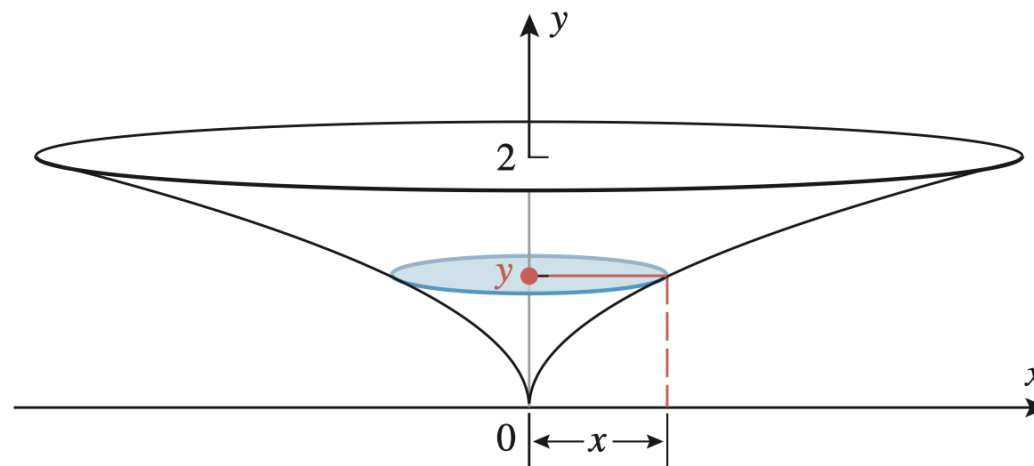
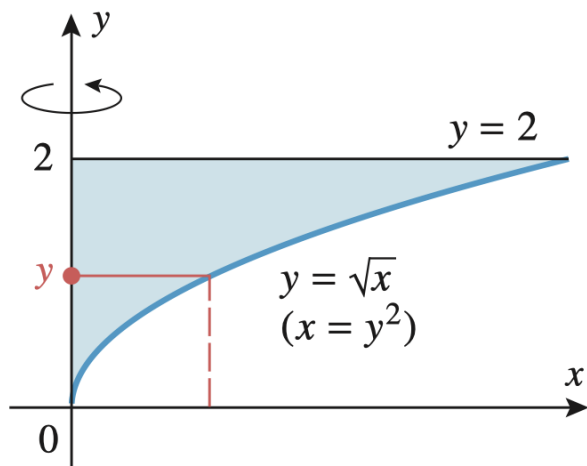


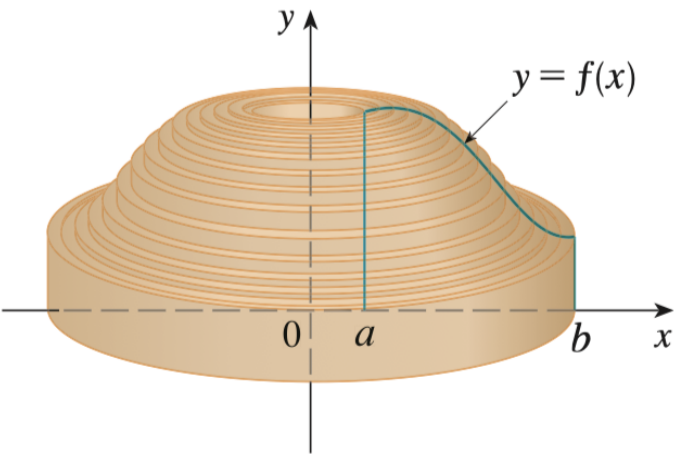
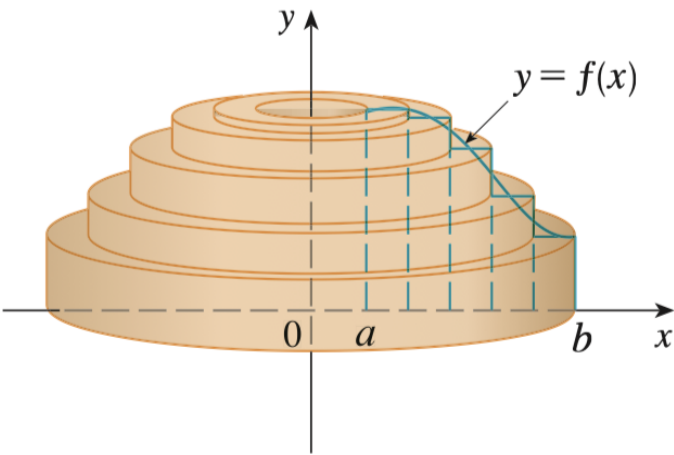
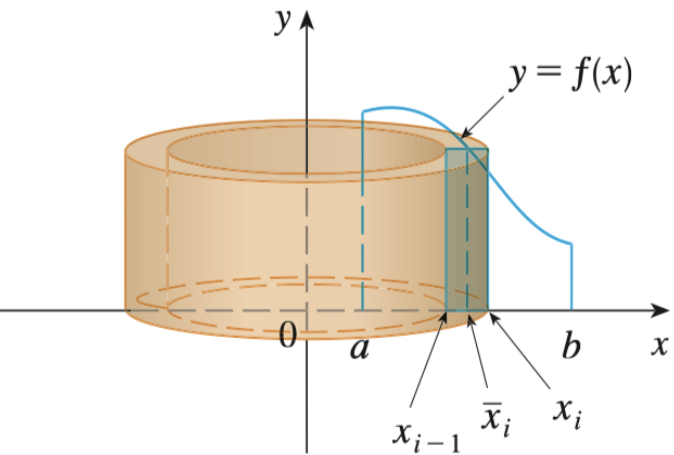
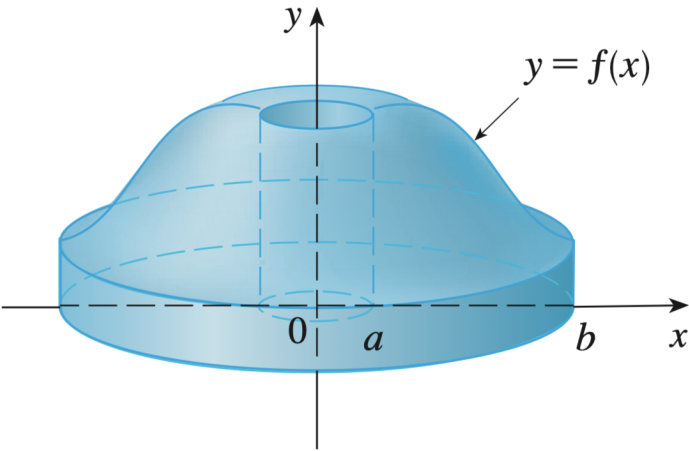
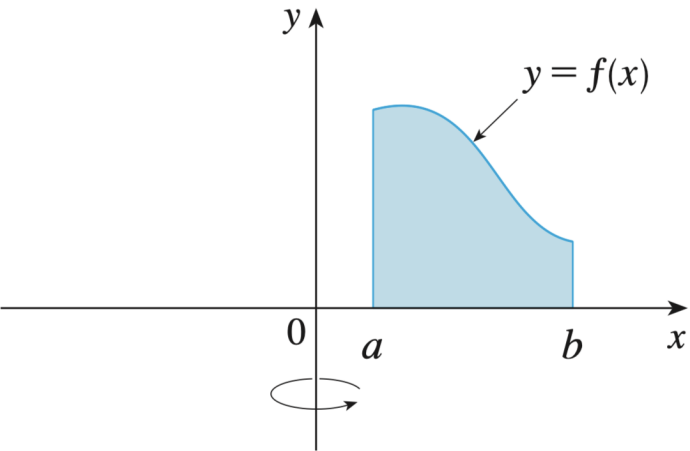
# How is the shell method used to find the volume of a solid of revolution?

## Quick Check

Find the volume of the solid generated when the region enclosed by  $y = \sqrt{x}$ ,  $y = 2$ , and  $x = 0$  is revolved about the  $y$ -axis.

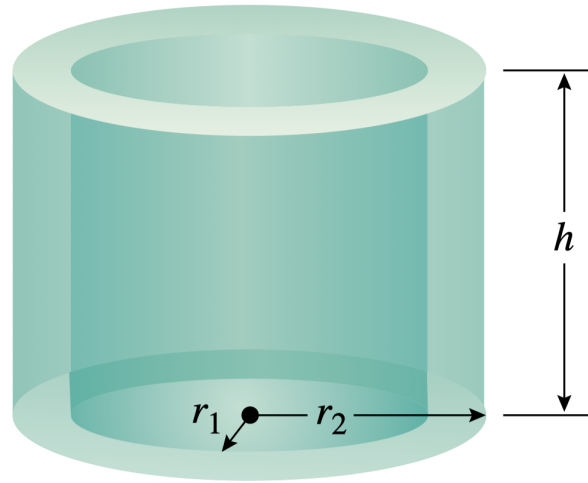


# Idea



# Cylindrical Shell

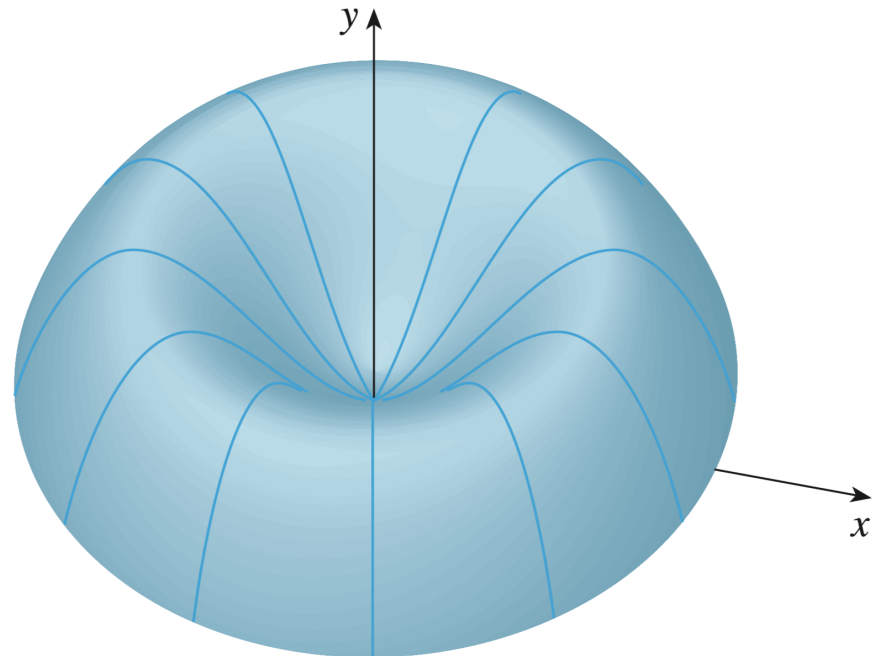
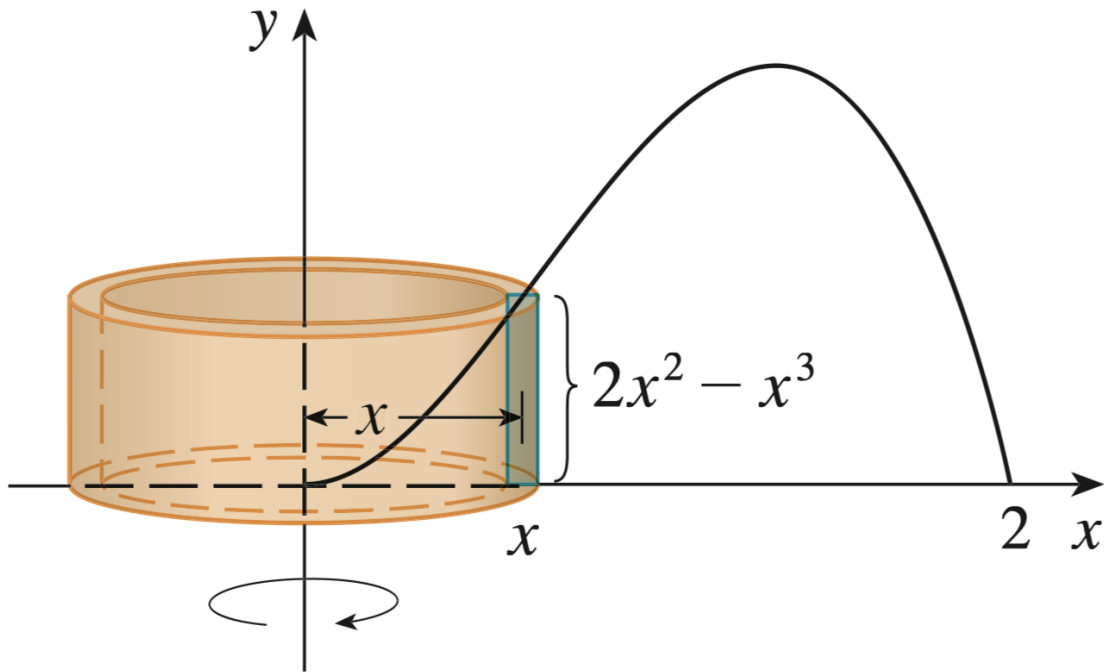
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$$V = 2\pi \cdot [\text{average radius}] \cdot [\text{height}] \cdot [\text{thickness}]$$

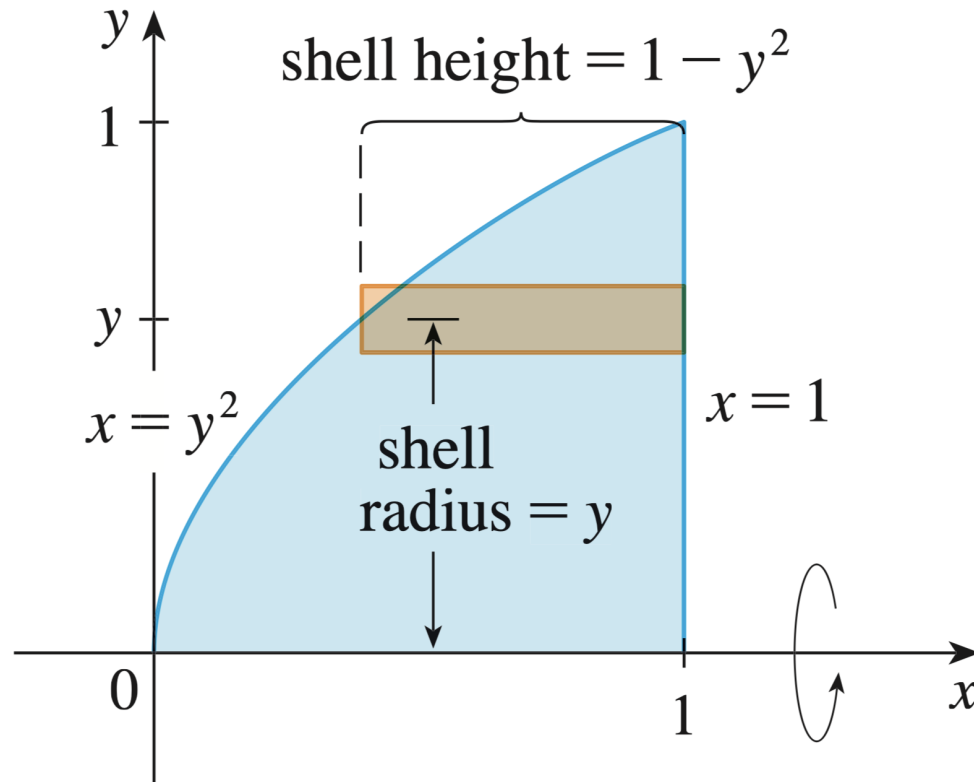
## Volume by Cylindrical Shells

Find the volume of the solid obtained by rotating about the  $y$ -axis the region bounded by  $y = 2x^2 - x^3$  and  $y = 0$ .



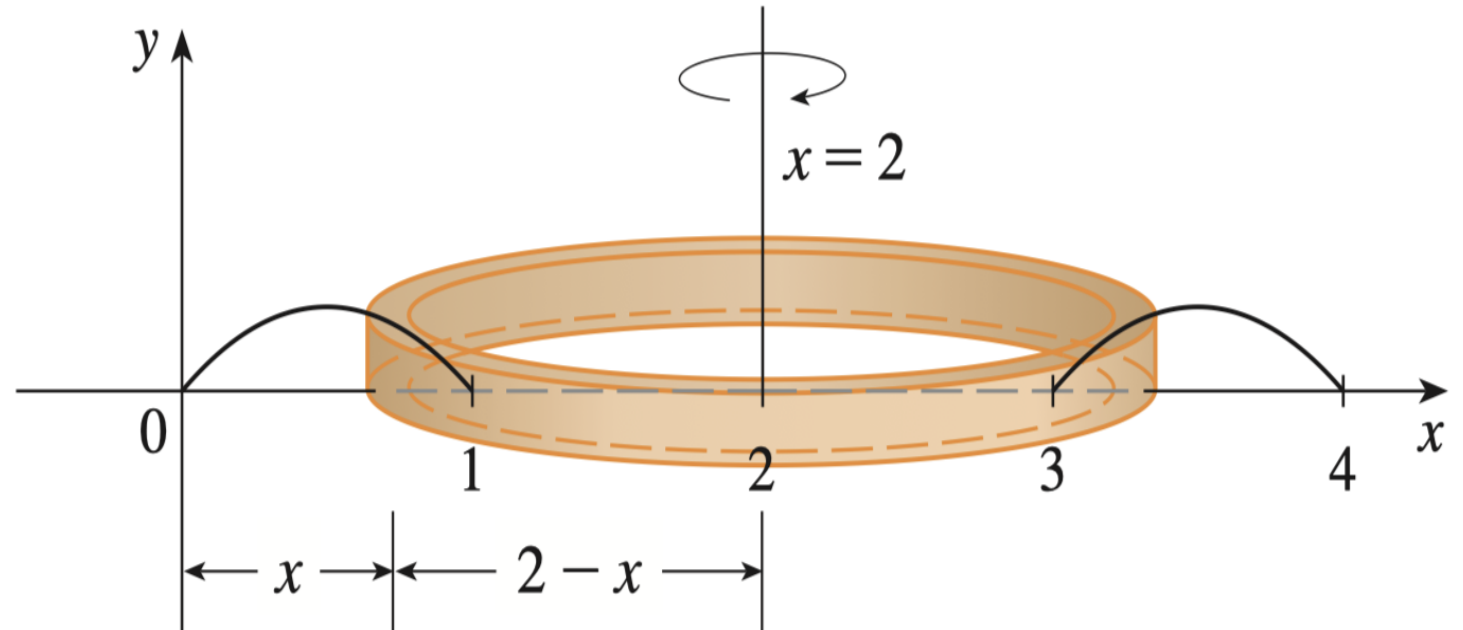
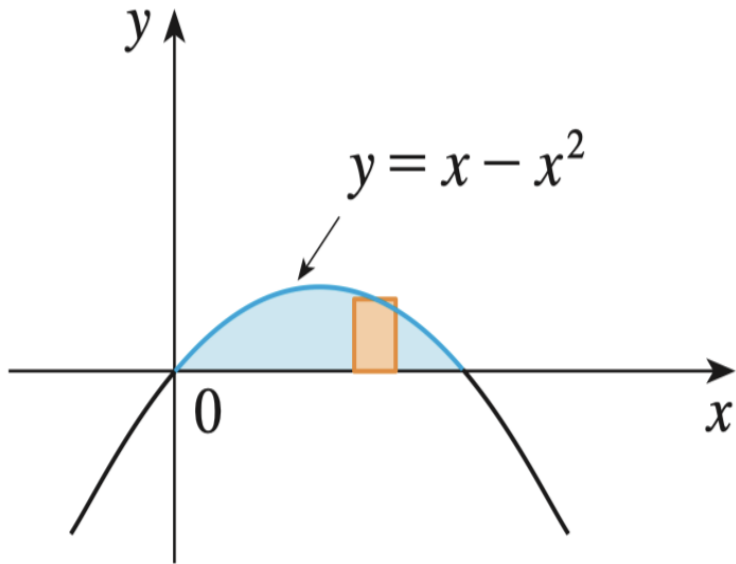
# Volume by Cylindrical Shells

Use cylindrical shells to find the volume of the solid obtained by rotating about the  $x$ -axis the region under the curve  $y = \sqrt{x}$  from 0 to 1.



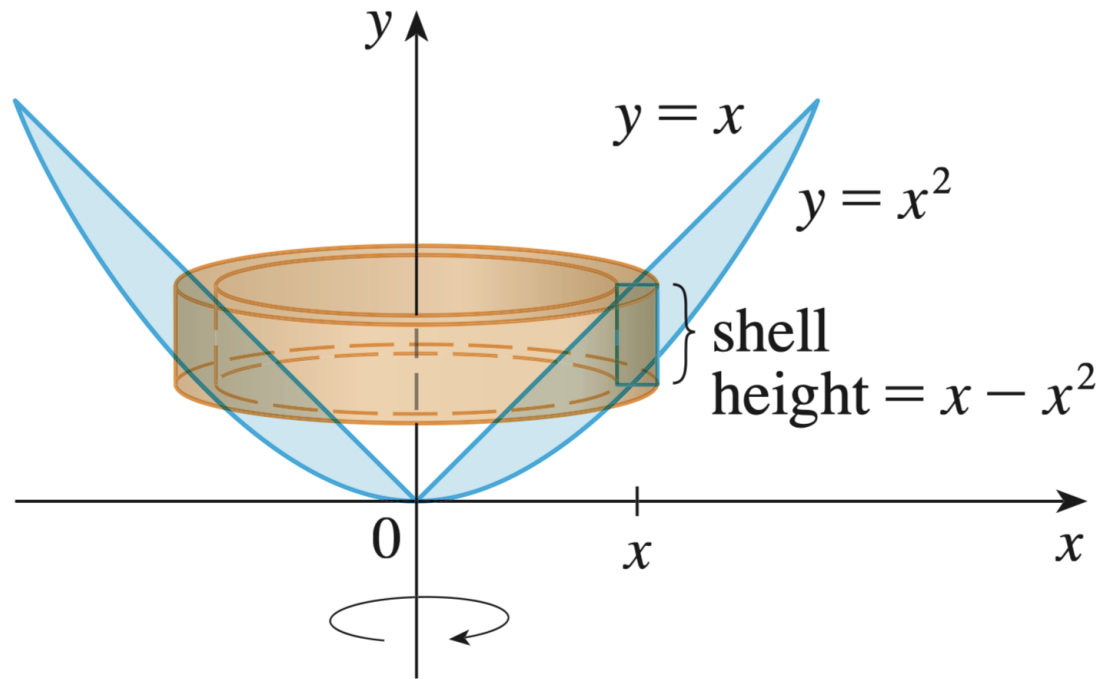
## Volume by Cylindrical Shells

Find the volume of the solid obtained by rotating the region bounded by  $y = x - x^2$  and  $y = 0$  about the line  $x = 2$ .



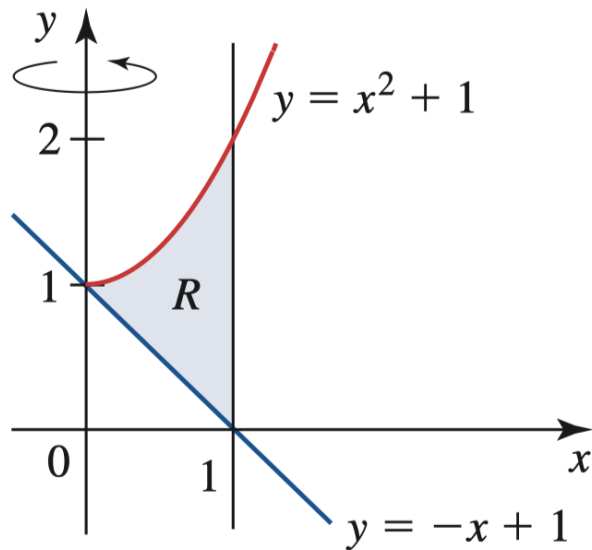
## Washer vs. Shell

Find the volume of the solid obtained by rotating about the  $y$ -axis the region between  $y = x$  and  $y = x^2$ .

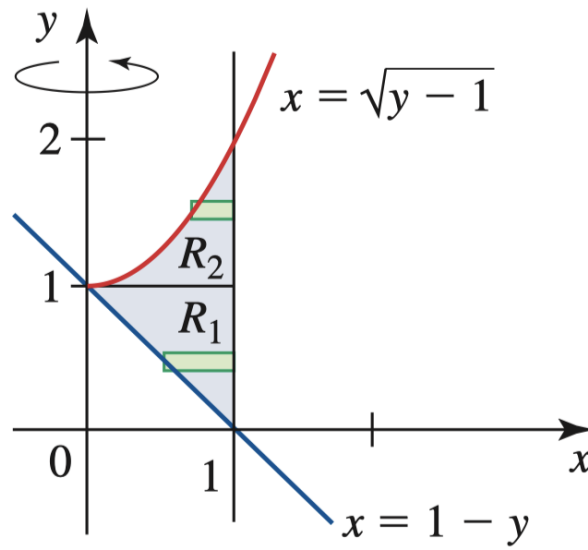


## Washer vs. Shell

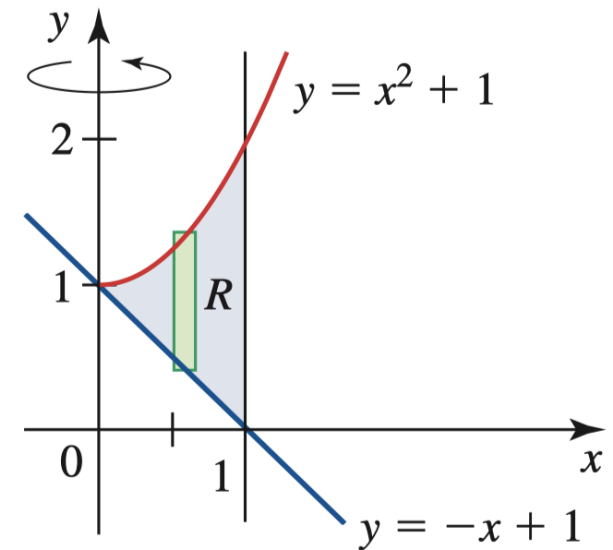
Let  $R$  be the region bounded by the graphs of  $y = x^2 + 1$ ,  $y = -x + 1$ , and  $x = 1$ . Find the volume of the solid that is obtained by revolving  $R$  about the  $y$ -axis using the method of washers and the method of cylindrical shells.



(a) The region  $R$



(b) The method of washers



(c) The method of shells