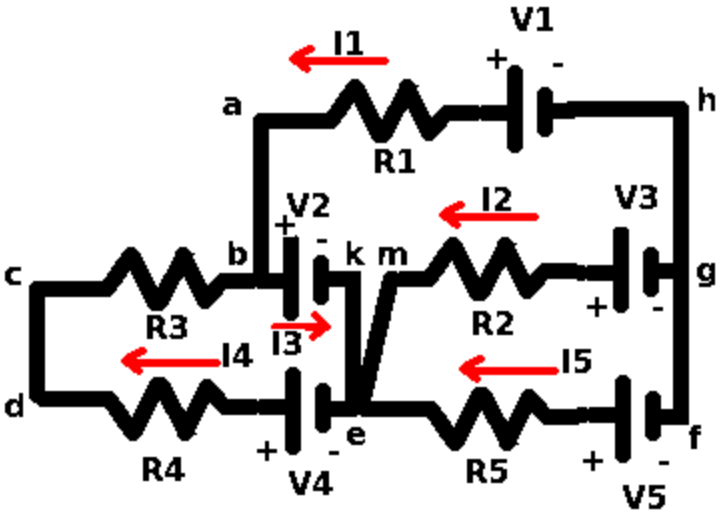
Friday February 28, 2025	**Physics250: UnTest 02**	Name _____

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

[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:
R1=1Ω, R2=2Ω, R3=3Ω, R4=4Ω and R5=5Ω
V1=10V, V2=20V, V3=30V, V4=40V and V5=50V
The following currents result:
I1=106.7 A, I2=73.3 A, I3=-103.9 A, I4=2.9 A, I5=33.3A

Calculate the power radiated by resistor R3.
What is the interpretation of the value provided for current I3?

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[2] A capacitor has a plate area of .25 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 3μf and C_2 has a capacitance of 6 μf, calculate the capacitance of the two capacitors when they are connected in series.
(c) If C_1 has a capacitance of 3μf and C_2 has a capacitance of 6 μf, calculate the capacitance of the two capacitors when they are connected in parallel.
A material has a resistivity of 30 Ωm. 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 30 Ω and resistor R_2 has a resistance of 60 Ω, calculate the resistance of the two resistors when connected in series.
(f) If R_1 has a resistance of 30 Ω and resistor R_2 has a resistance of 60 Ω, calculate the resistance of the two resistors when connected in parallel.
(g) Calculate the RC time constant when a resistor ($R=3x10^5$ Ω) is connected in series with a capacitor (C=6 μf).

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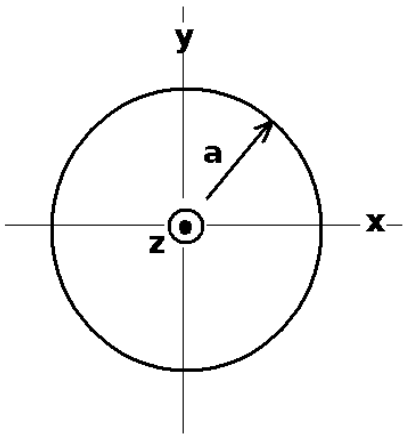
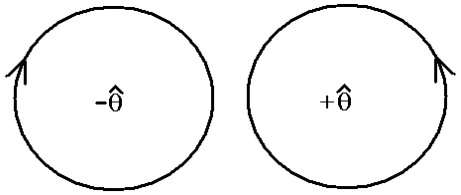


[3] A wire of radius a carries a uniform current density given by which is directed out of the page as shown. The wire carries a total current I.

(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=0.1m. Find the magnitude of the magnetic field at the surface of the wire with correct SI units.

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[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.