

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

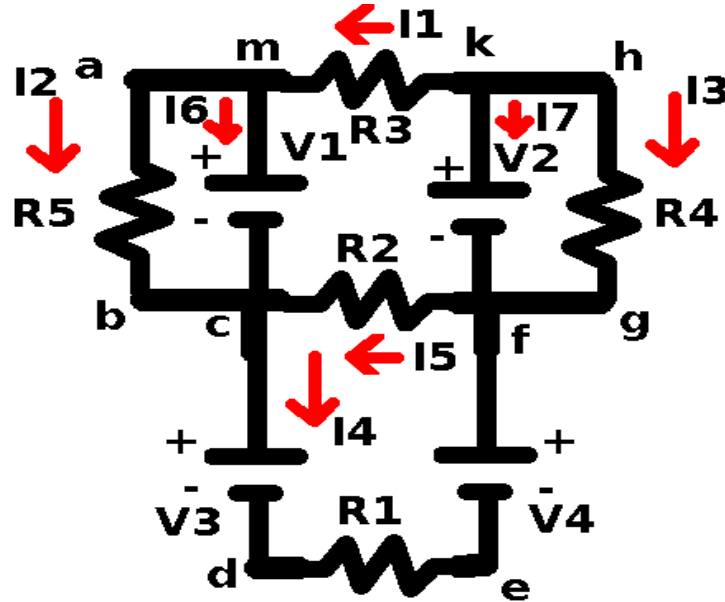
Answer each question completely showing complete details.

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:



(a) loop (abcma): _____

(b) loop(mcfkm): _____

(c) loop (kfgkh): _____

(d) loop (cdefc): _____

(e) @c: _____

(f)@f: _____

(g) @k: _____

If the components have the following values:

$R1=1\Omega$, $R2=2\Omega$, $R3=3\Omega$, $R4=4\Omega$ and $R5=5\Omega$

$V1=10\text{V}$, $V2=20\text{V}$, $V3=30\text{V}$, $V4=40\text{V}$

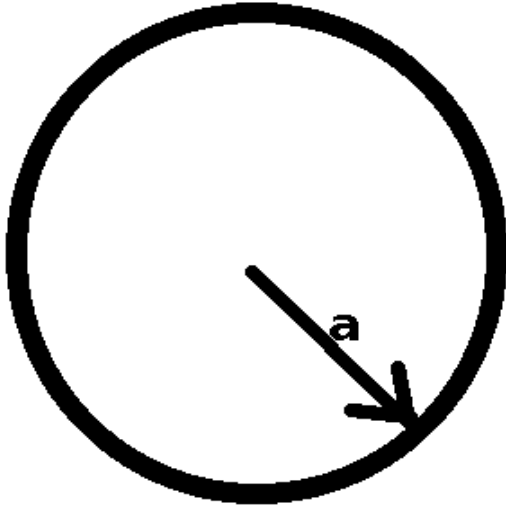
The following currents result:

$I1=7.1 \text{ A}$, $I2=2.0 \text{ A}$, $I3=5.0$, $I4=-1.4 \text{ A}$, $I5=5.7 \text{ A}$, $I6=-9.1\text{A}$, $I7=2.1 \text{ A}$

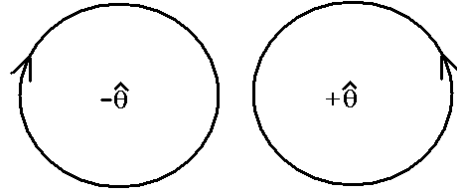
(h) Calculate the power radiated by resistor R1.

(i) What is the interpretation of the value provided for current I6?

[2] A wire of radius a carries a **uniform** current density given by $\vec{j} = -|\vec{j}|\hat{z}$ which is directed into the page. 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, $|\vec{j}|$ in terms of I and a .

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

(d) 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 .

(e) Suppose $I=10$ A and $a=0.1$ m. Find the magnitude of the magnetic field at the surface of the wire with correct SI units.

[3] 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 0.1m . If the potential between the plates varies as

$$V(z) = 1000 - 1000z,$$

find the magnitude of 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 $|\vec{E}| = \left| -\frac{\Delta V}{\Delta z} \right|$, noting that $\Delta z = d$. Be sure to use correct SI units.

(c) Find the surface charge density of the separated charge 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.

[4] A material has a resistivity of $60 \Omega\text{m}$. A resistor from this material in the shape of a cylinder is 0.5 m long and has a cross sectional area of 0.25 m^2 .

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

(b) If R_1 has a resistance of 10Ω and resistor R_2 has a resistance of 100Ω , calculate the resistance of the two resistors when connected in series.

(c) If R_1 has a resistance of 10Ω and resistor R_2 has a resistance of 100Ω , calculate the resistance of the two resistors when connected in parallel.

A capacitor has a plate area of $.5 \text{ m}^2$ and a plate separation of 0.01 m .

(d) Calculate the capacitance of this capacitor.

(e) If C_1 has a capacitance of $5\mu\text{f}$ and C_2 has a capacitance of $8\mu\text{f}$, calculate the capacitance of the two capacitors when they are connected in series.

(f) If C_1 has a capacitance of $5\mu\text{f}$ and C_2 has a capacitance of $8\mu\text{f}$, calculate the capacitance of the two capacitors when they are connected in parallel.

(g) Calculate the RC time constant when a resistor ($R=4 \times 10^6 \Omega$) is connected in series with a capacitor ($C=4 \mu\text{f}$).