Introduction to Scientific Computing Using Fortran 90
Converting Temperatures

The goal of this exercise is to practice writing functions and subroutines.

Recall that the Celsius scale sets freezing and boiling points of water between 0°C and 100°C whereas Fahrenheit sets it between 32°F and 212°F. So we can convert Celsius to Fahrenheit using the expression

$$F = \frac{9}{5}C + 32$$

and we can convert a Fahrenheit temperature to a Celsius temperature from the formula

$$C = \frac{5}{9}(F - 32)$$

where F represents the Fahrenheit temperature and C the Celsius temperature. Scientists also use a third scale called the absolute or Kelvin scale (named after Lord Kelvin). In theory scientists believe the coldest it can get is -273.15°C which is called absolute zero and thus is assigned the value 0°K. So to convert from Celsius to Kelvin we simply add this value, i.e.,

$$K = C + 273.15\,,$$

where K denotes the temperature in degrees Kelvin. To convert from Fahrenheit to Kelvin we could first convert to Celsius and then add 273.15 degrees. The expressions to convert Kelvin to Fahrenheit or Celsius are readily obtained from the above expressions.

1. When writing a code the best strategy is to write it in parts and debug each part as you go. So the first thing we are going to do is to write a program which does the following

   - Create a function, say `fahrenheit_to_celsius` which as input has a Fahrenheit temperature and output is the corresponding Celsius temperature. Remember to use real numbers for the division $\frac{5}{9}$ and for 32.

   - Create a main program called something like `convert_temperatures` which
   - reads in a Fahrenheit temperature
   - calls your function to convert the temperature to Celsius
   - provides a write statement which says something like "a temperature of xx Fahrenheit equals xx degrees Celsius" where you have to print out the input Fahrenheit temperature and the converted Celsius temperature; this can be done with a statement like

        print*,"A temperature of ", f_temp, "Fahrenheit...", c_temp.

     where `f_temp, c_temp` are the Fahrenheit and Celsius temperatures respectively.
   - provide comment statements to indicate the program's purpose and the steps you are doing

   - Debug your code and test it on 32°F and 212°.

   - If you are having trouble creating this code, take a look at the sample code `convert_temperatures1.f90` from the Resources page of our website.

2. Make a copy of your working code to save (it's always good to do this). Now modify your code by
   - adding a function to convert from Celsius to Fahrenheit,
   - add a section to your main code where you read in the Celsius temperature from the screen and call this routine.

Your code will now ask the user for a Fahrenheit temperature, convert this to Celsius and print result, then ask the user for a Celsius temperature and convert this to Fahrenheit and print the result. Debug your code and try it on a couple of temperatures.

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3. The way the code is written now, if you want to convert 5 Fahrenheit temperatures then you have to execute the code 5 times. Now we want to modify the code to read in the number of Fahrenheit (and Celsius) temperatures to convert. To do this we need to modify the code to

- read in the number of temperatures to be converted; allow a different number for Fahrenheit and Celsius
- add a do loop which goes from one to thee number of temperatures to be converted; think carefully about where should it go; remember to add a blank space before and after the `do` and end do statements for readability and indent the statements in your do loop. You will have 2 do loops, one over each conversion of temperatures.

Note that if the user inputs 0 temperatures to be converted then your do loop is skipped since the final value (0) of the counter is less than your initial value of the counter (which is 1)

- Make sure your code is working properly.

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4. Now we are going to write a similar code which uses a subroutine. Create a program which does the following

- reads in (from the screen) the number of Fahrenheit temperatures to be converted and each temperature;
- add a subroutine, say `convert_fahrenheit` to your program which converts the Fahrenheit temperature to Celsius and to Kelvin
- add a do loop from one to the number of temperatures; in this loop call your subroutine which as input has the Fahrenheit temperature and as output has both the corresponding Celsius and Kelvin temperatures;
- print out the 3 temperatures with text indicating what they are

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The finished code from (3.) along with your code from (4.) should be submitted (to both Peterson and Lay) before the next class on 1/31. This can be done by email.