Exercise 1. A fence 8 ft tall runs parallel to a tall building at a distance of 4 ft from the building. What is the length of the shortest ladder that will reach from the ground over the fence to the wall of the building?

Exercise 2. A box with a square base and open top is to be made using exactly 1200 cm$^2$ of material. What is the largest possible volume of such a box?

Exercise 3. A driver involved in an accident claims he was going only 25 mi/h. When investigators tested his car, they found that the maximum deceleration its brakes could provide was 15 ft/s$^2$. Given that the skid marks left by the car at the scene of the accident were 210 ft long, is the driver telling the truth?

Exercise 4. For the function $f(x)$, whose graph is shown below, define

$$g(x) = \int_0^x f(t) \, dt.$$

a. At what values of $x$ do the local maximum and minimum values of $g$ occur?
b. Find the absolute maximum and minimum values of $g$ on the interval [0, 7].
c. Find the intervals on which \( g \) is concave up and concave down.

d. Carefully sketch the graph of \( g \).

Exercise 5. Evaluate the limit

\[
\lim_{n \to \infty} \sum_{i=1}^{n} \frac{i\sqrt{1 + i^2/n^2}}{n^2}.
\]

[Hint: Express the limit as a definite integral.]

Exercise 6. If \( f \) is a continuous function such that

\[
\int_{0}^{x} f(t) \, dt = xe^{2x} + \int_{0}^{x} e^{-t} f(t) \, dt
\]

for all \( x \), find an explicit formula for \( f(x) \). [Hint: Apply the Fundamental Theorem of Calculus to get rid of the integrals.]

Exercise 7. Evaluate the integral.

\[
\begin{align*}
a. & \quad \int_{1}^{9} \frac{\sqrt{u} - 2u^2}{u} \, du \\
& \quad \int_{0}^{1} \sin(3\pi t) \, dt \\
c. & \quad \int \frac{x^2}{\sqrt{x} - 3} \, dx \\
d. & \quad \int_{1}^{10} \frac{x}{x^2 - 4} \, dx \\
e. & \quad \int \frac{\cos(\ln x) - \sin(\ln x)}{x} \, dx \\
f. & \quad \int_{0}^{\pi/4} (1 + \tan \theta)^3 \sec^2 \theta \, d\theta \\
g. & \quad \int_{0}^{1} \frac{e^z + 1}{e^z + z} \, dz \\
h. & \quad \int_{0}^{4} |\sqrt{x} - 1| \, dx
\end{align*}
\]

Exercise 8. Find the area of the region bounded by the given curves.

\[
\begin{align*}
a. & \quad y = \sin(\pi x/2), \ y = x^2 - 2x \\
b. & \quad y = \sqrt{x}, \ y = 2x - 1, \ y = 0 \ (n > 1) \\
c. & \quad y = x^2 - 4, \ y = x^3 - 4x
\end{align*}
\]

Exercise 9. Find the volume of the solid whose base is the region enclosed by the parabola \( y = 1 - x^2 \) and the \( x \)-axis, and whose cross-sections perpendicular to the \( y \)-axis are semicircles.
Exercise 10. Find the volume of the “cap” of a sphere with radius $r$ and height $h$ (see the diagram below).