"1.21. Airfreight breakage. A substance used in biological and medical research is shipped by airfreight to users in cartons of 1,000 ampules. The data below, involving 10 shipments, were collected on the number of times the carton was transferred from one aircraft to another over the shipment route *(X)* and the number of ampules found to be broken upon arrival *(Y).* Assume that first-order regression model (1.1) is appropriate."

2.15. Refer to Airfreight breakage Problem 1.21.

a. Because of changes in airline routes, shipments may have to be transferred more frequently than in the past. Estimate the mean breakage for the following numbers of transfers: X = 2, 4. Use separate 99 percent confidence intervals. Interpret your results.

b. The next shipment will entail two transfers. Obtain a 99 percent prediction interval for the number of broken ampules for this shipment. Interpret your prediction interval.

c. In the next several days, three independent shipments will be made, each entailing two transfers. Obtain a 99 percent prediction interval for the mean number of ampules broken in the three shipments. Convert this interval into a 99 percent prediction interval for the total number of ampules broken in the three shipments.

"1.22. Sixteen batches of the plastic were made, and from each batch one test item was molded. Each test item was randomly assigned to one of the four predetermined time levels, and the hardness was measured after the assigned elapsed time. The results are shown below; X is the elapsed time in hours? and Y is hardness in Brinell units. Assume that first-order regression model (1.1) is appropriate."

2.16. Refer to Plastic hardness Problem 1.22.

a. Obtain a 98 percent confidence interval for the mean hardness of molded items with an elapsed time of 30 hours. Interpret your confidence interval.

b. Obtain a 98 percent prediction interval for the hardness of a newly molded test item with an elapsed time of 30 hours.

c. Obtain a 98 percent prediction interval for the mean hardness of 10 newly molded test items, each with an elapsed time of 30 hours.

d. Is the prediction interval in part (c) narrower than the one in part (b)? Should it be?

2.17. An analyst fitted normal error regression model (2.1) and conducted an F test of $β\_{1}=0 $versus $β\_{1}\ne 0$. The P-value of the test was .033, and the analyst concluded Ha: $β\_{1}\ne 0$. Was the $α$ level used by the analyst greater than or smaller than .033? If the $α$ level had been .01, what would have been the appropriate conclusion?

2.25. Refer to Airfreight breakage Problem 1.21.

a. Set up the ANOVA table. Which elements are additive?

b. Conduct an F test to decide whether or not there is a linear association between the number of times a carton is transferred and the number of broken ampules; control the $α$ risk at .05. State the alternatives, decision rule, and conclusion.

c. Obtain the t\* statistic for the test in part (b) and demonstrate numerically its equivalence to the F\* statistic obtained in part (b).

d. Calculate $R^{2}$ and r. What proportion of the variation in Y is accounted for by introducing X into the regression model?

3.6. Refer to Plastic hardness Problem 1.22.

a. Obtain the residuals $e\_{i}$ and prepare a box plot of the residuals. What information is provided by your plot?

b. Plot the residuals $e\_{i}$ against the fitted values $\hat{Y}\_{i}$; to ascertain whether any departures from regression model (2.1) are evident. State your findings.

c. Prepare a normal probability plot of the residuals. Also obtain the coefficient of correlation between the ordered residuals and their expected values under normality. Does the normality assumption appear to be reasonable here? Use Table B.6 and $α=0.05$.

e. Use the Brown-Forsythe test to determine whether or not the error variance varies with the level of X. Divide the data into the two groups, and use $α=0.05$. State the decision rule and conclusion. Does your conclusion support your preliminary findings in part (b)?