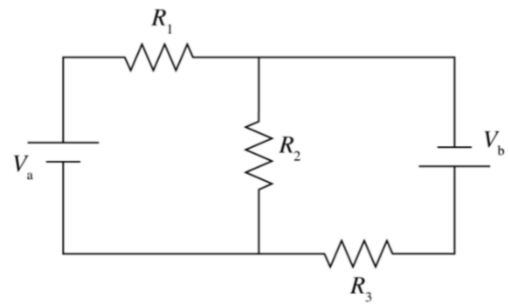


12. [8 pts] An electromagnetic plane wave has its magnetic field oscillating parallel to the z axis and has a Poynting vector given by $\vec{S}(x,t) = \frac{100\ W}{m^2}\cos^2(kx - \omega t)\ \hat{x}$.
The electric field must be given by

A) $\vec{E} = \left(0.011\frac{V}{m}\right) cos(kx - \omega t)\ \hat{y}$
B) $\vec{E} = \left(0.011\frac{V}{m}\right) cos(kx - \omega t)\ \hat{z}$
C) $\vec{E} = \left(10\frac{V}{m}\right)\ cos(kx - \omega t)\ \hat{y}$
D) $\vec{E} = \left(10\frac{V}{m}\right)\ cos(kx - \omega t)\ \hat{z}$
E) $\vec{E} = \left(194\frac{V}{m}\right)\ cos(kx - \omega t)\ \hat{y}$
F) $\vec{E} = \left(194\frac{V}{m}\right)\ cos(kx - \omega t)\ \hat{z}$

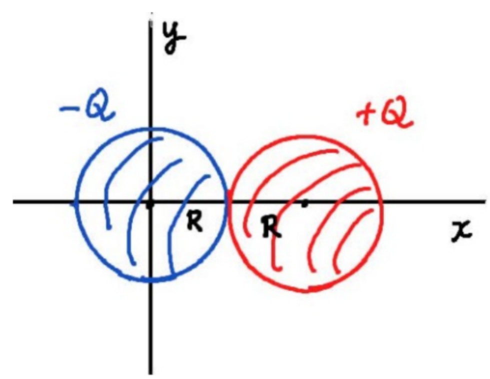
13. [7 pts] In the following diagram $R_1 = R_2 = R_3 = R$ and $V_a = 4\varepsilon$, $V_b = \varepsilon$.
In terms of R and V, the magnitudes of current I_1 and I_2 flowing through resistors R_1 and R_2 must be respectively

A) $|I_1| = 1\varepsilon/R$ $|I_2| = 3\varepsilon/R$
B) $|I_1| = 2\varepsilon/R$ $|I_2| = 2\varepsilon/R$
C) $|I_1| = 3\varepsilon/R$ $|I_2| = \varepsilon/R$
D) $|I_1| = 4\varepsilon/R$ $|I_2| = 2\varepsilon/R$
E) $|I_1| = 3\varepsilon/R$ $|I_2| = 3\varepsilon/R$
F) $|I_1| = 2\varepsilon/R$ $|I_2| = \varepsilon/R$



14. [8 pts] Two uniformly charged solid spheres of total charge $-Q$ and Q with radius R are placed along the x-axis with centers at x=0 and x=2R respectively. The electric field produced by both charged sphere at x=R/2 is

A) $\vec{E} = +k\frac{Q}{R^2}\left(\frac{1}{2}+\frac{1}{4}\right)\hat{x}$
B) $\vec{E} = -k\frac{Q}{R^2}\left(\frac{1}{2}+\frac{1}{4}\right)\hat{x}$
C) $\vec{E} = +k\frac{Q}{R^2}\left(\frac{4}{9}+\frac{1}{2}\right)\hat{x}$
D) $\vec{E} = -k\frac{Q}{R^2}\left(\frac{4}{9}+\frac{1}{2}\right)\hat{x}$
E) $\vec{E} = +k\frac{Q}{R^2}\left(\frac{4}{9}+\frac{1}{4}\right)\hat{x}$
F) $\vec{E} = -k\frac{Q}{R^2}\left(\frac{4}{9}+\frac{1}{4}\right)\hat{x}$



Scratch Paper

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