Problem 1 – Optimization of distance and area

On page 1.3, graph the line $y = 4x + 7$. Place a point on the line and then construct a segment from the point to the origin. Find the length of the segment and the coordinates of the point.

- What point do you think minimizes the distance from the point to the origin?

- What function are you trying to minimize?

- What is the constraint?

- Write the function to minimize using one variable.

On page 1.8, find the exact coordinates that minimize the distance using the **Derivative** and **Solve** commands. To do this, find the first derivative, solve to find the critical value(s), and then find the second derivative to confirm a minimum.

- What are the *x*- and *y*-coordinates of the point?

- What is the minimum distance?

Find the dimensions of a rectangle with perimeter 200 meters whose area is as large as possible.

On page 1.11, construct a rectangle and use the **Length** tool to find the perimeter. Adjust the size of the rectangle until the perimeter is 200 m. Then, use the **Attributes** tool to lock the measurement of the perimeter.

- What dimensions do you think maximize the area?

- What function are you trying to maximize?

- What is the constraint?

- Write the function to maximize using one variable.

Find the dimensions that maximize the area using the **Derivative** and **Solve** commands.

- What are the dimensions of the rectangle?

Problem 2 – Optimization of time derivative problems

A boat leaves a dock at 1 pm and travels north at a speed of 20 km/h. Another boat has been heading west at 15 km/h. It reaches the same dock at 2 pm. At what time were the boats closest together? Use *t* for time.

- What is the position function for the boat heading north? West?

- What function are you trying to minimize?

- What is the constraint?

- Write the function to minimize using one variable.

Find the time at which the distance between the two boats is minimized using the **Derivative** and **Solve** commands.

- What is the minimum distance?

- What is the time at which this occurs? Remember to convert the value of *t* to minutes.

Extension – Parametric function

A projectile is fired with the following parametric functions:

$x = 500\cos(30°)t$, $y = 500\sin(30°)t - 4.9t^2$

- What is the time when the projectile hits the ground?

- How far does it travel horizontally?

- What is the maximum height that it achieves?