

Precalculus, Section 4.5, #52  
The Graph of a Rational Function

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**Doppler Effect** The Doppler effect (named after Christian Doppler) is the change in the pitch (frequency) of the sound from a source ( $s$ ) as heard by an observer ( $o$ ) when one or both are in motion. If we assume both the source and the observer are moving in the same direction, the relationship is

$$f' = f_a \left( \frac{v - v_o}{v - v_s} \right)$$

where

$f'$  = perceived pitch by the observer

$f_a$  = actual pitch of the source

$v$  = speed of sound in air (assume 772.4 mph)

$v_o$  = speed of the observer

$v_s$  = speed of the source

Suppose that you are traveling down a road at 45 mph and you hear an ambulance (with siren) coming toward you from the rear. The actual pitch of the siren is 600 hertz (Hz).<sup>1</sup>

- a. Write a function  $f'(v_s)$  that describes this scenario.

We substitute the values given in the problem description into the formula

$$f'(v_s) = 600 \left( \frac{772.4 - 45}{772.4 - v_s} \right)$$

so

$$f'(v_s) = \frac{436440}{772.4 - v_s}$$

- b. If  $f' = 620$  Hz, find the speed of the ambulance.

Here, the speed of the ambulance is  $v_s$ , so we solve

$$\begin{aligned} 620 &= \frac{436440}{772.4 - v_s} \\ 620(772.4 - v_s) &= 436440 \\ 620 * 772.4 - 620v_s &= 436440 \\ 478888 - 620v_s &= 436440 \\ -620v_s &= -42448 \\ v_s &= \frac{42448}{620} \end{aligned}$$

Thus the speed of the ambulance is  $\approx 68.5$  mph.

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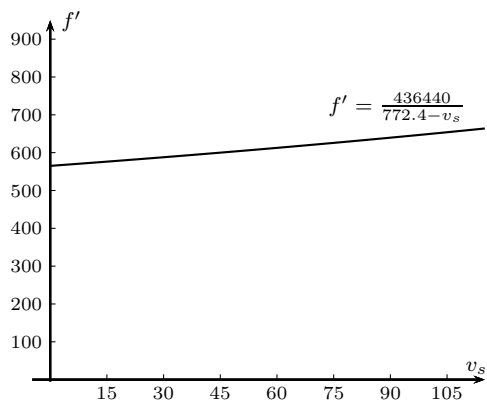
<sup>1</sup>Sullivan, *Precalculus: Enhanced with Graphing Utilities*, p. 235, #52.

## Precalculus

### The Graph of a Rational Function

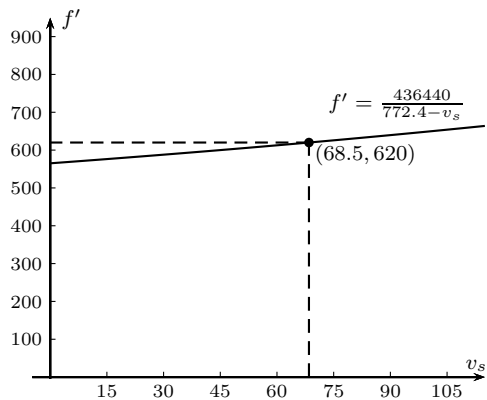
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c. Use a graphing utility to graph the function.



Although the graph looks linear, we know from the form of the function  $f' = \frac{436440}{772.4 - v_s}$  that it most certainly is *not* linear.

d. Verify your answer from part (b).



Thus, if  $f' = 620$ , then  $v_s \approx 68.5$ .