APM 153 Assignment Eight – Boiling Point of Water – Part 2

Introduction

(1) A better, but more complicated method than the Antoine equation for describing the change in boiling point vs. pressure is given by the following multi-step equation.

Equation 2.1 $$T = \frac{n_{10} + D - [(n_{10} + D)^2 - 4(n_9 + n_{10}D)]^{\frac{1}{2}}}{2}$$

Equation 2.2 $$D = \frac{2G}{-F - (F^2 - 4EG)^{\frac{1}{2}}}$$

Equation 2.3 $$E = \beta^2 + n_3\beta + n_6$$

Equation 2.4 $$F = n_1\beta^2 + n_4\beta + n_7$$

Equation 2.5 $$G = n_2\beta^2 + n_5\beta + n_8$$

Equation 2.6 $$\beta = P^{\frac{1}{4}}$$

where T is the temperature in °K
P is the pressure in MPa (1 MPa = 1000 kPa)
n_1, n_2, n_3 ,…n_{10} are constants given in the table below

Table 1. Values for the Constants n1 – n10 .

n_1 =	0.116 705 214 527 67 E4	n_6 =	0.149 151 086 135 30 E2
n_2 =	- 0.724 213 167 032 06 E6	n_7 =	- 0.482 326 573 615 91 E4
n_3 =	- 0.170 738 469 400 92 E2	n_8 =	0.405 113 405 420 57 E6
n_4 =	0.120 208 247 024 70 E5	n_9 =	- 0.238 555 575 678 49
n_5 =	- 0.323 255 503 223 33 E7	n_{10} =	0.650 175 348 447 98 E3

Note: The equation is valid only for pressures between 611.213 Pa to 22.064 MPa.

Define the Problem

(4) Write a VBA function that uses the equation above to solve for the change in the boiling point of water as a function of elevation.

Define the Inputs and Outputs

(5) The inputs to the equation are a column representing altitude from 0 to 10,000 meters in 500 meter increments and the **constants** stored **in cells** on the worksheet.

(6) The output is the calculated value of the boiling point at each elevation, or a message saying that the "Pressure is outside of valid range".

(7) So, if the calculated pressure is less than 611.213 Pa or greater than 22.064 MPa, the function returns the message "Pressure is outside of valid range".

One Line of Code

(8) "Declaring" the function **As Variant** allows it to return two types of output.

```
Function Boiling_Point(altitude) As Variant
```

Steps to Solve the Problem

(9) Your function must first solve for the change in pressure due to the change in altitude.

(10) Once you have solved for the pressure, you work backward from Equation 2.6 to 2.1

What to Turn In

(11) Assignment Eight will be due in Lab on Friday, March 31st, which is when we will have our second hourly exam. You will turn in one MS Word document with,…

Part One Your algorithm as pseudocode only.

Part Two A copy of your VBA function

Part Three A copy of one Excel Chart showing the altitude on the x axis and boiling point on the y axis.

Part Four A copy of your Excel spreadsheet with the solutions to the quadratic equations listed in Lecture 17 using the Quad_Roots subroutine.