Homework 2

Due: May 10, 2023 **Points:** 100

1. (*40 points*) A string is said to be *reverse alphabetic* if the letters in it, regardless of case, are in the reverse of dictionary order. So, for example, "miff" and "pooka" are reverse alphabetic, and "willow" and "computer" are not. In the following, assume the arguments contain *only* alphabetic characters.
   (a) Write a program called `isrevalpha` that uses a recursive function to determine whether a single command-line argument is reverse alphabetic. The program prints `argument: True` if its argument is reverse alphabetic, and `argument: False` otherwise. For this version, assume the argument is either all lower case or all upper case alphabetic characters. Call your program "abcde1.c".
   (b) Change your program so that the letters can be any case, not all upper or lower case. Again, you can assume all characters in the argument are alphabetic. Call your program "abcde2.c".
   (c) Finally, modify your program to take any number of arguments. Each argument must produce one line of the type above. Call your program "abcde3.c".
2. (*30 points*) Define the function:

$$f(n) = \begin{cases} n/2 & \text{if } n \text{ is even} \\ 3n+1 & \text{if } n \text{ is odd} \end{cases}$$

   The *Collatz conjecture* says that, if you iterate this sequence for any initial value of n, then eventually the sequence will reach the number 1.

   For a given number n, let k be the *least* number of iterations needed to reach the number 1 (excluding the initial value). Then k is called the *total stopping time* of n.

   For example, if $n = 29$, then the sequence is:

```
29 88 44 22 11 34 17 52 26 13 40 20 10 5 16 8 4 2 1
```

   and so the total stopping time of 29 is 18.

   Write a program that takes as input a positive integer and prints both the sequence and the total stopping time for that integer. Prompt the user with "> " (note the trailing space and no newline). The output should look like (user input is in red):

```
> 29
29 88 44 22 11 34 17 52 26 13 40 20 10 5 16 8 4 2 1
The total stopping time for 29 is 18
```

   Call your program "collatz.c".
3. (*30 points*) A paper[1] proposed the following equation for the cumulative deaths for COVID-19 after x days, where $x \geq 30$:

$$9 \times 10^{-9}x^6 - 6 \times 10^{-6}x^5 + 0.0015x^4 - 0.1376x^3 + 7.4558x^2 - 97.284x$$

   Write a program that reads an integer number of days and prints the cumulative deaths. If the number of days is less than 30, reject the input. Round the number of deaths to the nearest integer.
   You will need to use the mathematical function `pow`. You must also include the math library header file *math.h* and, when you compile, put "–lm" after the compile command to link the math library (if you forget this, the compiler will say that `pow` is undefined).
   Here are some examples of input and output:

```
Number of days: 150
After 150 days, the number of deaths predicted is 95029

Number of days: 8
The number of days must be at least 18
```

   In the latter case, the message is written to the standard error, not the standard output. Call your program "covid.c".

[1] H. Kumar, P. Arora, M. Pant, A. Kumar, and S. Khan, "A simple mathematical model to predict and validate the spread of Covid-19 in India," *Materials Today: Proceedings of the Third International Conference on Computational and Experimental Methods in Mechanical Engineering*, **47**(13) pp. 3859–3864 (doi: 10.1016/j.matpr.2021.03.434