Physics 101 Fall 2006: Suggested Problems # 4

1. Problem 24-52. (**+10 pts**)

   STATEMENT OF PROBLEM:

   Charges are distributed with uniform charge density λ along a semicircle of radius R, centered at the origin of a coordinate system. What is the potential at the origin?

   (a) +3 pts - correct set up for dV.

   $$dV = \frac{k\,dq}{r}$$

   $$\Delta V = k \int \frac{dq}{r}$$

   (b) +5 pts - completing the integral.

   i. +2 pts r is constant ($r = R$) with respect to the integration.

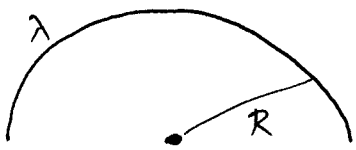
   ii. +3 pts - correct answer for ΔV:

   $$\Delta V = \frac{k\,Q}{R}$$

   (c) +2 pts - correct answer in terms of λ.

   $$\Delta V = \frac{\lambda}{4\,\varepsilon_0}$$

24-52



$\lambda \equiv Q/L = \frac{Q}{\pi R} \rightarrow \boxed{Q = \lambda \pi R}$

We know $dV = k\, dq/r \Rightarrow \Delta V = k \int dq/r$

r is equidistant from all points on the semicircle ($r \equiv R$)

so $\Delta V = \frac{k}{R} \int dq = \frac{kQ}{R}$

$\Delta V = \frac{k \lambda \pi R}{R} = k \lambda \pi = \frac{\lambda}{4\varepsilon_0}$

$\Rightarrow \boxed{\Delta V = \frac{\lambda}{4\varepsilon_0}}$ with $V \to 0$ as $r \to \infty$

$\boxed{V = \frac{\lambda}{4\varepsilon_0}}$