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General Physics II, Midterm 4
PHYS10400, Class year 99
05-19-2011

SN:_____, Name:_____

This is an open-book examine. You are allowed to use any material you brought, but not others and computer. **ABSOLUTELY NO CHEATING**!

Problems (6 Problems, total 100 points)

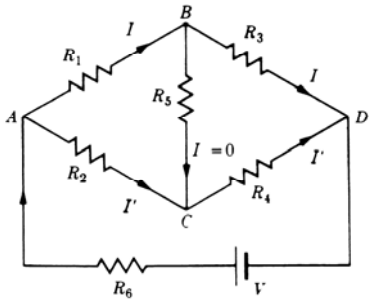
1. **General Concept** (a) Qualitatively explain what a capacitor is and what an inductor is. (10%), (b) Write down Maxwell's 4 Equations, and explain them (10%).

2. **Electric Power:** How much heat (in calorie) is produced in 5 minutes by an electric iron which draws 5 amperes from a 120 volt line? (20%)

3. **Resistance:** The cross-sectional area of the copper wire used in a household wiring system is approximately 3 $mm^2 = 3\times10^{-6}$ m^2. Find the resistance of a copper wire 10 m log, at 20°C, if the resistivity of copper is 1.72× 10-8Ω·m. (20%)

4. **Bohr Theory**: Assume, for simplicity, the electron (charge ***e***) of hydrogen atom moves around the nucleus (with charge ***Ze***) in a circular orbit, (a) derive the orbital angular momentum of the electron according to classical model. (b) What is the total classical energy of this electron in the system? (c) What is the total energy in terms of charge and angular momentum? (d) However, experimentally, angular momentum was observed, "quantized" as $L = n\hbar$, where $\hbar = \frac{h}{2\pi}$ $=1.0545\times10^{-34}$Js and ***n*** is a positive integer. What is the "quantized" energy obtained in (c)? When n=1, we said the electron is in its "ground state", that means the electron is closest to the nucleus possible. The radius of the electron can be expressed as $r = \frac{a_0}{Z}n^2$, where a_0 is called Bohr radius. (e) What is the Bohr radius of the hydrogen electron? Note 1: $\boldsymbol{m_e}$ = the electron mass = 9.1×10^{-31} ***Kg***; $\boldsymbol{\varepsilon_0}$ = vacuum permittivity = $8.85\times10^{-12}\boldsymbol{N^{-1}m^{-2}C^2}$; ***e*** = the charge of the electron = 1.6×10^{-19} ***C***. Note 2: However, it should be emphasized that the value of r obtained in (d) must not be taken too literally. According to quantum mechanics it should be considered only as an indication of the order of magnitude of the region in which the electron is most likely to be found. (20%)

5. **Wheatstone bridge**: The circuit on the right is called Wheatstone bridge. This circuit is often used to measure resistance for it is a very sensitive measuring device. Determine the conditions under which the current through R_5 in the circuit is zero; i. e. what is the relation between R_1, R_2, R_3 and R_4? (10%)



6. **Moving charge in magnetic field:** What is the radius of the orbit of a 1 MeV proton in a 10^4 Gauss magnetic field? Derive this answer, R=14.4 cm Hint: If the particle move is a speed v, close to the speed of light, then the total kinetic energy (KE) is given by $KE = \frac{m_0c^2}{\sqrt{1-\beta^2}}$, $\beta = \frac{v}{c}$, c is the speed of light. (20%)