

Second Programming Assignment – Due Tuesday, February 28, 11:59 pm¹

Objective

This assignment introduces the use of the VBA editor (the VBE), the use of functions and subs, and writing code using replacement statements with numerical variables. The analysis in this assignment uses the same equations as in the first assignment: the calculation of the density of an ideal gas.

Background

The ideal gas density, ρ , is computed from the pressure, P , and absolute temperature, T , by one of the following equations.

$$\rho = \frac{P}{RT} \qquad \rho = \frac{MP}{R_u T}$$

The engineering gas constant, R , is the universal gas constant, R_u , divided by the molar mass, M . A consistent set of SI units for these equations are P in kPa, T in K, and R in kJ/kg•K. With these units, the universal gas constant is $R_u = 8.31447$ kJ/kmol•K.

Exercises

Download the workbook <http://www.csun.edu/~lcaretto/me209/pa2start.xlsm> from the course web site. This workbook contains the VBA code to do the table look-up that finds the molar mass for a given substance name. These functions and macros are in a separate module named dataTable. You should write your code on a new module. Remember to put the Option Explicit statement at the top of the macro. Follow that statement with the statement below to define a global variable for the universal gas constant that you can use in any function or macro you write in your module.

```
Const universalGasConstant As Double = 8.31447 'kJ/kmol-K
```

First exercise. Set up a worksheet that has the following input data **in sequential rows**, starting in the first row. Place the name of the data (not the symbol) in column A, the value of the data in column B, and the units in column C.

- Substance; Air; (no units)
- Molar mass; 28.966; kg/kmol
- Pressure; 101.325; kPa (This is the standard atmospheric pressure.)
- Temperature; 300; K
- Density; **<write equation later>**; kg/m³

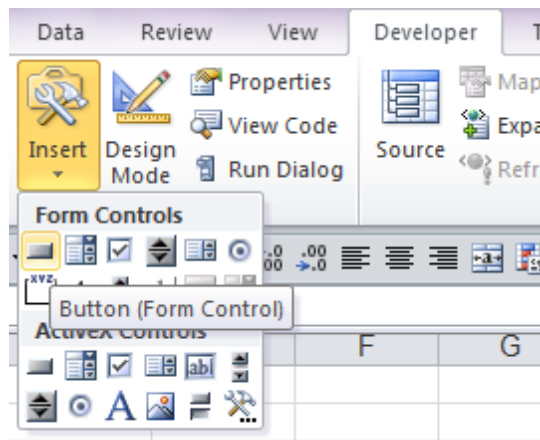
Write a VBA function called idealGasDensity with the input arguments of molar mass, pressure, and temperature that computes the density. Call this function from the **<write equation later>** cell above to calculate the density. Name the worksheet **molarMass**.

Second exercise. On the same worksheet, copy the cells you have in A1:C5 to E1:G5 and replace the data in cells F1:F4 by an equation makes the values in each cell row equal to the values in the cell of same row in column B. Leave the density cell, F5, blank. Write a macro (a sub with no arguments) that

¹ It may be submitted by 11:59 pm, Friday, March 3, with a 30% penalty. No later submissions accepted

uses statements like `M = range("F1").Value` to get data from the worksheet and a statement like `range("F5").value = density` to write data to the worksheet. Name the sub `idealGasDensityMacro`. (Note that you cannot use the same name for the macro that you have used for the function. In fact, no two procedures in the same Excel workbook can have the same name.) Follow the instructions below to set up a command button to run the macro.

1. Select **Insert** from the Controls group in the **Developer** tab. You will see a menu with **Form Controls** as shown at the right.
2. Select the first control from this menu, the **Button (Form Control)**, by left clicking on the button icon.
3. Move the mouse to the worksheet and note that the icon changes to a cross.
4. Click and drag the mouse to give the shape of the button you desire.
5. As soon as you release the mouse, you should see the **Assign Macro** dialog box. Select the **idealGasDensityMacro** macro and click **OK**.



After you do this, your command button should look like the figure shown at the left. Note the rectangular border surrounding the button, the circles at the corners of the button and at the centers of the button sides. So long as these are in place, the button is in the edit mode. You can rename the button from the default name to a more meaningful one² (e.g., calculate ideal gas density.) You can resize it or move it to any other location on the worksheet. When

you are ready to use the button, click the mouse anywhere on the worksheet off the button location and the circles/border will disappear. Now, left-clicking the button will execute the macro you assigned. (If you want to return to the edit mode for the button, simply right-click it.)

Run the macro. You should get the same result you got with your function. Change the temperature. What happens to the density values in cells B4 and F4 when you change the data? You will have to click the button every time that you change data; **recalculation is not automatic for macros**.

Third exercise. You are now asked to put a title, "Ideal Gas Calculation" in the first row of your worksheet. To do this, insert a new row above the current first row, merge cells A1:G1 in this new row, insert the title in the merged cell, and center the title. Make any necessary changes in the function and the macro to give correct results after you make this change. Create a text box on your worksheet³ and in that text box describe what changes you had to make to the macro and to the function when you added the new row.

Fourth exercise. Copy the previous worksheet and name it **Substance**. Make the following edits in the worksheet

- Replace the two entries for the molar mass by an entry titled Substance and delete the units.
- Set a data validation for the entry for the substance in column B using a list with a range name `dataTable`. (This range name is already defined, on a hidden worksheet, in the workbook you downloaded.)
- Select air as the substance. Leave the input data in column F still equal to the input data in column B. (You do not have to change the other input data.)
- See the directions below for the new function that uses the substance name to compute the density.

² To change the button name, select the current name ("Button 2" in the figure above) and type the desired name.

³ To create a text box on the worksheet, (1) click the Text Box icon on the Insert tab. (2) Release the mouse button and drag the mouse to the worksheet at the location where you want the upper, left-hand corner of the box. (3) Click and drag the mouse to the location of the lower, right-hand corner. You can then move the mouse so that it is located inside the text box and click it to start typing.

Write a new VBA function to compute the ideal gas density with the input arguments of species name, pressure, and temperature that computes the density. In writing this function, you can call the following VBA function, which is already in the workbook, in the dataTable module: `Function getMolarMass(name as string) as double`. This function provides the molar mass for any name that is in the data table. Use the function you write to compute the density on the work sheet. Do your values agree with the previous calculation? Should they? (HINT: Call the `getMolarMass` function from the worksheet to see if the molar mass used in the calculation from the substance name matches the one you used on the other worksheet.

Fifth exercise. Write a VBA macro that computes the ideal gas density from the substance name, pressure, and temperature. Place a command button on the Substance worksheet to use this macro to compute the density for this worksheet.