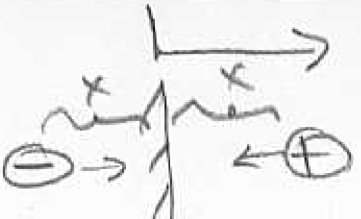


method of images

3. (10 pts) A point charge q of mass m is released from rest at a distance d from an infinite grounded conducting plane. Derive an expression for (a) the velocity (b) an integral representation of the position (assume $v = \sqrt{\frac{kq^2}{2d} - \frac{kq^2}{2x}}$ where $k = \frac{1}{4\pi\epsilon_0}$. (5 points extra credit) What do you expect to happen quantum mechanically and explain why for credit?

cons. energy

$KE + PE = \text{const.}$

$\frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{kq^2}{2x} = \text{const}$

at $t=0$ $v=0$ $\therefore$ $\text{const} = \frac{kq^2}{2d}$

$v^2 = \frac{kq^2}{2md} - \frac{kq^2}{2mx}$

$-v = -\frac{dx}{dt} = \sqrt{\frac{kq^2}{m2d} - \frac{kq^2}{m2x}}$

Newton's Law

$F = -\frac{kq^2}{(2x)^2} = m\frac{dv}{dt}$ multiply by v

$m\frac{dv}{dt}v = -\frac{kq^2}{4x^2}\frac{dx}{dt}$

$m\frac{d}{dt}\left(\frac{v^2}{2}\right) = -\frac{kq^2}{4}\frac{d}{dt}\left(\frac{1}{x}\right)$

multiply by dt & integrate

$\frac{1}{2}v^2 = -\frac{kq^2}{m4x} + \text{const}$

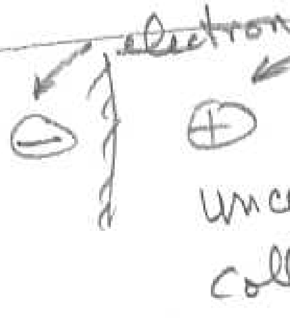
initial condition $v=0$ @ $x=d$ $\Rightarrow$ $\text{const} = kq^2/4dm$

4. (0 to -20 pts) (a) Using the integral form of Gauss's Law, **DERIVE** the electric field due to an infinite **CYLINDER** of charge, with radius R and charge density $\rho = Ar$ **AND** a constant surface charge density σ_0 at $r = R$, where A is a constant. Find the field both inside and outside the cylinder. (b) Prove that your result is consistent with the differential form of Gauss's Law.

Note $\nabla \cdot \vec{v} = \frac{1}{s}\frac{\partial}{\partial s}(s v_s) + \frac{1}{s}\frac{\partial}{\partial \phi}(v_\phi) + \frac{\partial}{\partial z}v_z$

$v^2 = \frac{kq^2}{2dm} - \frac{kq^2}{2mx}$

$\int_d^0 \frac{dx}{\sqrt{\quad}} = \int_0^{t_f} dt$



looks like positronium atom.
uncertainty principle keeps atom from collapsing.