DEGREE IN COMPUTER ENGINEERING

PHYSICS EXAM **10th JANUARY 2011**

Surname:

Name:

Group 89

E1	E2	E3	E4	Q1	Q2	Q3

1.- The exam has 4 exercises and 3 questions.
2.- The corresponding marks are attached to each exercise or question.
3.- Each exercise or question must be solved on a separate sheet.
4.- On each square above, mark with an X the exercises or questions that have <u>NOT</u> been solved.

<u>CONSTANTS:</u>

Charge of the electron: $-1{,}6 \times 10^{-19}\ C$

Permittivity of free space: $\varepsilon_0 = 8{,}85 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$

Permeability of free space: $\mu_0 = 4\ \pi \times 10^{-7}\ N\ A^{-2}$

Mass of the electron: $9{,}11 \times 10^{-31}\ kg.$

$h = 6.626 \times 10^{-34}\ \mathrm{J\,s}$

Mass of the proton: $1{,}67 \times 10^{-27}\ kg$

$c = 2.998 \times 10^{8}\ \mathrm{m/s}$

<u>EXERCISES:</u>

E1. ***(2p)*** A proton starting from rest is accelerated by a uniform electric field of magnitude 640 N/C. After some time, the speed of the proton is 1.2×10^6 m/s.

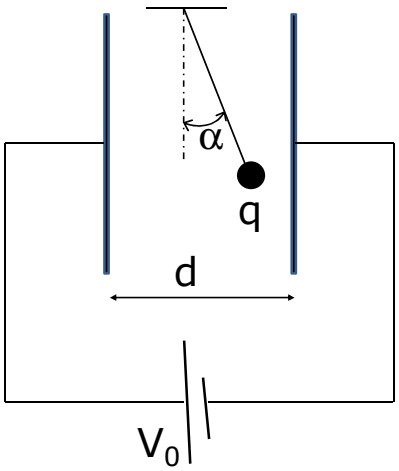
a) How long does it take for the proton to reach that speed?
b) Find the distance travelled by the proton until it reaches that speed.
c) Find the kinetic energy of the proton when it reaches that speed in J and eV.

E2. ***(2p)*** A small sphere of mass m and charge q hanging from a massless string is located inside a parallel-plate capacitor with plates of area A and distance between the plates d (as shown in the figure).

a) Find the capacitance of the capacitor, the electric field inside the capacitor and the charge on the plates.

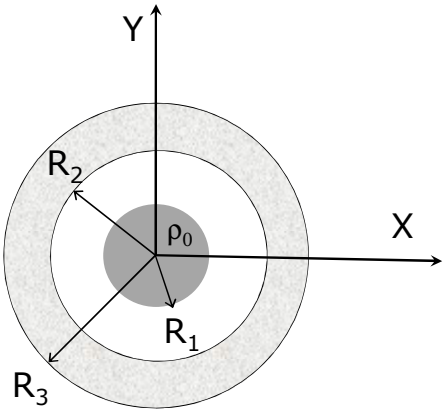
b) Find the charge q of the sphere knowing that the pendulum is in equilibrium when the string forms an angle α with the vertical.

DATA: A= 1.13 m^2; d= 4 cm; V_0 = 500 V, m= 2 g; α= 30°



E3. ***(2p)*** A solid sphere of radius R_1 is uniformly charged with a volume charge density ρ_0. A metallic spherical shell of inner radius R_2 and outer radius R_3 concentric with the solid sphere is charged with Q (see figure). Find the electric field $\vec{E}$ (expressed in <u>rectangular</u> coordinates) at points: A (5,0,0); B (20,0,0); C (38,0,0) and D (25,35,0) (all coordinates are expressed in cm).

DATA: ρ_0 = - 4.8× 10^{-3} C/m^3; R_1 = 10 cm; R_2 = 30 cm; R_3 = 40 cm; Q = 30 μC

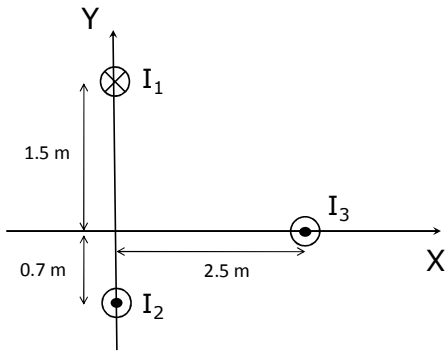


E4. ***(2p)*** Three infinite conducting wires parallel to the Z axis carry currents I_1 = 2 A, I_2 = 5 A, I_3 = 10 A. The location of the wires and the direction of the current intensities are shown in the figure attached.

a) Find $\vec{B}$ at (0, 0, 0).

b) Find the magnetic force $\vec{F}$ exerted on an electron located at (0,0,0) knowing that it travels with a velocity $\vec{v} = 3\times10^4\vec{i} + 5\times10^4\vec{j}$ (m/s).

Express all vectors in rectangular coordinates.



<u>QUESTIONS:</u>

Q1. ***(1 p)*** Describe the conduction properties of an intrinsic semiconductor (both at 0 K and at T>0 K). Use the band theory of solids in the explanation.

Q2. ***(1p)*** Explain the physical behaviour of a semiconductor diode (see the characteristic curve attached). Consider both forward and reverse bias in the explanation.