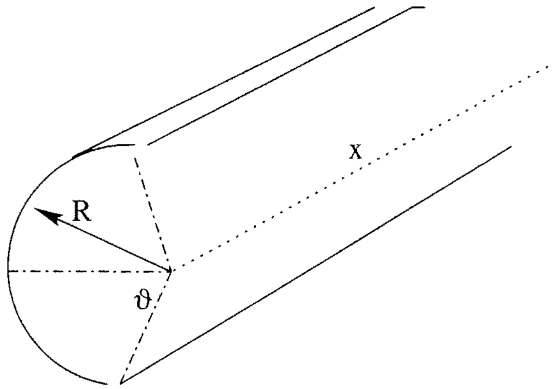
General Physics II: PHYS 2611

≡ KEY ≡

Yet more Coulomb Law Practice...potentials!

1) Show that the magnitude of the electric potential of a pipe-section as measured at the centerline of the pipe is given by $V = 4k\sigma R\theta \log(R)$ where θ is the angle that the pipe subtends and σ is its surface charge density.

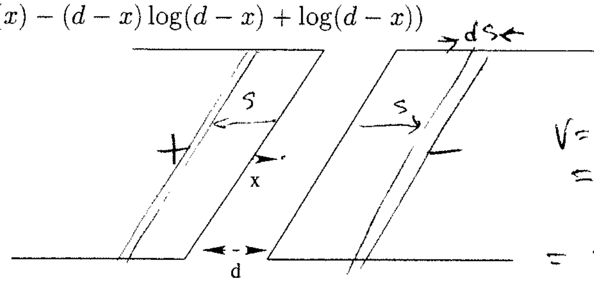
$$V = \sum dV \qquad d\lambda = \sigma R\, d\theta$$
$$= \sum 2k\, d\lambda \ln R$$
$$= \int 2k\sigma R \ln R\, d\theta$$
$$= 2k\sigma R \ln R \int d\theta = \underbrace{4k\sigma R\theta \ln R}$$



2) Show that the electric ~~field~~ POTENTIAL at a distance x between two **oppositely**-charged plates separated by distance d, each half-infinite and carrying surface charge of magnitude density σ is $V = 2k\sigma(x\log(x) - \log(x) - (d-x)\log(d-x) + \log(d-x))$

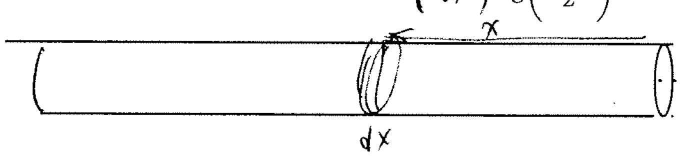
POT FROM LINE CHARGE $\sim 2k\lambda \ln R$

$$\lambda = \sigma\, ds$$
$$V = \sum dV = \sum (2k\sigma\, ds \ln(s+d-x) - 2k\sigma\, ds \ln(s+x))$$
$$= \int_0^\infty 2k\sigma \ln\left(\frac{s+d-x}{s+x}\right) ds$$
$$= 2k\sigma\left[(s+d-x)\ln(s+d-x) - (s+d-x) - (s+x)\ln(s+x) + (x+s)\right]$$
$$= 2k\sigma\left[(d-x)\ln(d-x) - x\ln x\right]$$



3) For a very thin wire of length L carrying total charge Q show that the electrostatic potential at a distance Z from the end as show is $V = (kQ/L)\log\left(\frac{L+Z}{Z}\right)$

$$dq = \lambda\, dx \qquad \lambda = Q/L$$



$$V = \int dV = \int_0^L \frac{k(\lambda\, dx)}{x+Z} = k\lambda \ln(x+Z)\Big]_0^L$$
$$\boxed{V = \frac{kQ}{L}\ln\left(\frac{L+Z}{Z}\right)}$$

4) For the half-sphere shown below, a charge Q is uniformly distributed across it's surface. It has radius R. Show using Coulomb's law that the magnitude of the electric potential at X (the center of the sphere) is $\frac{kQ}{R}$ ~~directed to the right~~.

$$V = \sum dV \qquad dV = \frac{k\,dq}{R}$$

ALL R'S THE SAME TO CENTER

$$\Rightarrow V = \int dV = \frac{k}{R}\int dq = \frac{kQ}{R}$$

Q TOTAL CHARGE.