Car tires need to be inflated properly because overinflation or underinflation can cause premature tread wear. The data in the table show tire life L (in thousands of miles) for a certain type of tire at various pressures P (in lb/in^2*).*[1]

P	26	28	31	35	38	42	45
L	50	66	78	81	74	70	59

(a) *Use a calculator to model tire life with a quadratic function of the pressure.*

Here, the input to the function is the pressure and the output is the tire life. Using the TI-84, we get

$$L(P) = -0.2754P^2 + 19.7485P - 273.5523$$

(Step-by-step instructions for the data analysis can be found in the document "6 Important Graphing Calculator Skills".)

(b) *Use the model to estimate* $\mathrm{d}L/\mathrm{d}P$ *when* $P = 30$ *and when* $P = 40$*. What is the meaning of the derivative? What are the units? What is the significance of the signs of the derivatives?*

$$\frac{\mathrm{d}L}{\mathrm{d}P} = -0.5508P + 19.7485$$

so

$$\left.\frac{\mathrm{d}L}{\mathrm{d}P}\right|_{P=30} = -0.5508\,(30) + 19.7485$$
$$\approx 3.22$$

$$\left.\frac{\mathrm{d}L}{\mathrm{d}P}\right|_{P=40} = -0.5508\,(40) + 19.7485$$
$$\approx -2.28$$

Here, the derivative gives the rate of change of tire life as a function if the pressure. The units are $\frac{\text{thousands of miles}}{\text{lb/in}^2}$. (As with all derivatives, the units are $\frac{\text{units of output from original function}}{\text{units of input to original function}}$.) At $P = 30$, the derivative is positive, so tire life is increasing, while at $P = 40$ the derivative is negative, so tire life is decreasing.

[1] Stewart, *Calculus, Early Transcendentals*, p. 181, #54.