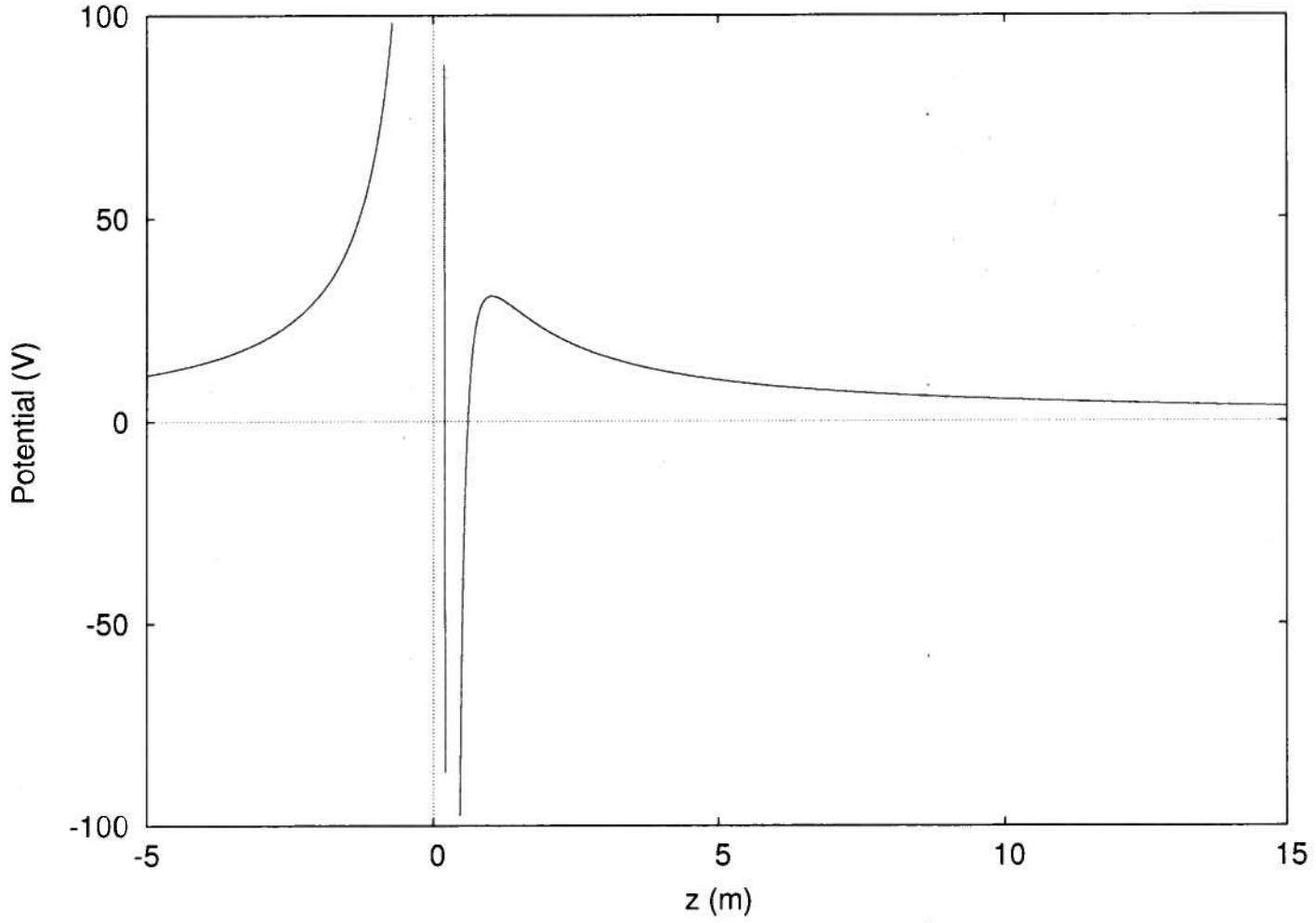
PHYS 272/272H - HW #3 Solutions

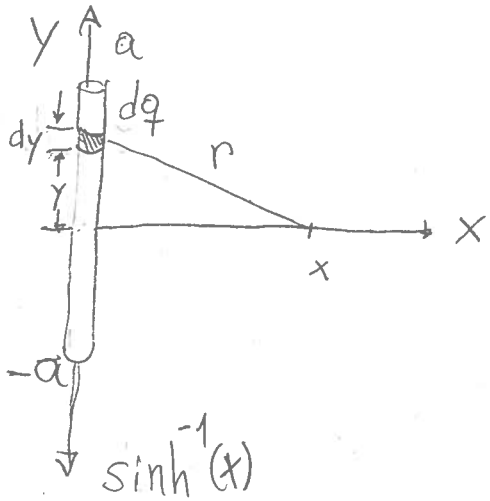
Problem 1:

$$V = K\left(\frac{q_1}{z} - \frac{q_2}{z-a}\right)$$

$$V = 8.9876\left(\frac{12}{z} - \frac{6}{z-0.3}\right)$$



Problem 2:



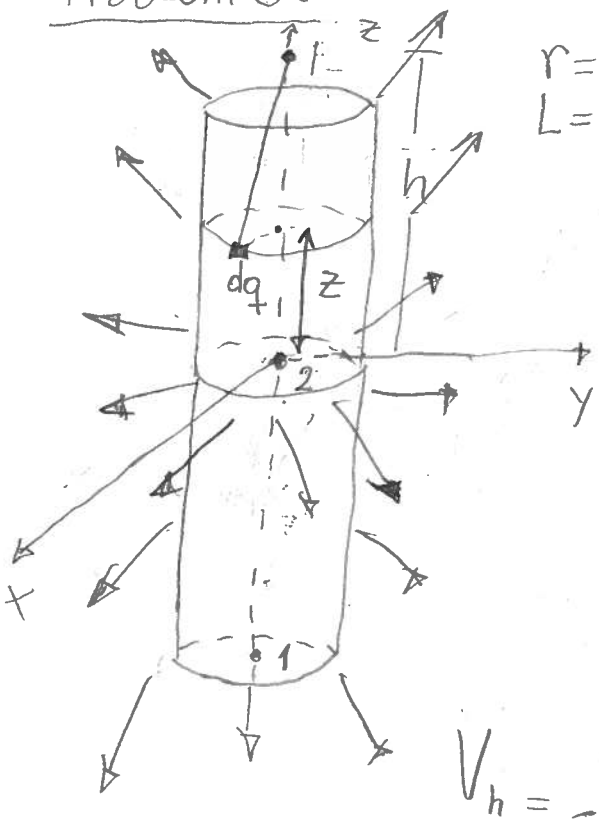
$$dV = -K\frac{dq}{r} = -\frac{K\lambda\, dy}{\sqrt{y^2+x^2}}$$

$$V = \int dV = -K\lambda \int_{-a}^{a} \frac{dy}{(y^2+x^2)^{1/2}}$$

$$\sinh^{-1}(x) = \ln\left[x+\sqrt{x^2+1}\right]$$

$$\boxed{V = -2K\lambda \sinh^{-1}\left(a/x\right)}$$

Problem 3:



$$\sigma = \frac{Q}{2\pi ab}$$

$$V_{21} = V_2 - V_1$$

$$V_h = \int dV \;;\quad dV = -K\frac{\sigma\, d\ell\, dz}{\sqrt{(h-z)^2+a^2}} = \frac{-K dq}{r}$$

$$d\ell = a\, d\theta$$

$$V_h = -K\sigma a \int_{-b/2}^{b/2} \frac{dz}{\sqrt{(h-z)^2+a^2}} \int_0^{2\pi} d\theta$$

$$V_h = -\frac{KQ}{b} \int_{-b/2}^{b/2} \frac{dz}{\sqrt{(h-z)^2+a^2}}$$

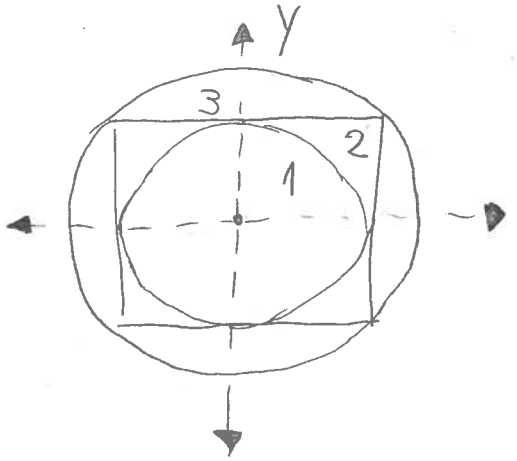
$$V_h = -\frac{KQ}{b}\left[\sinh^{-1}\left(\frac{h+b/2}{a}\right) - \sinh^{-1}\left(\frac{h-b/2}{a}\right)\right]$$

$$V_2(h=0) = -\frac{2kQ}{b}\sinh^{-1}\left(b/2a\right)$$

$$V_1(h=-b/2) = -\frac{kQ}{b}\sinh^{-1}\left(b/a\right)$$

$$V_{21} = -\frac{kQ}{b}\left[\sinh^{-1}(b/a) - 2\sinh^{-1}(b/2a)\right]$$

Problem 4:



$$V_{disk} = \frac{\sigma a}{2\epsilon_0} \quad \text{(center)}$$

$$V_3 = \frac{\sigma\sqrt{2}b}{2\epsilon_0} \; ; \; V_1 = \frac{\sigma b}{2\epsilon_0}$$

$$V_1 < V_2 < V_3$$

$$V_{Avg} = V_2 \approx \frac{V_1+V_3}{2}$$ ⇒ Estimation can now be compared to the average:

$$\text{Error} \simeq \frac{|V_{est} - V_{avg}|}{V_{avg}} \times 100$$