**Physics C2801, Fall 2013** Prof. Brian Cole

| Issued: **Sept. 26** | Problem Set # 4 | Due: **Oct. 3** |
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**Problem 1.** Kleppner and Kolenkow problem 3.4

**Problem 2.** Kleppner and Kolenkow problem 3.7

**Problem 3.** Kleppner and Kolenkow problem 3.12

**Problem 4.** Kleppner and Kolenkow problem 3.13

Don't be fooled by the apparent simplicity of this problem. Read it carefully. The rope has to do more than just carry the skiers up the hill against the gravitational forces.

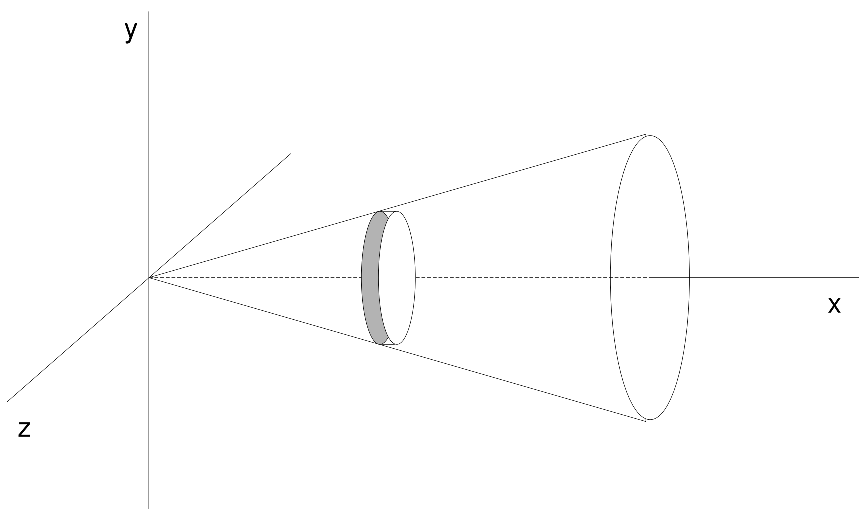
**Problem 5.** Kleppner and Kolenkow problem 3.14

**Problem 6.** Kleppner and Kolenkow problem 3.15

**Problem 7.** Kleppner and Kolenkow problem 3.18

**Problem 8.** Kleppner and Kolenkow problem 3.20

**Problem 9.** Center of mass calculation: cone




One of the formulations for the calculation of the center of mass position of an extended object that I gave in class was written

$$\vec{r}_{\mathrm{CM}} = \frac{\int \rho \vec{r}\, dV}{\int \rho dV}, \tag{1}$$

where $dV$ represents a differential volume element centered on the point described by the position vector $\vec{r}$. We will use this formulation to calculate the center of mass of the cone shown in the figure whose axis lies along the $x$ axis. Let the cone have length $R$, end radius $R_c$, and constant density $\rho$.

This problem is simplified by the symmetry of the cone because $y_{\rm CM} = z_{\rm CM} = 0$. So we only have to determine $x_{\rm CM}$,

$$x_{\rm CM} = \frac{\int \rho x\, dV}{\int \rho dV}, \tag{2}$$

Because the integrand is constant as a function of $y$ and $z$ we can write $dV = A(x)\, dx$ with $A(x)$ the area of face of a differential slice of the cone as shown in the figure. So, find an expression for $A(x)$ in terms of the provided parameters, and evaluate $\int \rho A(x) dx$. Check that you have the correct dimensions in your result. Then using the same approach evaluate the numerator and obtain $x_{\rm CM}$.