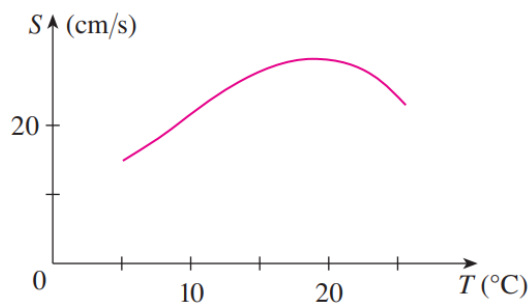## Exercise 58

The graph shows the influence of the temperature T on the maximum sustainable swimming speed S of Coho salmon.

   (a) What is the meaning of the derivative $S'(T)$? What are its units?

   (b) Estimate the values of $S'(15)$ and $S'(25)$ and interpret them.

Solution

   (a) $S'(T)$ is the rate that the maximum sustainable swimming speed increases with respect to temperature. Its units are cm/s per Celsius degree.

   (b) $S'(15)$ and $S'(25)$ are the rates that the swimming speed increases with respect to temperature when the temperature is 15 °C and 25 °C, respectively.

Compute the slope of the secant line from $[10, 15]$

$$\frac{S(15) - S(10)}{15 - 10} \approx \frac{25 - 20}{5} = 1$$

and the slope of the secant line from $[15, 20]$.

$$\frac{S(20) - S(15)}{20 - 15} \approx \frac{30 - 25}{5} = 1$$

Then take the average of the two to get the best estimate for S' when the temperature is 15 °F.

$$\frac{1 + 1}{2} = 1$$

Therefore, the maximum sustainable swimming speed is increasing by about 1 cm/s per Celsius degree when the temperature is 15 °C. Use the slope of the secant line from $[20, 25]$ as an approximation for S' at 25 °C.

$$\frac{S(25) - S(20)}{25 - 20} \approx \frac{22 - 30}{5} = -\frac{8}{5} = -1.6$$

The maximum sustainable swimming speed is decreasing by about 1.6 cm/s per Celsius degree when the temperature is 25 °C.

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