1. Read pages 190, 191, 193.

2. Big idea:
   (a) A good model makes the residuals small.
   (b) The standard deviation of the residuals is a measure of the smallness of the residuals (since the mean of the residuals is 0).
   (c) The standard deviation of the residuals is computed with a denominator of \( n - 2 \) rather than \( n - 1 \) for mysterious technical reasons. In this form, it is usually called the residual standard error. (The mystery will be revealed later.)

3. Example: Ch08Body We want to predict percentage of Body Fat from Weight in pounds.

   ```r
   > attach(Ch08Body)
   > l = lm(Fat ~ Weight)
   > summary(l)
   Call:
   lm(formula = Fat ~ Weight)
   Residuals:
   Min 1Q Median 3Q Max
   -12.5935 -5.7904 0.6536 5.2731 10.4004
   Coefficients:
   Estimate Std. Error t value Pr(>|t|)
   (Intercept) -27.37626 11.54743 -2.371 0.029119 *
   Weight 0.24987 0.06065 4.120 0.000643 ***
   ---
   Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
   Residual standard error: 7.049 on 18 degrees of freedom
   Multiple R-squared: 0.4853, Adjusted R-squared: 0.4567
   F-statistic: 16.97 on 1 and 18 DF, p-value: 0.0006434
   > sd(Fat)
   [1] 9.5635
   > sd(residuals(l))
   [1] 6.861122
   ```

4. Interpretation of standard deviation of residuals:
   (a) The standard deviation of our response variable Fat is 9.6%. We call this \( s_{Fat} \). (The units of Fat are percent). This is a measure of the variation in the response variable that we are trying to account for with the explanatory variable Waist.
   (b) The standard deviation of the residual (residual standard error in R, \( s_e \)) is 7.049%. This is a measure of the variation “left over” after we fit the model.
   (c) Note that \( sd(residuals) \) is slightly smaller since it uses \( n - 1 \) instead of \( n - 2 \) as the denominator.
   (d) The standard deviation of the residuals will always be less than the standard deviation of the response variable since at worst we could use a slope of 0 in our model and get the mean as the intercept. In this case, \( sd(residuals(l)) \) would be the same as the standard deviation of our response variable.

Test your understanding by referring to problem 9 of the Review problems at the end of Part II (page 263). The data is Rev02Manatees. Compute \( s_e \) and \( s_{Manatee} \) and say precisely what it shows about the power of Powerboat registrations in predicting manatee deaths.