Lab 2: Houdini's Escape

Harry Houdini (1874-1926) was a famous escape artist. In this project, you will consider one of his many tricks. For the trick of interest, Houdini had his feet shackled to the top of a concrete block which was placed on the bottom of a giant laboratory flask. The flask is round, with a radius given as a function of the height y, in feet as $r(y) = 10y^{-1/2}$, and the bottom of the flask at $y = 1$ due to the thickness of the flask. To make the trick more difficult, the flask is filled with water at a rate of 22π ft^3/min. Houdini's task was to escape before he was drowned by the rising water.

Houdini knew that he was 5'6" tall, and that it would take him 9 minutes to escape from the chains. He was allowed to decide only one thing: the height of the concrete block. He wants to make the escape as dramatic as possible, so he wants to escape just as the water covers the top of his head.

1. Use Maple to plot the radius function. Sketch the graph here: (be sure to use the vertical axis for y)

2. Find the height of the block (you may ignore the volume of the block and the volume of Houdini). Show any equations you set up here, but use Maple to evaluate/solve.

3. Use related rates to find out how fast the height of the water is changing at the beginning of the escape.

4. How fast is the height of the water changing at the end of the escape?

5. Suppose Houdini is given control of the flow rate, rather than the size of the block.

   (a) How fast should the water flow into the tank if Houdini is standing on a 1 foot thick block?

   (b) How fast should the water flow into the tank if Houdini is standing next to the block instead of on top of it?