Homework 2

Ch En 263 – Numerical Tools

Due: 22 Jan. 2024

Instructions

- Complete the problems below and submit the following files to Learning Suite:
  - Handwritten portion: scan each page (or take a picture) and combine them into a single pdf named: `LastName_FirstName_HW2.pdf`
  - Excel portion: submit a workbook named `LastName_FirstName_HW2.xlsx` where each worksheet tab is named "Problem_1", "Problem_2", etc.
  - Python portion: submit a separate file for each problem named `LastName_FirstName_HW2_ProblemXX.py` where XX is the problem number.

Problems

1. In the last homework, you were introduced to the Redlich-Kwong (RK) equation of state

$$P = \frac{RT}{V-b} - \frac{a}{V(V+b)\sqrt{T}}$$

where V is molar volume, $R = 8.314$ J/(mol K) is the universal gas constant and

$$a = 0.427\frac{R^2 T_c^{2.5}}{P_c}, \qquad b = 0.0866\frac{RT_c}{P_c}.$$

Given that $T = 370$ K, $V = 7.2$ L/mol, $P_c = 4.898 \times 10^6$ Pa, and $T_c = 150.86$ K.

   (a) Convert T, V, P_c, T_c and R to English units (slug, ft, s, °R) at the top of a Python file. Include comments that indicate their units. Try and do this without looking up the unit conversions.

   (b) Calculate a, b, and P and print the value of these variables to the console along with their units using an expression like:

```
a = #### (units)
```

   (c) Convert P to psi (psi = lbf/in^2) and print it to the console.

2. Use Excel for the following. Use cells to make the calculations, and record your written answers in a text box. Suppose you would like to evaluate the product

$$x = \left(3.7 \times 10^{109}\right) \times \left(5.4 \times 10^{245}\right) \times \left(2.1 \times 10^{37}\right).$$

   (a) Try and evaluate the expression directly. Why are you not able to do this?

   (b) Use the property of logarithms that $\log_b(NM) = \log_b(N) + \log_b(M)$ to find $\log_{10}(x)$. Now, determine the value of x. *Hint: You can use the expression* `=log10(Value)` *to evaluate a logarithm in Excel.*

3. Do the following in an Excel Workbook. Create a table in Excel that mirrors the table shown below. Enter the independent variable, x, in the first column. In a second column, display the text you would use to evaluate the given Excel function. In a third column, evaluate the function to show the value.

Input value (x)	Output function f(x)
0.5 radians	$\cos(x)$
30 degrees	$\sin(x)$
2	$\tan(\pi/x)$ with π/x in radians
5	$\max(2\sqrt{x}, x^2/2, x^3/3, (x^2+x^3)/5)$
25	$x!$
0.5	x^2 when $x < 1$; $\sin(\pi x/2)$ when $x \geq 1$
4.999	largest integer less than or equal to x

Hint: A single quote mark (') turns a cell in Excel into a text cell, e.g. '=Cos(A1) will show up as text.

4. Similar to the problem from lab, write Python functions : `m_to_ft`, `hr_to_s`, `kg_to_slug`, `K_to_degR` for converting meters to feet, hours to seconds, kilograms to slugs, and Kelvin to degrees Rankine. Use your functions to convert:

   (a) 5.3 m to ft

   (b) 72 hr to s

   (c) 41.2 kg to slug

   (d) 300 K to °R.

5. The data in the table below shows the opening stock price for Google from several days in August and September in 2016. Use Excel functions to calculate the maximum and minimum price, the average price, the standard deviation and the median price.

Date	Price ($)	Date	Price ($)
19-Sep-16	772.42	31-Aug-16	767.01
16-Sep-16	769.75	30-Aug-16	769.33
15-Sep-16	762.89	29-Aug-16	768.74
14-Sep-16	759.61	26-Aug-16	769.00
13-Sep-16	764.48	25-Aug-16	767.00
12-Sep-16	755.13	24-Aug-16	770.58
9-Sep-16	770.10	23-Aug-16	775.48
8-Sep-16	778.59	22-Aug-16	773.27
7-Sep-16	780.00	19-Aug-16	775.00
6-Sep-16	773.45		
2-Sep-16	773.01		
1-Sep-16	769.25		

6. Write a function in a Python program that can evaluate the following formula,

$$y(t) = 5\left[1 - \exp\left(-\frac{(t-\theta)}{\tau}\right)\right]$$

   where t is an argument to the function, but θ and τ are global variables defined before the function. Evaluate $y(11.0)$, $y(11.4)$, $y(11.8)$, $y(12.2)$, $y(12.6)$, $y(13.0)$ when $\theta = 2.1$ and

$\tau = 4.8$ and print the values to the console. Use the `numpy` module to import the necessary math functions.