Friday, February 24, 2023	**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: $k=8.987\text{x}10^{9}\frac{Nm^2}{C^2}:\epsilon_0=8.854\text{x}10^{-12}\frac{C^2}{Nm^2}:\mu_0=4\pi\,\text{x}10^{-7}\frac{Tm}{A}$

(1) Consider the circuit shown below. Provide correct Kirchoff's law equations for the following:

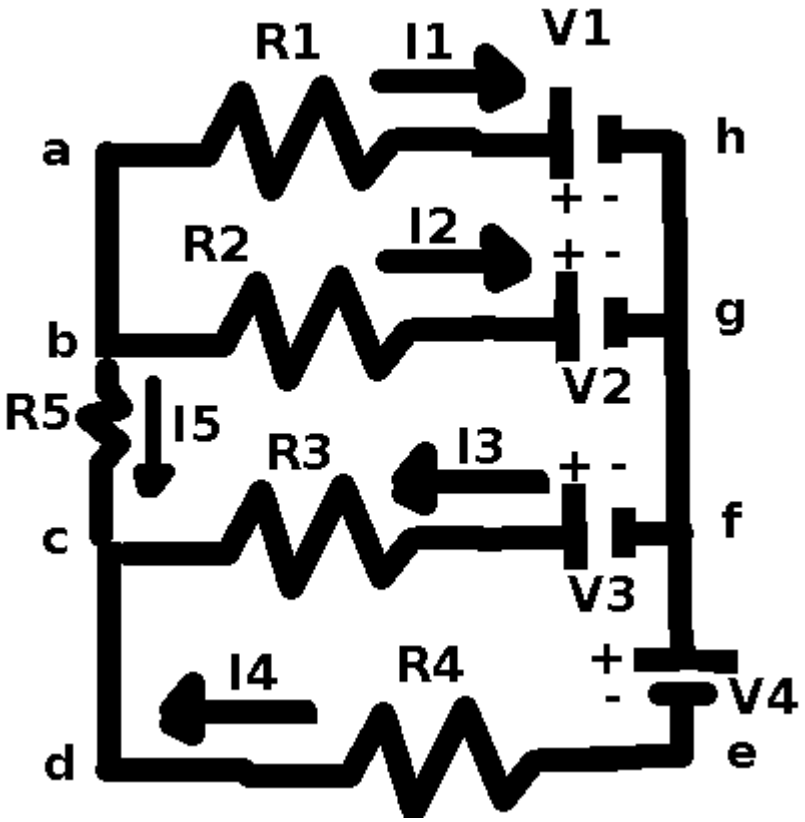
Loop (abgha):_____

Loop (bcfgb):_____

Loop (cdefc):_____

@b: _____

@c: _____



Suppose the following values exist:

resistances: R1=1Ω, R2=2Ω, R3=4Ω,
R4=4Ω R5=5Ω
Potentials: V1=10V,V2=20V,V3=30V,V4=40 V

If the solutions for the currents are:
I1=1.06A, I2=-3.94A,I3=1.81A,I4=-10.78A,I5=1.81A

Calculate the total power radiated by resistor R3.

What is the interpretation of the result provided for current I2?

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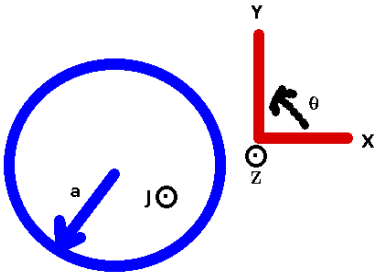

[1] A cylindrical wire of cross sectional area πa^2 has a radius a as shown. The wire carries current density given by $\vec{J} = c\hat{z}$.

[a] If the wire carries a total current I, find the constant c in terms of the radius of the wire and I.

[b] Find the **vector magnetic field** inside the wire (r<a).in terms of r and J. Be sure to include the appropriate unit vector here. Note: your answer contains the symbol J here.

[c] Find the vector magnetic field outside the wire (r>a) in terms of r, a and J. Again, be sure to include the appropriate unit vector here. Note: your answer contains the symbol J here.

[d] If a=0.1 m and J=10 A/m^2, provide a numerical value for the magnitude of the magnetic field at the surface of the wire (where r=a) with correct SI units.

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[2] A parallel plate capacitor has plates of area A and separation d. On the plate located at the z=0, a surface charge density +σ exists while on the plate located at z=d, a surface charge density -σ exists. Answer the following assuming that this can be regarded as an ideal capacitor. If the electric field inside the capacitor is 1000 V/m, and the plates are separated by d=0.2 m, answer the following:

(a) Find the magnitude of the potential difference between the plates of the capacitor with correct SI units.

(b) Find the magnitude of the surface charge density on one of the plates.

(c) Suppose the plates have an area of 0.1 m^2 . Calculate the capacitance of this capacitor with correct SI units.

(d) What is the total energy stored on the capacitor in terms of C and V.

(e) Calculate the energy density in terms of ϵ_0 and E.

(4) Note: in your answers below, be sure to include correct SI units.
Resistor R_1 has a resistance of 50 Ω and resistor R_2 has a resistance of 20 Ω.

(a) If the two resistors are placed in series, what is the equivalent resistance?

(b) If the two resistors are placed in parallel, find the equivalent resistance.

Capacitor C_1 has a capacitance of 5 μf and capacitor C_2 has a capacitance of 3 μf.

(c) if the two capacitors are placed in parallel, find the equivalent capacitance.

(d) if the two capacitors are placed in series, find the equivalent capacitance.

(e) Suppose that a resistor $R=1x10^6$ Ω is placed in series with a capacitor C=3.3 μf. Calculate the time constant of this RC circuit.