Stacks and Queues

(1) Read through the following code. Draw the states of the variables `stack` and `queue` when indicated.

```
1  Stack<String> stack = new CarlStack<String>();
2  Queue<String> queue = new ArrayDeque<String>();
3  queue.add("tofu");
4  queue.add("broccoli");
5  queue.add("rice");
6  // (a) Draw the states of stack and queue
7  System.out.println(queue.element());
8  while (!queue.isEmpty())
9  {
10    stack.push(queue.remove());
11 }
12 // (b) Draw the states of stack and queue
13 for (int i = 0; i < 2; i++)
14 {
15    queue.add(stack.peek());
16 }
17 // (c) Draw the states of stack and queue
```

```
  stack              queue
|        |    ----------------------
|        |     tofu  broccoli  rice
|        |    ----------------------
+--------+

|  rice  |    ----------------------
|broccoli|
|  tofu  |    ----------------------
+--------+

|  rice  |    ----------------------
|broccoli|     tofu  tofu
|  tofu  |    ----------------------
+--------+
```

(2) We briefly talked about post-fix notation. Brainstorm with your partner how to *evaluate* a post-fix notation expression using a stack; that is, find the final value that the expression represents. Write your steps down in pseudocode (step-by-step English). Assume your algorithm will take a list as input. *[Hint: Read the next question.]*

```
create an empty stack
for each item in list:
   if item is binary operator op:
      second = pop off stack
      first = pop off stack
      answer = evaluate "first op second"
      push answer onto stack
   else:
      push item onto stack
finalAnswer = pop off stack
return finalAnswer
```

(3) You receive the following list as input to your algorithm: `[3, 4, 2, /, 8, +, *]`. Walk through the steps of your algorithm with this input, and draw the state of the stack after each pop or push.

```
| |  | |  |2|  | |  | |  | |  |8|  | |  | |  |  |  | |  | |  |  |  | |
| |  |4|  |4|  |4|  | |  |2|  |2|  |2|  | |  |10|  | |  | |  |  |  | |
|3|  |3|  |3|  |3|  |3|  |3|  |3|  |3|  |3|  | 3|  |3|  | |  |30|  | |
+-+  +-+  +-+  +-+  +-+  +-+  +-+  +-+  +-+  +-+  +--+  +-+  +-+  +--+  +-+
```

(over)

(4) **Palindromes** are words or phrases that read the same forward and backward, ignoring spaces, punctuations, or capitalisation (*e.g.*, "racecar" or "Sit on a potato pan, Otis!"). How would you use a stack and a queue to check whether a word or phrase is a palindrome? Write down an algorithm (in pseudocode) to check if something is a palindrome using these two data structures.

```
create 1 stack and 1 queue
go through the string in order, one character at a time
   if it is not a letter, ignore and go on to next letter
   convert letter to lower case
   push it onto the stack and add it to the queue
afterwards, process stack and queue
while the stack is not empty
   pop the top item from the stack and remove the first item from the queue
   if they differ, return false
if the stack is exhausted, return true
```

Code:

```
   public static boolean isPalindrome(String s)
   {
      Stack<Character> stack = new CarlStack<Character>();
      Queue<Character> queue = new ArrayDeque<Character>();

      for (int i = 0; i < s.length(); i++)
      {
         char character = s.charAt(i);

         // ignore non-letter characters
         if (Character.isLetter(character))
         {
            // ignore upper/lower case differences
            character = Character.toLowerCase(character);
            stack.push(character);
            queue.add(character);
         }
      }

      while (!stack.isEmpty())
      {
         if (stack.pop() != queue.remove())
         {
            return false;
         }
      }
      return true;
   }
```

Extra time? Think about how to evaluate *infix* expressions, convert between infix and postfix, implement a queue using two stacks, implement a stack using two (or one!?) queues; or write Java code to implement your pseudocode algorithms.