BIRZEIT UNIVERSITY

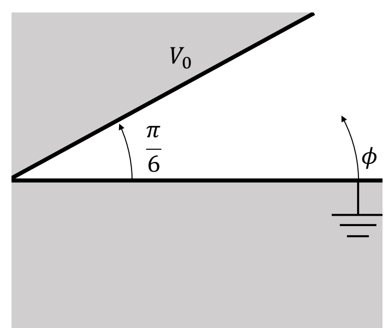
**Physics 331 Final Exam**
**Second Semester 2016/2017**
**Instructor: Abdallah Sayyed-Ahmad**

**Sunday 4/6/2017** **Time: 150 minutes**

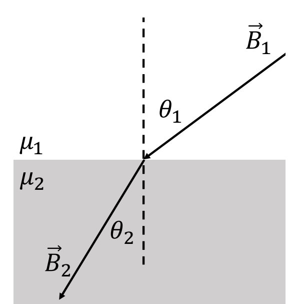
(1) Two uniform infinite sheets of electric charge densities $+\sigma$ and $-\sigma$ intersects at a right angle.
   (a) Find the magnitude the electric field everywhere (5%).
   (b) Determine the direction of the electric field everywhere by sketching the field lines (5%).

(2) According to quantum mechanics, the electron cloud for a hydrogen atom in the ground state has a charge density $\rho(r) = \frac{e}{\pi a^3}\exp\left(-\frac{2r}{a}\right)$. Where $e$ is the charge of the electron and $a$ is the Bohr radius.
   (a) Find the magnitude of the electric field $E(r)$ (10%).
   (b) Estimate the polarizability (by expanding the exponential assuming $r \ll a$ ) (10%).

(3) Two infinite insulated conducting planes maintained at a potential $0$ and $V_0$ form a wedge shaped configuration as shown in the figure. Determine the potential distribution for the region $0 < \phi < \frac{\pi}{6}$ (15%)




(4) At the interface between on linear magnetic material and another, the magnetic field lines bend. Show that $\frac{\tan\theta_2}{\tan\theta_1} = \frac{\mu_2}{\mu_1}$, assuming no free current at the boundary. (15%)



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(5) An infinitely long cylinder of radius $R$ carries a “frozen in” magnetization parallel to the cylinder axis $M = ks\hat{z}$. Where $k$ is constant and $s$ is the distance from the cylinder axis; there is no free current anywhere. Find the magnetic field inside and outside and the cylinder (15%)

(6) According to quantum mechanics, the current density due to an electron in a hydrogen atom state (n=2, l=2, m=2) is given by

$$\vec{J} = -\frac{1}{2\cdot 3^8}\frac{e\hbar}{\pi m a^7{}_0}\; r^3\; \exp\left(-\frac{2r}{3a}\right)\sin^3\theta\,\hat{\phi}$$

find the magnetic field at $r = 0$ (15%)