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Magnetic Fields

A square circuit with sides of length l consisting of a single resistor, R, is penetrated by a solenoid of radius a, as shown in the figure. A constant current $I = 100$ A flows through the solenoid producing a uniform magnetic field of $|\mathbf{B}| = 0.1$ T within the solenoid.

Question 6 [5 points]

What is n, the number of turns per unit length, of the solenoid?

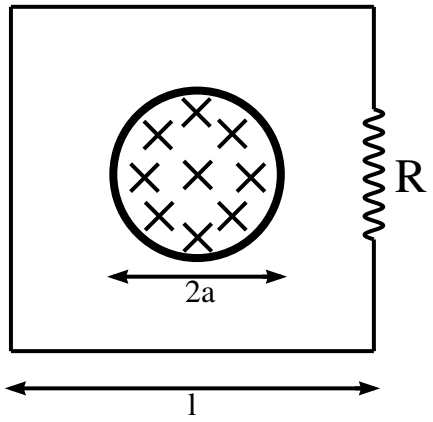
(a) $10/(4\pi)$

(b) $100/(4\pi)$

(c) $1000/(4\pi)$

(d) $10000/(4\pi)$

(e) $100000/(4\pi)$



Question 7 [5 points]

What is the flux penetrating the square circuit?

(a) 0.1 l^2 Tm^2

(b) 0.1 T

(c) 0.1 πa^2 Tm^2

(d) 0.1 πR^2 $\mathrm{T}\Omega^2$

(e) 100 l a $\mathrm{T}\Omega^2$

Question 8 [5 points]

What is the current in the square circuit?

(a) 100 A

(b) $100/(\pi a^2)$ $\mathrm{A/m}^2$

(c) $100/(\pi l^2)$ $\mathrm{A/m}^2$

(d) 0 A

(e) $100/R$ A

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The magnetic field within the solenoid is uniform, with time-dependence $|\mathbf{B}|(t) = B_0\, t^3 \quad (B_0 > 0)$.

Question 9 [5 points]
What is the current in the square circuit?

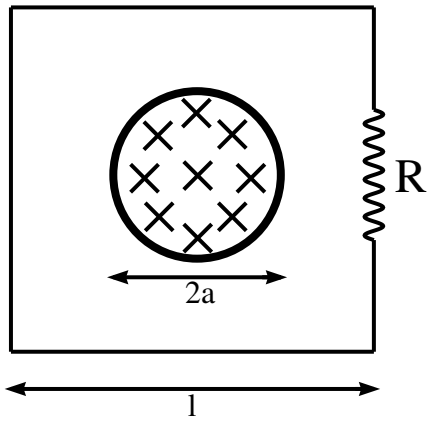
(a) $3B_0\pi a^2t^2/R$

(b) $B_0\pi a^2t^3/R$

(c) $3B_0l^2t^2/R$

(d) $B_0l^2t^3/R$

(e) $B_0\pi a^2t^4/(4R)$



Question 10 [5 points]
In the absence of the square circuit, what is the magnitude of the electric field a distance $r < a$ from the center of the solenoid?

(a) 0

(b) $B_0\pi r^2$

(c) $3B_0t^2$

(d) $3B_0t^2a^2/(2r)$

(e) $3B_0t^2r/2$

Question 11 [5 points]
What is the direction of the electric field for $r \neq 0$?

(a) radial

(b) parallel to the magnetic field

(c) no direction

(d) clockwise

(e) anti-clockwise

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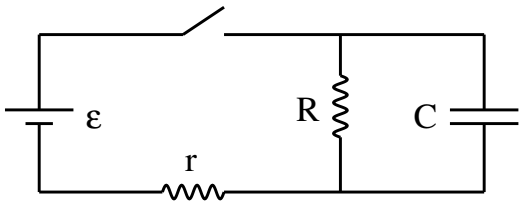
RC-Circuits
A circuit consists of two resistors, a capacitor, a battery and a switch, as shown in the figure.

Question 12 [5 points]
Immediately after the switch is closed, what is the current through resistor r?



(a) $\varepsilon/(R+r)$

(b) ε/r

(c) ε/R

(d) $\varepsilon/\sqrt{RC}$

(e) $C/(Q(R+r))$

Question 13 [5 points]
A long time after the switch is closed, what is the current flowing through the resistor R?

(a) $\varepsilon/(R+r)$

(b) ε/r

(c) ε/R

(d) $\varepsilon/\sqrt{RC}$

(e) $C/(Q(R+r))$

Question 14 [5 points]
At a time t after the switch is closed, what is the current flowing through the capacitor?

(a) $\varepsilon/r\ e^{-t/\tau}$, $\tau = rC$

(b) $\varepsilon/R\ e^{-t/\tau}$, $\tau = RC$

(c) $C\varepsilon$

(d) $\varepsilon/(r+R)\ e^{-t/\tau}$, $\tau = rRC/(R+r)$

(e) $\varepsilon/r\ e^{-t/\tau}$, $\tau = rRC/(R+r)$

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Question 15 [5 points]
A 1 cm^3 copper cube moves perpendicular to a uniform magnetic field $|\mathbf{B}| = 0.1$ T with a speed of $|\mathbf{v}| = 10$ m/s. Faces of the cube are perpendicular to the magnetic field while others are perpendicular to the velocity. What are the potential differences between parallel faces of the cube (the ordering is arbitrary)?

(a) $(0, 0, 0)$ V

(b) $(0.01, 0, 0)$ V

(c) $(0.01, 0.01, 0.01)$ V

(d) $(0.01, 0.01, 0)$ V

(e) $(1, 1, 1)$ V

Question 16 [5 points]
A large number of infinitely long fine conducting wires that are individually insulated are stuck together to form a conducting plate of width w. It carries a current I_2 that is uniformly distributed across the plate. Another infinite wire carries a current I_1 in the direction of I_2, is in the plane of the plate, and a distance c from its closest edge. What is the force per unit length on the wire?

(a) $\mu_0 I_1 I_2/(2\pi c)$ attractive

(b) $\mu_0 I_1^2/(2\pi c)$ repulsive

(c) $\mu_0 I_1 I_2 \log\left(\frac{c+w}{c}\right)/(2\pi w)$ repulsive

(d) $\mu_0 I_1 I_2 \log\left(\frac{c+w}{c}\right)/(2\pi w)$ attractive

(e) $\mu_0 I_1 I_2 \log\left(\frac{c+w}{w}\right)/(2\pi c)$ attractive