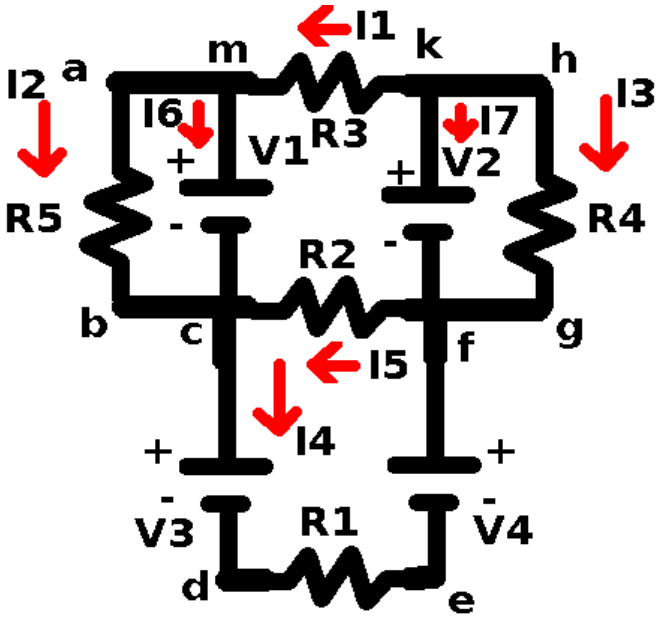
Wednesday, March 04, 2020	**Physics250: UnTest 02**	Name _____

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

[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 (kfghk): _____ (d) loop (cdefc): _____

(e) @c: _____ (f)@f: _____ (g) @k:_____

If the components have the following values:
R1=1Ω, R2=2Ω, R3=3Ω, R4=4Ω and R5=5Ω
V1=10V, V2=20V, V3=30V, V4=40V

The following currents result:
I1=7.1 A, I2=2.0 A, I3=5.0 , I4=-1.4 A, I5=5.7 A, I6=-9.1A, I7=2.1 A

(h) Calculate the power radiated by resistor R1.

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

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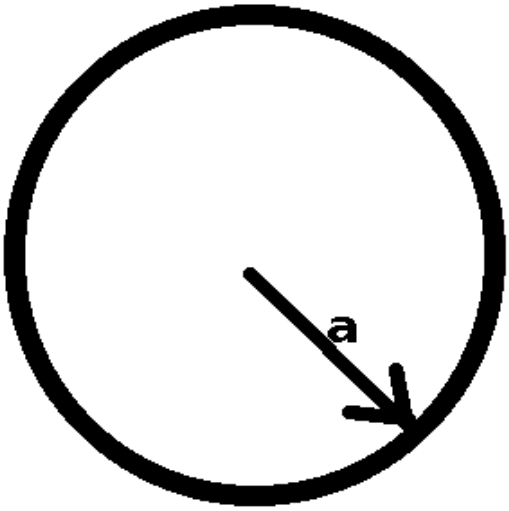
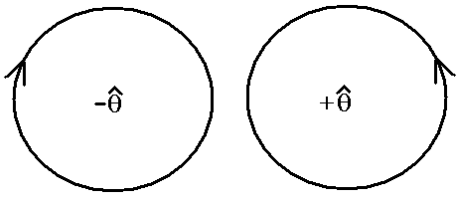


[2] A wire of radius a carries a **uniform** current density given by $\vec{J}=-|\vec{J}|\hat{z}$ which is directed into the page. The wire carries a total current I.

(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=0.1m. 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.

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[4] A material has a resistivity of 60 Ωm. 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 10 Ω and resistor R_2 has a resistance of 100 Ω, calculate the resistance of the two resistors when connected in series.

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

A capacitor has a plate area of .5 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 5μf and C_2 has a capacitance of 8μf, calculate the capacitance of the two capacitors when they are connected in series.

(f) If C_1 has a capacitance of 5μf and C_2 has a capacitance of 8μf, calculate the capacitance of the two capacitors when they are connected in parallel.

(g) Calculate the RC time constant when a resistor ($R=4x10^6$ Ω) is connected in series with a capacitor (C=4 μf).