1. You are standing on a pier, 6 feet above the deck of a boat. Attached to the boat is a line, which you are pulling in at a rate of 3 feet per second. When there are 10 feet of line between your hand and the boat, at what rate is the boat moving across the water?

2. You are watching a plane flying toward your position at a constant height of 3 miles and a speed of 500 miles per hour relative to the ground. At the moment when the plane is 5 miles from you (diagonally), at what rate is the angle of your vision toward the plane changing?
3. Use the Intermediate Value Theorem to show that \( f(x) = x^3 - 2x - 1 \) has a root on \([1, 2]\).

4. What (if anything) does the Extreme Value Theorem say about \( f(x) = x^2 \) on each of the following intervals?
   (a) \([1, 4]\)  
   (b) \((1, 4)\)

5. Find the value of the constant \( c \) that the Mean Value Theorem specifies for \( f(x) = x^3 + x \) on \([0, 3]\).

6. Water is leaking out of a tank at a decreasing rate \( r(t) \) as shown in the table below.

<table>
<thead>
<tr>
<th>time (min)</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>rate (gal/min)</td>
<td>15</td>
<td>11</td>
<td>8</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

   (a) Find an overestimate and underestimate for the total amount that leaked out during these 8 minutes.

   (b) Interpret the expression \( \int_{2}^{6} r(t) \, dt \) in terms of the situation described above.
7. Consider the graph of \( f(t) \) shown. It is made of straight lines and a semicircle.

Let \( G(x) = \int_{0}^{x} f(t) \, dt \) and \( H(x) = \int_{-3}^{x} f(t) \, dt \).

(a) Compute \( G(2) \), \( G(4) \), \( G(-4) \), and \( H(4) \).

(b) Where is \( G \) increasing? Where is \( G \) decreasing?

(c) Where is \( G \) concave up? Where is \( G \) concave down?

(d) At what \( x \)-value(s) does \( G \) have a local maximum? At what \( x \)-value(s) does \( G \) have a local minimum?

(e) Find a formula that relates \( G \) and \( H \).

(f) How would your answers to (b), (c), and (d) change if the questions were about \( H \) instead of \( G \)?

8. (a) Use sigma notation to express \( L_{10} \) and \( M_{10} \) as approximations to \( \int_{20}^{60} \ln x \, dx \).

(b) Draw a sketch that represents the sum \( M_{4} \).
9. Find the following.

(a) all antiderivatives of \( 1 + 2x + x^3 + 4\sqrt{x} + \frac{1}{x^5} + \sec^2(6x) + \frac{7}{1 + 100x^2} \)

(b) \( \int_{-2}^{2} \sqrt{4 - x^2} \, dx \)

(c) \( \frac{d}{dx} \int_{1}^{x} \sin \sqrt{t} \, dt \)

(d) \( \int_{0}^{2} x^2 \, dx \)