(1)

$0 \le y \le 1$
at height y, the radius is $\sqrt{y}$.

Thus, the total volume is

$$V = \int_0^1 \pi (\sqrt{y})^2 dy = \pi \int_0^1 y\, dy = \frac{\pi y^2}{2}\Big|_0^1 = \frac{\pi}{2} \text{ cubic meters}$$

≈ 1.57 cubic meters $\approx 1{,}570$ liters, weighing slightly over $1\frac{1}{2}$ metric tons.

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(2) The total length of cable is about

$$\int_0^1 \sqrt{1+(y'(x))^2}\, dx = \int_0^1 \sqrt{1+\sinh^2(x-0.5)}\, dx = \int_0^1 \sqrt{\cosh^2(x-0.5)}\, dx$$

$$= \int_0^1 \cosh(x-0.5)\, dx = \sinh(x-0.5)\Big|_{x=0}^{1} = \sinh(0.5) - \sinh(-0.5)$$

$$= 2\sinh(0.5) \boxed{\approx 1.042 \text{ units}}$$

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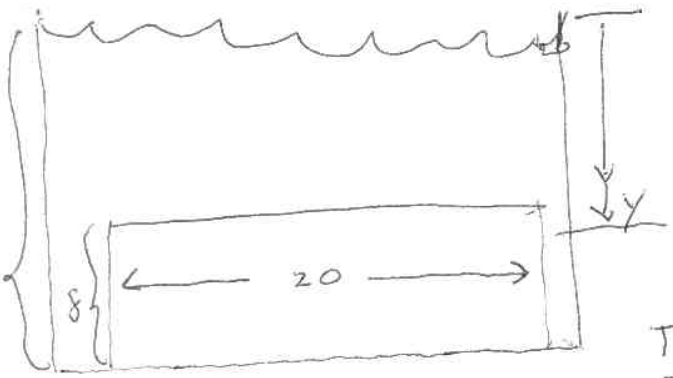
(3) The area of a ring r units from the center is about $(2\pi r \Delta r)$, so its population is about $(2\pi r\Delta r)[5000(6-r)]$, so the total population is about:

$$10000\pi \int_{r=0}^{6} r(6-r)\, dr = 10000\pi\left[3r^2 - \frac{r^3}{3}\right]\Big|_{r=0}^{6}$$

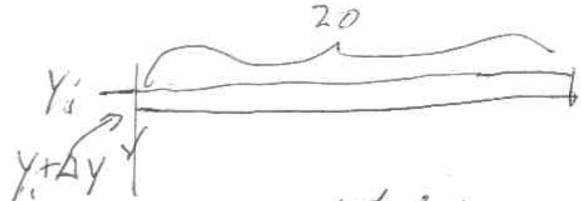
$$= 10000\pi\left[3(36) - 72\right] = 10000\pi(36) \approx 1.131 \text{ million people.}$$

(4)



The weight of a column of of water with base 1 ft at depth y is $(62.4)y$, which is the pressure at depth y.

Thus, the weight on a strip at y_i and extending to $y_i + \Delta y$ is about $(62.4y)(20\Delta y)$.



Thus, the total force on the window is about

$$\sum_{i=1}^{N} (62.4y)(20\Delta y) \longrightarrow \int_{y=12}^{20} 1248y\,dy$$

$$= 624y^2 \Big|_{y=12}^{20} = 624(20^2-12^2) = 624(400-144)$$

$$= 159744 \text{ lb} \approx 80 \text{ tons}$$