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General Physics II, Midterm 4
PHYS10400, Class year 100
05-24-2012

SN:_____, Name:_____

Note: This is an OPEN BOOK examine. You can bring any materials into the classroom in examine. However, you should work on your examine sheet using your own material; You can NOT borrow other's calculators and no discussion with others are allowed.
ABSOLUTELY NO CHEATING!

Problems (5 Problems, total 100%)

1. **Dipole in an Electricity field:** (15%) What is the electric potential when an electric dipole ***P*** is placed in an electric field ***E***? Derive it. Initially, you can assume the dipole is placed at an angle θ with the electric field, and then you work out the general form of it.

2. **Bohr theory** (30%): 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 $\hbar = \frac{h}{2\pi}$ =1.0545×10^{-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: m_e = the electron mass = 9.1×10^{-31} ***Kg***; ε_0 = vacuum permitivity = 8.85×10^{-12}***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.

3. **Earth's magnetic field** (15%): In an experiment designed to measure the Earth's magnetic field (***B***) using the Hall effect, a copper bar 0.500 cm thick is positioned along an east–west direction. If a current of 8.00 A in the conductor results in a Hall voltage of 5.10×10^{-12} V, what is the magnitude of the Earth's magnetic field? (Assume n = 8.46×10^{28} electrons/m^3 and the plane of the bar is rotated to be perpendicular to the direction of ***B***.)

4. **Displacement current** (20%) Explain, what is displacement current? What is its role played in the Ampere's law?

5. **Resistance**: (20%) The cross-sectional area of the copper wire used in a household wiring system is approximately 3 mm^2. Find the resistance of a copper wire 10 m long, at 20°C, if the resistivity of copper is 1.72×10^{-8} ohm•m. Note: you need to derive this, not just plug in number with formula.