1. Data on new vehicles for the 2004 model year are given in the December 2003 issue of *Kiplinger’s Personal Finance*. A random sample of 100 vehicles was selected. Using these data we wish to predict the Highway MPG of the vehicles. The explanatory variables are listed below. The JMP data set is posted on the course web site.

- Weight – gross weight of vehicle in pounds (Min = 2035, Max = 6133)
- Engine – size of the engine in liters (Min = 1.5, Max = 6)
- Length – overall length of the vehicle in inches (Min = 144, Max = 219)
- Horsepower (Min = 100, Max = 477)

The data are on the class web page [http://www.public.iastate.edu/~wrstephe/stat301.html](http://www.public.iastate.edu/~wrstephe/stat301.html)

a) Use JMP’s **Fit Model** to fit a multiple regression model with Highway MPG as the response variable and Engine, Horsepower, Weight and Length as four explanatory variables. Use the JMP output to answer the following questions. Attach the JMP output at the end of your lab assignment.

b) Give the multiple regression equation.

c) Give the value of the estimate of the error standard deviation, σ.

d) Give the value and an interpretation of $R^2$.

e) What is the value of the adjusted $R^2$?

f) Test the hypothesis $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ versus the alternative that at least one slope parameter is not zero. What does this test tell you about the relationship between the Highway MPG and the four explanatory variables?

g) Look at the plot of residuals versus Engine. What does this plot tell you about the linear model?

h) Describe what you see in the analysis of residuals; histogram, box plot and normal quantile plot. What does this indicate about the conditions necessary for multiple regression analysis?

2. Use JMP’s **Fit Model** to fit the models necessary to answer the following questions. Be sure to support your answers with the appropriate test statistic and $P$-value from the appropriate JMP output. For all tests use $\alpha = 0.05$ as your level of significance. Attach the JMP output at the end of your lab assignment.

a) Is there a statistically significant relationship between Highway MPG and the Weight of the vehicle?

b) Does the Length of the vehicle add significantly to the model that already contains Weight? How much does Length add to Weight? Give either the additional sum of squares or the change in $R^2$. 
c) Does Horsepower add significantly to the model that already contains Weight? How much does Horsepower add to Weight? Give either the additional sum of squares or the change in $R^2$.

d) Does Engine add significantly to the model that already contains the two variables Weight and Horsepower? How much does Engine add to the two variables Weight and Horsepower? Give either the additional sum of squares or the change in $R^2$.

e) Does Weight add significantly to the model that already contains Engine and Horsepower? How much does Weight add to the two variables Engine and Horsepower? Give either the additional sum of squares or the change in $R^2$.

f) Does Engine add significantly to the model that already contains the three variables Weight, Horsepower and Length? How much does Engine add to the three variables Weight, Horsepower and Length? Give either the additional sum of squares or the change in $R^2$.

3. Use JMP’s Fit Y by X to fit a simple linear model with Highway MPG as the response and Horsepower as the explanatory variable. Use the JMP output to answer the following questions. Attach your JMP output to the end of your lab assignment

a) How much of the variation in Highway MPG is explained by the linear relationship with Horsepower?

b) What is the value of the Root Mean Square Error?

c) Is the model useful? Support your answer with an appropriate test of hypothesis.

Highlight all the rows in your JMP data table that correspond to all vehicles that have 4, 5 or 8 Cylinders. Go to Rows and click on Exclude/Unexclude. Any further analysis will deal only with 6 cylinder cars in the sample. Use Fit Y by X to fit a simple linear model with Highway MPG as the response and Horsepower as the explanatory variable for 6 cylinder vehicles only. Use the JMP output to answer the following questions regarding 6 cylinder vehicles only. Attach your JMP output to the end of your lab assignment.

d) How much of the variation in Highway MPG is explained by the linear relationship with Horsepower?

e) What is the value of the Root Mean Square Error?

f) Is the model useful? Support your answer with an appropriate test of hypothesis.

g) Comment on the difference between the relationship between Highway MPG and Horsepower using all the vehicles in the sample and using only 6 cylinder vehicles. What might this indicate about the variables Horsepower and Cylinder?