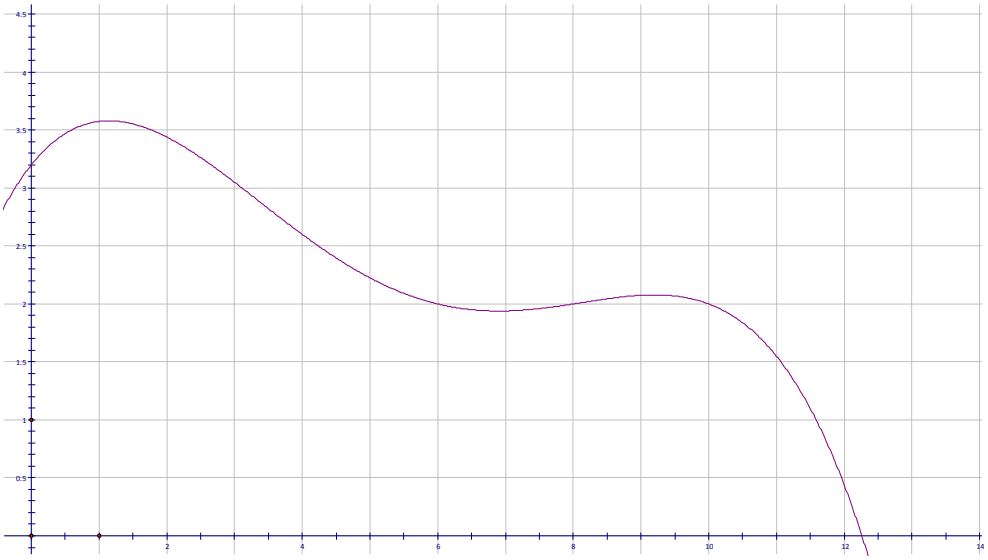
MHF4U Rate of Change For Functions

The polynomial graph below models the height in feet above ground of a paper airplane versus time in seconds.



1. Use the graph to answer the following questions:
   a. When is the instantaneous velocity of the paper airplane 0?
   b. Give at least three time intervals during which the paper airplane's average velocity was 0. Explain how you obtained these intervals.
   c. What was the average velocity of the paper airplane between 4s and 12 s?
   d. What was the average velocity of the paper airplane during its entire trip?
   e. Estimate the times at which the instantaneous velocity of the paper airplane equals the average velocity of the paper airplane during its entire trip. Explain how you obtained these answers.
   f. Estimate the initial velocity of the paper airplane.
   g. Estimate the velocity of the airplane when it hits the ground.
   h. When is the instantaneous velocity of the paper airplane a maximum? Estimate this instantaneous velocity.
   i. Use your answers from part a and parts e-h to sketch a graph of the velocity of the airplane versus time.

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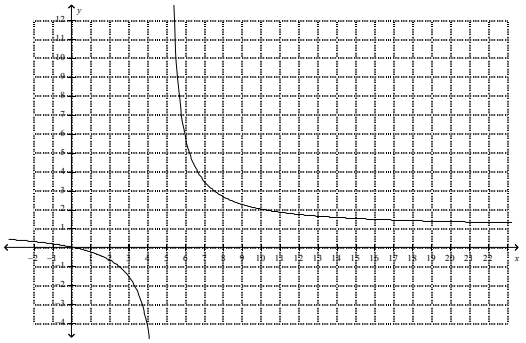
The ratio of your age (in years) to your younger sibling's age (also in years) as time passes is modeled by the equation $r(x) = \frac{x}{x-5}$. A graphical representation is shown below.



Interpret each of these average rates of change in the context of the situation.

State the domain of the function for this situation.

1. What is the difference in your ages?
2. Calculate the average rate of change from:
   a) $x = 6$ to $x = 10$
   b) $x = 0$ to $x = 6$
   c) $x = 80$ to $x = 90$
3. Determine when the magnitude of the instantaneous rate of change is 1. What does this mean?
4. Determine the instantaneous rate of change at 6.
5. Determine the following
   a. When is the instantaneous rate of change of the function 0?
   b. When is the function's average rate of change 0?
   c. Using set notation, state all possible values of the rate of change.
6. As the older sibling, what does the rate of change really mean? The answer may not be obvious…Think it through.

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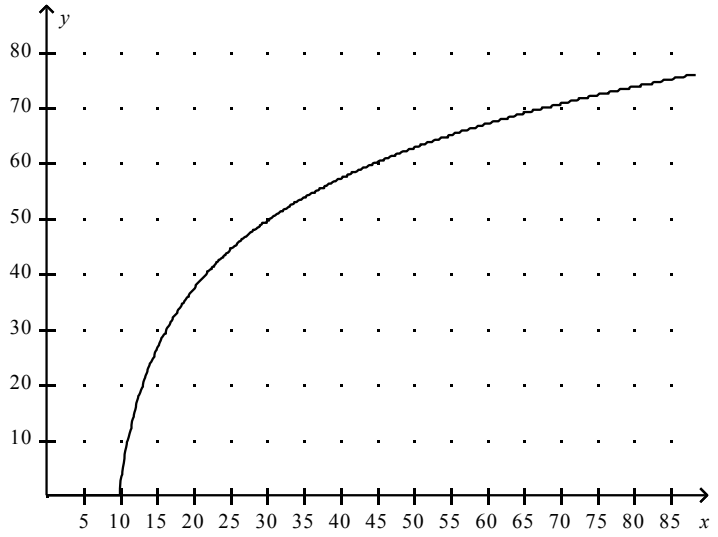
A bird spends time foraging for food, then, having found a food source, perhaps a crab-apple tree, it begins to eat. At the beginning, the crab-apples are easy to find and the bird gains food energy at a high rate. As time passes, the tree is depleted, and the rate of energy gain decreases. At some point, the bird should leave the tree and search for a new one.

Where E (calories) represents the energy obtained in the t minutes since foraging began, this relationship is modelled by the equation:

$$E(t) = \begin{cases} 0; t \leq 10 \\ log_{1.05}(0.5t - 4); t \geq 10 \end{cases}$$

A graphical representation is shown.



1. Label the axes of the graph.
2. In this model, how long did it take the bird to find the crab-apple tree?
3. Calculate the average rate of change from:
   a. $t = 0 \text{ to } t = 10$
   b. $t = 0 \text{ to } t = 15$
   c. $t = 60 \text{ to } t = 70$
4. Determine when the magnitude of the instantaneous rate of change is the highest. What does this mean?
5. Determine the instantaneous rate of change at 6.
6. Determine the following:
   a. When is the instantaneous rate of change of the function 0?
   b. State all possible values of the instantaneous rate of change.
7. According to this model, for how long should the bird stay at this tree before leaving to seek another?