

## 2.5 Regression Lines (Part 2): Residuals

Even when we are not extrapolating, our predictions are seldom perfect. For a specific point, the difference between the actual value of  $y$  and the predicted value of  $y$  is called a **residual**.

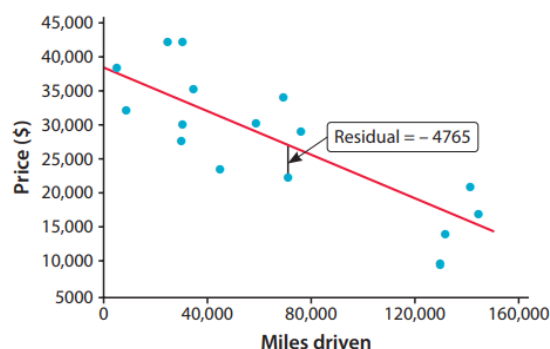
A **residual** is the difference between an actual value of  $y$  and the value of  $y$  predicted by the regression line. That is:

$$\text{residual} = \text{actual } y - \text{predicted } y = y - \hat{y}$$

The scatterplot below shows the residual for the F-150 with 70,583 miles and an actual price of \$21,994.

The predicted price is  $\hat{y} = 38,257 - 0.1629(70,583) = \$26,759$ , so the residual is  $21,994 - 26,759 = -\$4765$ .

The negative value means that the price of this truck was \$4765 less than predicted, based on the number of miles it had been driven. It also means that the point is below the regression line on the scatterplot.



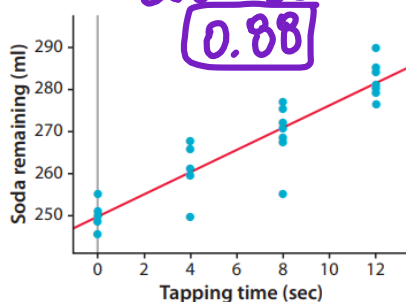
**Example:** Don't you hate it when you open a can of soda and some of the contents spray out of the can? Two students wanted to investigate if tapping on a can of soda would reduce the amount of soda expelled after the can has been shaken. For their experiment, they vigorously shook 40 cans of soda and randomly assigned each can to be tapped for 0 seconds, 4 seconds, 8 seconds, or 12 seconds. Then, after opening the can and cleaning up the mess, the students measured the amount of soda left in each can (in milliliters, or ml). Here is the scatterplot, along with the regression line  $\hat{y} = 248.6 + 2.63x$ , where  $x$  is the tapping time (in seconds) and  $y$  is the amount of soda remaining (in milliliters).

residual: actual - predicted

$$y - \hat{y}$$

$$260 - 259.12$$

$$0.88$$



a.) Calculate the residual for the can that was tapped for 4 seconds and had 260 milliliters of soda remaining.  $x=4$

$$\hat{y} = 248.6 + 2.63x$$

$$\hat{y} = 248.6 + 2.63(4)$$

$$= 248.6 + 10.52$$

$$\hat{y} = 259.12$$

b.) Interpret the residual from part (a).

The amount of soda left in the can is 0.88 mL more than predicted.