Homework 5 Solutions - STAT 324

# Solutions and Grading Rubric

Each of the following open-ended questions is worth **1 point**. Partial credit may be awarded based on the rubric criteria.

## Q1. Residual vs. Fitted Plot – Model 0

**Solution:**

The residual vs. fitted plot for the untransformed model (mpg ~ horsepower) likely shows a curved pattern, indicating a violation of the linearity assumption. There is also evidence of non-constant variance (heteroscedasticity), where residual spread increases or decreases across the range of fitted values.

**Rubric:**

| Criterion | Points |
| --- | --- |
| Identifies curvature/nonlinearity | 0.5 |
| Identifies heteroscedasticity or changing variance | 0.5 |

## Q2. Interpretation of Slope with sqrt(horsepower)

**Solution:**

The slope represents the expected change in mpg for a one-unit increase in the **square root** of horsepower. Since the predictor is transformed, this means a unit increase in sqrt(horsepower) corresponds to a larger increase in raw horsepower at higher values. The interpretation must reflect this non-linear scaling.

Example: “For every 1-unit increase in sqrt(horsepower), the expected mpg decreases by [slope] units, on average.”

**Rubric:**

| Criterion | Points |
| --- | --- |
| Acknowledges that the predictor is transformed (sqrt) | 0.5 |
| Provides a correct contextual interpretation of slope in transformed scale | 0.5 |

## Q3. Prediction with log(horsepower)

**Solution:**

Students should apply the model equation using log(200) (natural log in R), then explain the predicted mpg value. The interpretation should include:

* A statement like: “A car with 200 horsepower is expected to achieve approximately \_\_\_ mpg.”
* A reflection on feasibility: “This is within the observed range of mpg, so the prediction appears reasonable.”

**Rubric:**

| Criterion | Points |
| --- | --- |
| Applies natural log transformation to horsepower and calculates mpg | 0.5 |
| Interprets the prediction and assesses reasonableness within the data | 0.5 |

## Q4. Interpretation of log(horsepower) in MLR with weight

**Solution:**

The coefficient of log(horsepower) represents the expected change in mpg for a one-unit increase in log(horsepower), **holding weight constant**. This means that among cars with the same weight, increasing horsepower by a factor of *e* (because log is natural log) is associated with a change in mpg by the value of the coefficient.

Example: “Holding weight constant, a one-unit increase in log(horsepower) (i.e., multiplying horsepower by e) is associated with a [decrease/increase] of \_\_\_ mpg.”

**Rubric:**

| Criterion | Points |
| --- | --- |
| Accurately uses the phrase “holding weight constant” | 0.5 |
| Correctly interprets the log-transformed coefficient in multiple regression | 0.5 |