

Instructions: You have a total of 50 minutes to complete this test.

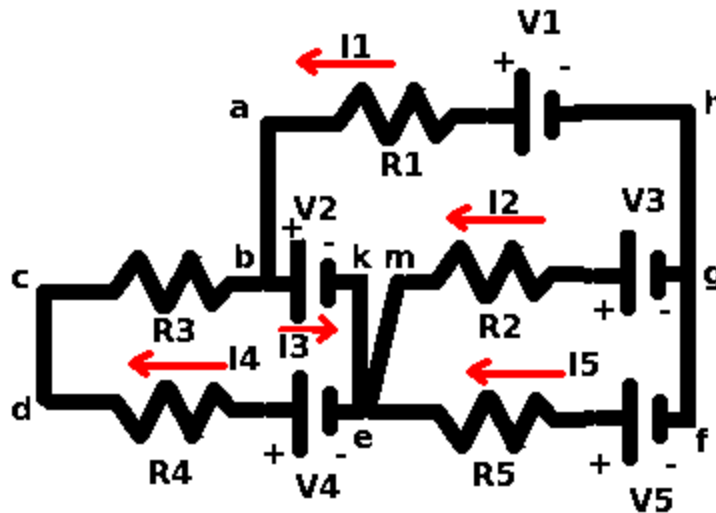
Answer each question completely showing complete details.

For complete credit you must include correct SI units with numerical answers.

Time Start _____ Time finish _____ pledged _____

Constants: $k=8.987 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}$; $\epsilon_0=8.854 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2}$; $\mu_0=4\pi \times 10^{-7} \frac{\text{Tm}}{\text{A}}$; $\mu \equiv 1 \times 10^{-6}$

[1] Consider the circuit shown above. Write the Kirchoff's laws equations that result from the following:



loop (abkemgha):

loop (cdekbc):

loop (mefgm):

@g:

@e:

If the components have the following values:

$R_1=1\Omega$, $R_2=2\Omega$, $R_3=3\Omega$, $R_4=4\Omega$ and $R_5=5\Omega$

$V_1=10\text{V}$, $V_2=20\text{V}$, $V_3=30\text{V}$, $V_4=40\text{V}$ and $V_5=50\text{V}$

The following currents result:

$I_1=106.7 \text{ A}$, $I_2=73.3 \text{ A}$, $I_3=-103.9 \text{ A}$, $I_4=2.9 \text{ A}$, $I_5=33.3 \text{ A}$

Calculate the power radiated by resistor R_3 .

What is the interpretation of the value provided for current I_3 ?

[2] A capacitor has a plate area of $.25 \text{ m}^2$ and a plate separation of 0.1 m .

(a) Calculate the capacitance of this capacitor.

(b) If C_1 has a capacitance of $3 \mu\text{f}$ and C_2 has a capacitance of $6 \mu\text{f}$, calculate the capacitance of the two capacitors when they are connected in series.

(c) If C_1 has a capacitance of $3 \mu\text{f}$ and C_2 has a capacitance of $6 \mu\text{f}$, calculate the capacitance of the two capacitors when they are connected in parallel.

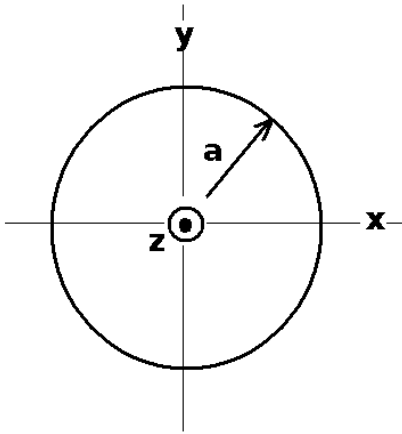
A material has a resistivity of $30 \Omega\text{m}$. A resistor from this material in the shape of a cylinder is 0.1 m long and has a cross sectional area of 0.1 m^2 .

(d) Calculate the resistance of this resistor measured across the ends.

(e) If R_1 has a resistance of 30Ω and resistor R_2 has a resistance of 60Ω , calculate the resistance of the two resistors when connected in series.

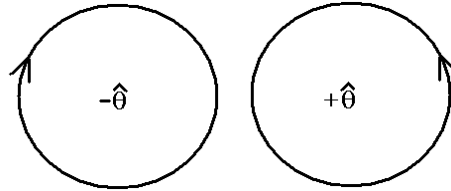
(f) If R_1 has a resistance of 30Ω and resistor R_2 has a resistance of 60Ω , calculate the resistance of the two resistors when connected in parallel.

(g) Calculate the RC time constant when a resistor ($R=3 \times 10^5 \Omega$) is connected in series with a capacitor ($C=6 \mu\text{f}$).



[3] A wire of radius a carries a uniform current density given by \mathbf{j} which is directed out of the page as shown. The wire carries a total current I .

(a) Which direction does the magnetic field circulate around the wire? (circle the correct answer below).



(b) Calculate the magnitude of the current density in terms of I and a .

(c) Showing complete details, including sketches as necessary, calculate the vector magnetic field inside the wire in terms of I , a and the radius vector r .

(d) Showing complete details, including sketches as necessary, calculate the vector magnetic field outside the wire in terms of I , and the radius vector r .

(e) Suppose $I=100$ A and $a=0.1$ m. Find the magnitude of the magnetic field at the surface of the wire with correct SI units.

[4] A parallel plate capacitor has plates of area A separated by a distance d . One plate is in the x - y plane at $z=0$ and the other plate is in the x - y plane at $z=d$.

(a) Allow d to be equal to 1m . If the potential between the plates varies as $V=10 - 10z$, find the potential difference defined by $\Delta V=V(z=d)-V(z=0)$ between the plates. Be sure to include correct SI units here.

(b) Find the electric field between the plates defined by $\vec{E}=-\frac{\Delta V}{\Delta z}\hat{z}$, noting that $\Delta z=d$. Be sure to use correct SI units.

(c) Find the surface charge density defined by $E=\frac{\sigma}{\epsilon_0}$. Be sure to use correct SI units.

(d) Find the energy density in the capacitor, using correct SI units.