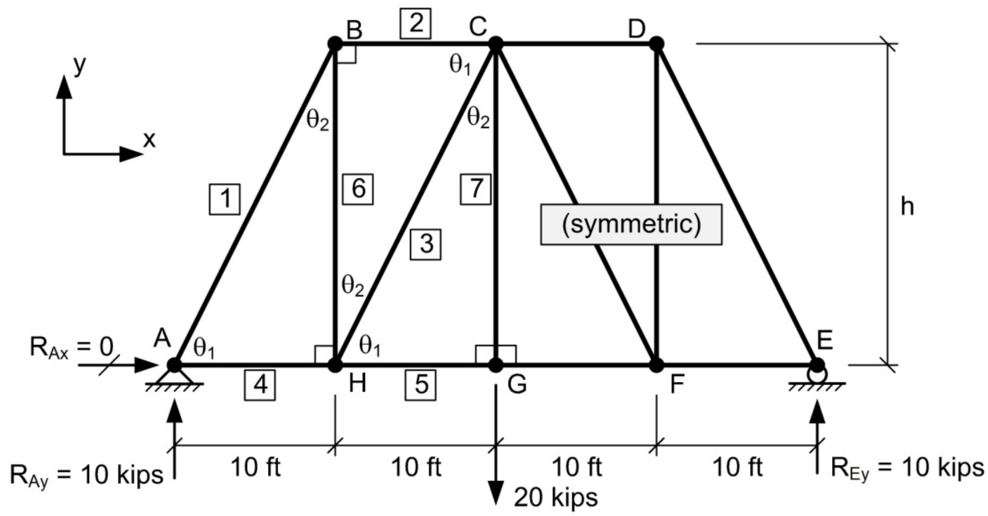
Problem 3 ***Truss height optimization***

You have been asked to analyze the truss below to be used in to support a small bridge. In the design of the bridge, you have been given some leeway to help decide the height (h) that the bridge will be. Assume that your design load for the truss is a 20 kip gravity load located at mid-span. The bridge and loading are symmetric so you can cut your workload in half.



a) Find the internal axial forces in members 1-7 in terms of height, h. Indicate which members will be in compression and which will be in tension (note: $h > 0$, for reasons that I hope are obvious).

b) Find and write the equation for the first derivative of internal axial force with respect to height for members 1-7. Plot these derivatives over a domain of 2ft<h<40ft.

c) Describe what the plots in part **b** are telling you about the effect on height on the internal axial forces of the members. Some of your plots should be equal to zero for all heights; what does this mean? For other members, the derivative approaches but never actually equals zero; can you "optimize" those? What should the height of the truss be? Justify your answer.

<u>**Hints:**</u>

- $\sin\theta_1 = \cos\theta_2 = \frac{h}{\sqrt{10^2+h^2}}$
- $\sin\theta_2 = \cos\theta_1 = \frac{10}{\sqrt{10^2+h^2}}$
- $\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{h}{10}$
- Simplify before you differentiate.
- The chain rule can be your friend.