

5.8.7: Solid Cylinder

Refer to figure V.8. The potential from the elemental disc is

$$d\psi = -2\pi G\rho\delta z \left[(z^2 + a^2)^{1/2} - z \right] \quad (5.8.21)$$

and therefore the potential from the entire cylinder is

$$\psi = \text{const.} - 2\pi G\rho \left[\int_h^{h+l} (z^2 + a^2)^{1/2} dz - \int_h^{h+l} z dz \right]. \quad (5.8.22)$$

I leave it to the reader to carry out this integration and obtain a final expression. One way to deal with the first integral might be to try $z = a \tan \theta$. This may lead to $\int \sec^3 \theta d\theta$. From there, you could try something like $\int \sec^3 \theta = \int \sec \theta d \tan \theta = \sec \theta \tan \theta - \int \tan \theta d \sec \theta = \sec \theta \tan \theta - \int \sec \theta \tan^2 \theta d\theta = \sec \theta \tan \theta - \int \sec^3 \theta + \int \sec \theta d\theta$, and so on.

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