CS3460: Data Structures   Spring 2018
Assignment 03: Fun with Stacks
Due Date: Monday, February 12; 23:00 hrs
Total Points: 20

This assignment will first build an integer stack data structure, and then use it to solve a fun problem of computing the molecular mass of a chemical molecule.

1. **Integer Stack (10 points):** An integer stack data structure is a stack that holds integer data and supports two operations.

1. `push(x)`: This operation pushes an integer x onto the stack. You are guaranteed to not have more than 100 elements on the stack.

2. `pop()`: This operation pops the last pushed element from the stack. Since the elements that are stored on the stack are positive integers, please return -1 if the user attempts to pop from an empty stack.

You are given the file `IntStack.java`. Please fill out all the operations of the integer stack as described above. You may implement the stack as either an array or a linked list. Please test your functions thoroughly by writing an appropriate driver program.

2. **Molecular Mass (10 points):** A molecule can be defined as a sequence of atoms and represented by a chemical formula consisting of letters denoting these atoms. E.g. letter H denotes atom of hydrogen, C denotes atom of carbon, O denotes atom of oxygen, formula COOH represents molecule consisting of one atom of carbon, two atoms of oxygen and one atom of hydrogen.

To write some formulas efficiently, we use the following rules. Letters denoting some atoms can be grouped by enclosing in parentheses, e.g. formula CH(OH) contains group OH. Groups can be nested – a group can also contain other groups. To simplify a formula, consecutive occurrences of the same letter can be replaced with that letter followed by a number of these occurrences. E.g. formula COOHHH can be written as CO2H3 and it represents a molecule consisting of one atom of carbon, two atoms of oxygen and three atoms of hydrogen. Furthermore, consecutive occurrences of the same group can be replaced with that group followed by a number of these occurrences. E.g. formula CH (CO2H) (CO2H) (CO2H) can be written as CH(CO2H)3 and molecule represented by both those formulas consists of four atoms of carbon, four atoms of hydrogen and six atoms of oxygen. A number written after a letter or a group is always greater than or equal to 2 and less than or equal to 9. A mass of a molecule is a sum of masses of all its atoms. One atom of hydrogen has mass 1, one atom of carbon has mass 12 and one atom of oxygen has mass 16.

Please write a Java program `MolecularMass.java` that takes a string representation of a molecule as input and prints its total molecular mass. The input is guaranteed to come with only characters C, H or O, and strictly follows the rules given above (that is, one doesn't have to check for the invalidity of the input). It is also guaranteed that there are no more than 100 characters in the input. As a hint, think about how to use the integer stack from problem # 1, and what stack operations are needed. Several sample input and outputs are shown below.

```
Sample Input and Output:

Enter the molecule: H2O
The Molecular Mass of H2O is 18

Enter the molecule: CH(CO2H)3
The Molecular Mass of CH(CO2H)3 is 148

Enter the molecule: ((CH)2(OH2H)(C(H))O)3
The Molecular Mass of ((CH)2(OH2H)(C(H))O)3 is 222
```

Submission: Please submit the files `IntStack.java` and `MolecularMass.java` as a single zip archive `hw3.zip` through ASULearn.

Input/ Output Instructions: For all programs, until and otherwise stated, we will be taking the input from standard input (`System.in`) and will be sending the output to standard output (`System.out`).

Notes on Coding: Please do not include user-defined packages in your code. Your code should run in the Unix/Linux machine using the commands `javac` and `java`.