

Let's divide S into n "slabs" of equal width Δx by using the planes P_{x_1}, P_{x_2}, \dots to slice the solid. (Think of slicing a loaf of bread.) If we choose sample points x_i^* in $[x_{i-1}, x_i]$, we can approximate the i th slab S_i (the part of S that lies between the planes $P_{x_{i-1}}$ and P_{x_i}) by a cylinder with base area $A(x_i^*)$ and "height" Δx . (See Figure 3.)

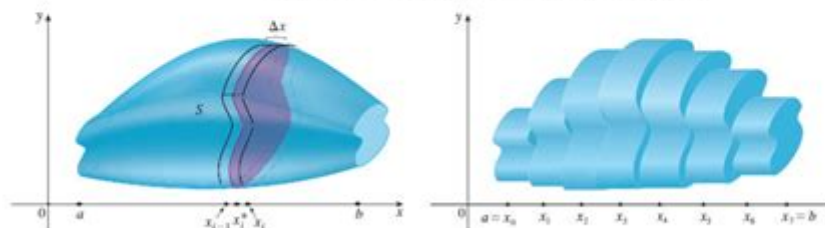


FIGURE 3

The volume of this cylinder is $A(x_i^*) \Delta x$, so an approximation to our intuitive conception of the volume of the i th slab S_i is

$$V(S_i) \approx A(x_i^*) \Delta x$$

Adding the volumes of these slabs, we get an approximation to the total volume (that is, what we think of intuitively as the volume):

$$V \approx \sum_{i=1}^n A(x_i^*) \Delta x$$

This approximation appears to become better and better as $n \rightarrow \infty$. (Think of the slices as becoming thinner and thinner.) Therefore we *define* the volume as the limit of these sums as $n \rightarrow \infty$. But we recognize the limit of Riemann sums as a definite integral and so we have the following definition.

Definition of Volume Let S be a solid that lies between $x = a$ and $x = b$. If the cross-sectional area of S in the plane P_x , through x and perpendicular to the x -axis, is $A(x)$, where A is a continuous function, then the volume of S is

$$V = \lim_{n \rightarrow \infty} \sum_{i=1}^n A(x_i^*) \Delta x = \int_a^b A(x) dx$$

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