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First Semester Examinations 2011/2012

First Year Examinations for the Degree of Bachelor of Science in Mechanical Engineering

SPH 2174: PHYSICS FOR ENGINEERS II

Supplementary/Special

Date **Time**

Please, answer the first question and any two other questions

Question One

- (a) State in words the Coulomb's law. Write down mathematical expression in such a way that reflects all the features of interaction of point charges. Give the name and SI units of each symbol used **(6 marks)**
- (b) Define "current density" through a conductor. Give its SI units. From there derive Ohm's law in differential form. Give the name and the SI units of each symbol. **(6 marks)**
- (c) Write down the expression on which the definition of the "Ampere" as one of the seven units of SI system of units. State in words that definition **(6 marks)**
- (d) Explain the phenomenon of refraction of a wave at interface between two different media of propagation. Write down the laws of refraction of light. Give the name and SI unit of each symbol **(6 marks)**
- (e) Formulate Bohr's three postulates on the structure of the atom and atomic spectra **(6 marks)**

Question Two

- (a) Using dimensional analysis, prove that SI unit for quantity RC is second **(6 marks)**
- (b) A 30cm -diameter metal sphere hangs from a thread in a very large room, so its surroundings are essentially at infinity. If the electric field at its surface is to be equal to the breakdown strength of air, $3M \frac{V}{m}$,
- (i) What must be the absolute potential of the sphere?
 - (ii) What is meant by "breakdown strength of a dielectric"?
 - (iii) Why do we have to assume that the surroundings of the sphere are essentially at infinity? **(8 marks)**
- (c) The work function for tungsten is 4.9eV . Will photoeffect take place if a tungsten surface is illuminated with a beam from diode laser at $\lambda = 405\text{nm}$? If yes, what is the velocity of photoelectrons? **(6 marks)**

Question Three

- (a) There is a way of determining the resistance of a resistor by using a battery, a voltmeter and ammeter. Give the circuit and the procedure for such a measurement **(8 marks)**
- (b) Two identical tiny metal balls carry charges of $+3\text{nC}$ and -12nC , respectively. They are 3cm apart.
- (i) Compute the force of attraction
 - (ii) The balls are now touched together and then separated to 3cm . Describe the forces on them now **(6 marks)**
- (c) Alpha particle ($m = 6.68 \times 10^{-27} \text{kg}$, $q = +2e$), accelerated through a potential difference V to 2keV enters a magnetic field $B = 0.2\text{T}$ perpendicular to their direction of motion. Calculate the radius of their path **(6 marks)**

Question Four

- (a) Give a simplified and labelled diagram of experimental setup to demonstrate the photoelectric effect. Write down the Einstein equation for electric effect. Give the name and SI unit of each symbol used. **(8 marks)**
- (b) It is needed to transmit DC electric power at a distance of 5km and $2.5 \times 10^5 \frac{\text{A}}{\text{m}^2}$ current in such way that the power losses in copper wires do not exceed 1% of the generated power. What must the minimum transmission voltage? the specific resistance of copper is ... = $1.68 \times 10^{-8} \Omega \cdot \text{m}$ **(6 marks)**
- (c) Using the lens equation, show that if a convex lens produces the same size image as the object, both object distance and image distance are twice the focal length. Prove the same using ray tracing technique **(6 marks)**

Question Five

- (a) (i) Give a simplified labelled of an X-ray machine
 (ii) Show that the cut-off wavelength (in picometres) in the continuous X-ray spectrum from in target is given by $\lambda_{\min} = \frac{1240}{V}$, where V is the potential difference in kV through which the electrons are accelerated before they strike the target **(8 marks)**
- (b) The deflection of an electron beam is 1mm when it travels a distance of 5cm between two plates of a capacitor as shown in Fig.1. Determine the average velocity of electrons if the distance between the plates is 1cm and their potential difference is 250V **(8 marks)**

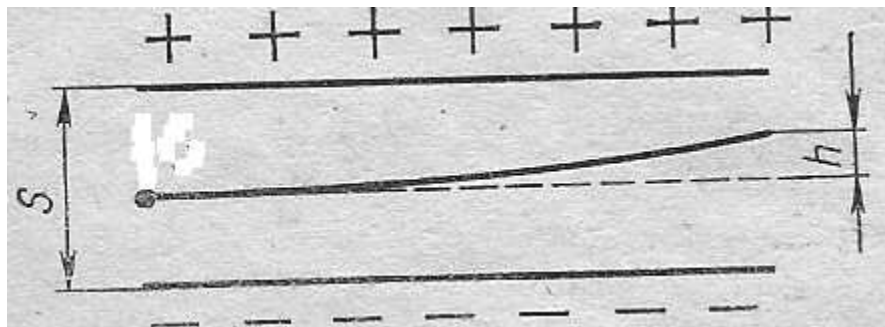


Fig.1. Question Five (b)

- (c) A wire bearing a current of 10A lies perpendicular to a uniform magnetic field. A force of 0.2N is found exist on a section of the wire 80cm long. Determine the magnetic and direction of the magnetic induction B **(4 marks)**