1. **Cubic Net Area.** Consider the graph of a cubic polynomial $y = x(x-a)(x-b)$ where $0 < a < b$. Verify that the graph bounds a region above the x-axis for $0 < x < a$ and below the x-axis for $a < x < b$. What is the relationship between a and b if these two regions are equal?

2. **Max/min of Area Functions.** Suppose f is continuous on $[0, \infty)$ and $A(x)$ is the net area of the region bounded by f and the t-axis on $[0, x]$. Show that the local maxima and local minima of A occur at the zeros of f. Verify this for $f(x) = x^2 - 10x$.

3. **Sine Integral Function.** The function

$$\mathrm{Si}(x) = \int_0^x \frac{\sin t}{t} dt$$

is an important function in electrical engineering.

(a) Draw the graph of Si.

(b) At what values of x does this function have local maximum values?

(c) Find the coordinates of the first inflection point to the right of the origin.

4. **Leveraging Integration.** Evaluate the following limits by recognizing the sum as a Riemann sum for some function defined on $[0, 1]$.

   (a) $\lim_{n\to\infty} \sum_{i=1}^{n} \frac{i^3}{n^4}$

   (b) $\lim_{n\to\infty} \frac{1}{n}\left(\sqrt{\frac{1}{n}} + \sqrt{\frac{2}{n}} + \sqrt{\frac{3}{n}} + \cdots + \sqrt{\frac{n}{n}}\right)$