Rocket Engine Regression Analysis Lab

AP Calculus

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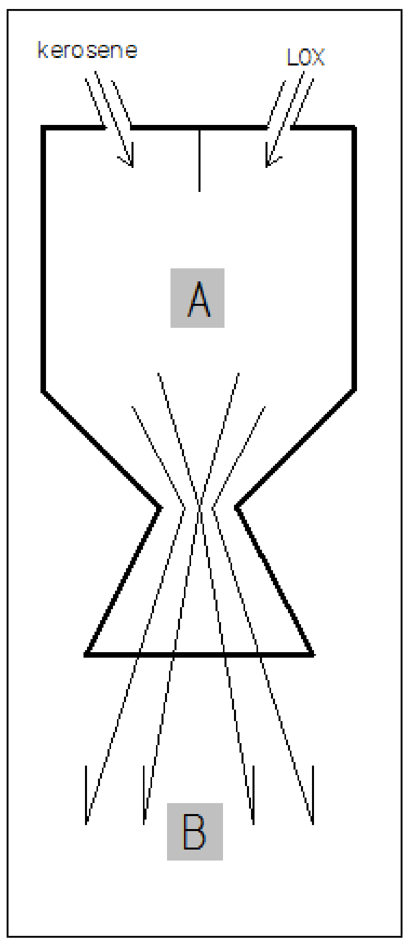

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I. Problem Statement

Using the (partial) experimental rocket engine data shown in Appendix A, provide answers the following questions:

A. Using regression analysis, develop an equation from the data which best describes the velocity at Point B as a function of temperature at Point A.

B. Fill in the missing data points using interpolation.

C. Extrapolate the temperature required at Point A for the gas velocity at Point B to be 550 m/sec.

D. Discuss the potential errors of predicting a temperature to produce a gas velocity of 550 m/sec.

II. Solution Technique

A. MS Excel was used to plot the data points and regression analysis was performed. A scatter plot was created and a logarithmic regression line was selected as best fit. The commuter was commanded to provide the equation of the logarithmic function determine the R^2 value.

B. The regression equation was then used to calculate (interpolate) the missing data points.

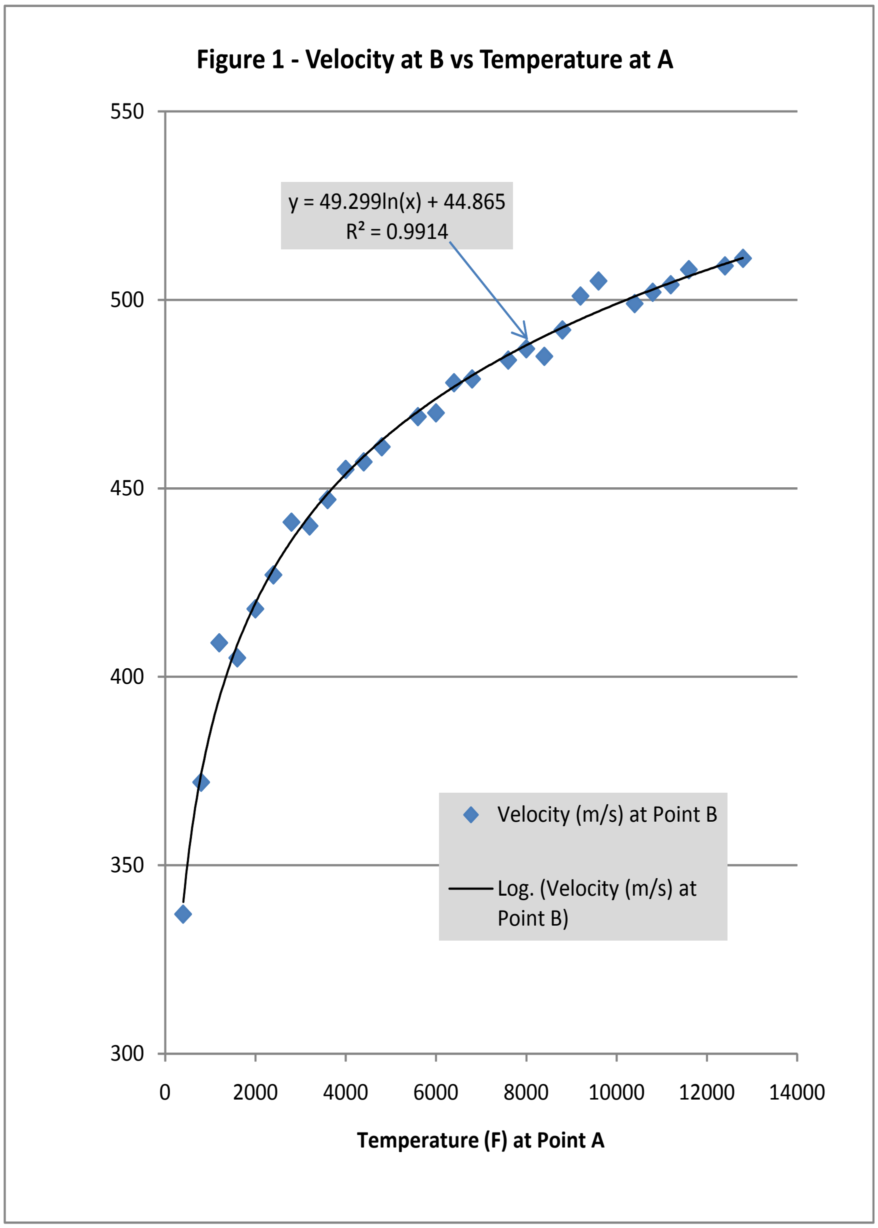
C. To extrapolate the temperature required to produce a gas velocity of 550 m/s at Point B, the logarithmic equation was solved for the temperature and the velocity of 550 m/s was input as the independent variable thus solving for the temperature.

D. In Section IV (Conclusions) the potential error(s) of predicting the temperature at Point A to produce a gas velocity of 550 m/s at Point B are explored.

III. Data Results

A. The scatter plot of the data is shown in Figure 1 accompanied by the logarithmic regression line equation and R^2 value.

Temp (F) at Point A	Velocity (m/s) at Point B
400	337
800	372
1200	409
1600	405
2000	418
2400	427
2800	441
3200	440
3600	447
4000	455
4400	457
4800	461
5200	
5600	469
6000	470
6400	478
6800	479
7200	
7600	484
8000	487
8400	485
8800	492
9200	501
9600	505
10000	
10400	499
10800	502
11200	504
11600	508
12000	
12400	509
12800	511



B. The regression equation was manipulated as follows:

regression equation from MS Excel: $v = 49.299 \cdot \ln(t) + 44.865$

solving for t as a function of v: $t(v) := e^{0.02028 \cdot v - 0.9100}$

solving for t(550): $t(550) = 28113.4$

IV. Conclusions

A. The missing (interpolated) are points are shown highlighted in the data set to the right.

B. The extrapolated temperature to produce a gas velocity at Point B of 550 m/s is 28,113.4 as shown above in Section III.B.

C. The potential errors associated with predicting the temperature required to produce a 550 m/s velocity at Point B stem from the assumption that the regression equation will remain unchanged. **The stability of this equation is <u>uncertain</u>.**

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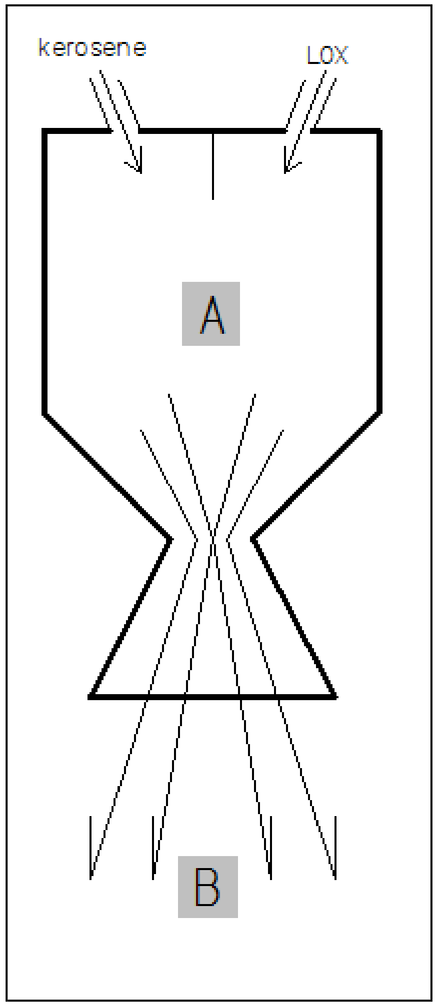
4400	457
4800	461
5200	466.69
5600	469
6000	470
6400	478
6800	479
7200	482.73
7600	484
8000	487
8400	485
8800	492
9200	501
9600	505
10000	498.93
10400	499
10800	502
11200	504
11600	508
12000	507.91
12400	509
12800	511

Appendix A – Clean copy of the problem Statement

A typical liquid fueled liquid oxygen-kerosene rocket engine is shown schematically to the right. The exit velocity of the gasses at Point B are primarily a function of the temperature at Point A. Empirical data for the test engine is provided in the table.



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Using regression analysis, develop an equation from the data which best describes the velocity at Point B as a function of temperature at Point A.
Fill in the missing data points using interpolation.
Extrapolate the temperature required at Point A for the gas velocity at Point B at be 550 m/sec.
Discuss the potential errors of predicting a temperature to produce a gas velocity of 550 m/sec.

Create a single, professional MS Word document as a solution for this project and e-mail this document as an attachment to mheinen_1@msn.com.

Use the following format for your file:

LastName_FirstInitial-RocketLab

Example: HeinenM-RocketLab.docx

Include all calculations, data, graphs, and include explicit answers.