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Examination

Electrodynamics, TFYY67
2009-06-10
Elektromagnetisk fältteori och vågutbredning

The examination consists of 4 problems. Each correctly solved problem gives 4 points. The points you have earned from solving the home-work problems will be added to the results of the examination. The grades will be set according to:

grade 3: total score of 8-11 points
grade 4: 12-15 points
grade 5: 16-20 points

Allowed to bring to the examination: "Classical Electromagnetic Radiation" by Heald & Marion, Physics Handbook, English dictionary, electronic calculator.
Additional material might be distributed during the examination.

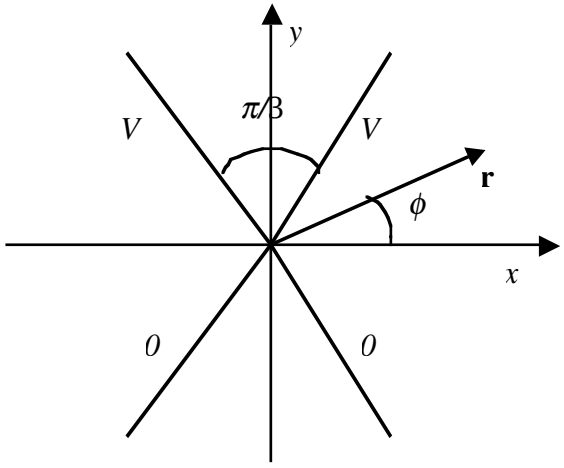
The solutions should be in either English or Swedish.

1. (4p) Determine the E-field in spherical coordinates from a hydrogen atom placed at the origin. The charges producing the field is the nucleus at the origin and the electron cloud. The point charge e is placed at the origin (the nucleus). The charge density from the electron cloud is given by

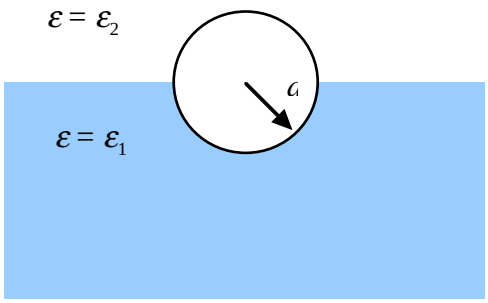
$$\rho(r) = \left(\frac{-e}{\pi a_0^3}\right)\exp\left(-\frac{2r}{a_0}\right)$$

2. (4p) Let a square sheet of side length a be placed in the xy-plane with its center at the origin and the sides parallel to the x- and y-axes. The charge q is evenly distributed over the sheet. Make a multipole expansion of the resulting potential up to and including the quadrupole contribution. The answer should be given in spherical coordinates.

3. (4p) Two metallic half-planes are each bent into a V-shape with angle $\pi/3$ (60º). They are placed on top of each other with their edges almost in contact. There is an infinitesimal gap separating them. The upper object has the constant potential V and the lower is grounded.
   a) Find the potential everywhere.
   b) Describe the equi-potential surfaces.
   c) Find the **E**-field everywhere
   d) Find the surface charge density on both metal plates.



4. (4p) A conducting sphere of radius a is half-embedded in a liquid dielectric medium of permittivity ε_1 as in the figure. The region above the liquid is a gas of permittivity ε_2. If the total free charge of the sphere is Q, determine the **E**-, and **D**- fields everywhere.



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