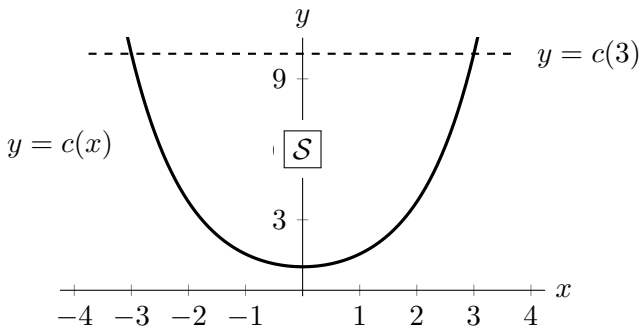
2. [13 points]

Consider the function c defined for all real numbers x by the formula

$$c(x) = \frac{e^x + e^{-x}}{2}.$$

A portion of the graph of this "catenary" function is shown as the solid curve in the graph on the right.



Let $\mathcal{S}$ be the region bounded by the graph of $y = c(x)$ and the line $y = c(3)$. This region $\mathcal{S}$ is shown in the figure above.

a. [2 points] Write, but do **not** evaluate, an expression involving one or more integrals that gives the area of $\mathcal{S}$.

b. [5 points] A solid is obtained by rotating the region $\mathcal{S}$ about the x-axis. Write, but do **not** evaluate, an expression involving one or more integrals that gives the volume of this solid.

c. [3 points] Write, but do **not** evaluate, an expression involving one or more integrals that gives the arc length of the graph of $y = c(x)$ over the interval $-3 \le x \le 3$. (Your answer should **not** involve any function names.)

d. [3 points] Will the midpoint rule with 2000 subdivisions give an underestimate or an overestimate of the value of $\displaystyle\int_{-3}^{0} c(x)\,dx$?

Circle your answer below. Then briefly explain your reasoning in the space on the right.

Circle one:

Underestimate

Overestimate

Neither (They are equal)

Cannot be determined

Briefly explain your reasoning.