1. An “abstract” view of the stack:

Using an array implementation would look something like:

<table>
<thead>
<tr>
<th>items</th>
<th>top</th>
<th>bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>a b c</td>
<td>0</td>
<td>3 (max-1)</td>
</tr>
<tr>
<td>a b c</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Complete the big-oh notation for the following stack methods assuming an array implementation: ("n" is the # items)

<table>
<thead>
<tr>
<th>Method</th>
<th>Big-oh</th>
</tr>
</thead>
<tbody>
<tr>
<td>push(item)</td>
<td>$O(1)$</td>
</tr>
<tr>
<td>pop()</td>
<td>$O(1)$</td>
</tr>
<tr>
<td>peek()</td>
<td>$O(1)$</td>
</tr>
<tr>
<td>size()</td>
<td>$O(1)$</td>
</tr>
<tr>
<td>isEmpty()</td>
<td>$O(1)$</td>
</tr>
<tr>
<td>isFull()</td>
<td>$O(1)$</td>
</tr>
</tbody>
</table>

2. Since Python does not have a (directly accessible) built-in array, we can use a list.

```python
class Stack:
    def __init__(self):
        self.items = []
    def isEmpty(self):
        return self.items == []
    def push(self, item):
        self.items.append(item)
    def pop(self):
        return self.items.pop()
    def peek(self):
        return self.items[len(self.items)-1]
    def size(self):
        return len(self.items)
```

Since Python uses an array of references (pointers) to list items in their implementation of a list.

"Abstract" Stack Object list Object

<table>
<thead>
<tr>
<th>push(item)</th>
<th>pop()</th>
<th>peek()</th>
<th>size()</th>
<th>isEmpty()</th>
<th><strong>init</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>$O(1)$</td>
<td>$O(1)$</td>
<td>$O(1)$</td>
<td>$O(1)$</td>
<td>$O(1)$</td>
<td>$O(1)$</td>
</tr>
</tbody>
</table>

b) Which operations should have what preconditions?

*pop and peek, the stack cannot be empty*
3. The text’s alternative stack implementation also using a Python list is:

```python
class Stack:
    def __init__(self):
        self.items = []
    def isEmpty(self):
        return self.items == []
    def push(self, item):
        self.items.insert(0, item)
    def pop(self):
        return self.items.pop(0)
    def peek(self):
        return self.items[0]
    def size(self):
        return len(self.items)
```

Since an array is used to implement a Python list, the alternate Stack implementation using a list:

<table>
<thead>
<tr>
<th>&quot;Abstract&quot; Stack</th>
<th>&quot;alternate&quot; Stack Object</th>
<th>list Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>c</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>a</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>top</td>
</tr>
<tr>
<td></td>
<td></td>
<td>bottom</td>
</tr>
</tbody>
</table>

![Diagram of stack implementation](image)

a) Complete the big-oh notation for the "alternate" Stack methods: ("n" is the # items)

<table>
<thead>
<tr>
<th>Method</th>
<th>Big-oh</th>
</tr>
</thead>
<tbody>
<tr>
<td>push(item)</td>
<td>(O(n))</td>
</tr>
<tr>
<td>pop()</td>
<td>(O(1))</td>
</tr>
<tr>
<td>peek()</td>
<td>(O(1))</td>
</tr>
<tr>
<td>size()</td>
<td>(O(1))</td>
</tr>
<tr>
<td>isEmpty()</td>
<td>(O(1))</td>
</tr>
<tr>
<td><strong>init</strong></td>
<td>(O(1))</td>
</tr>
</tbody>
</table>

4. How could we use a stack to check if a word is a palindrome (e.g., radar, toot)?

1. Push first half of characters to stack.
2. Pop middle letter if length is odd.
3. As we scan right half, pop and compare letters from string.

5. How could we check to see if we have a balanced string of nested symbols? ("(()[])([])[[]]")

![Diagram of balanced string](image)
1. The Node class (in node.py) is used to dynamically create storage for a new item added to the stack. The LinkedStack class (in linked_stack.py) uses this Node class. Conceptually, a LinkedStack object would look like:

```
class Node:
    def __init__(self, initdata):
        self.data = initdata
        self.next = None
    def getData(self):
        return self.data
    def getNext(self):
        return self.next
    def setData(self, newdata):
        self.data = newdata
    def setNext(self, newnext):
        self.next = newnext
```

class LinkedStack(object):
    """Link-based stack implementation."""
    def __init__(self):
        self._top = None
        self._size = 0
    def push(self, newitem):
        """Inserts new item at top of stack."""
        temp = Node(newItem)
        temp.setNext(self._top)
        self._top = temp
        self._size += 1
    def pop(self):
        """Removes and returns the item at top of the stack.
        Precondition: the stack is not empty."""
        if self._size == 0:
            return None
        else:
            return self._top.getData()
    def size(self):
        """Returns the number of items in the stack."""
        return self._size
    def isEmpty(self):
        return self._size == 0
    def __str__(self):
        """Items strung from top to bottom."""
```

a) Complete the push, pop, and __str__ methods.

b) Stack methods big-oh’s?
   (Assume “n” items in stack)
   - constructor __init__:  \( O(1) \)
   - push(item): \( O(1) \)
   - pop(): \( O(1) \)
   - peek(): \( O(1) \)
   - size(): \( O(1) \)
   - isEmpty(): \( O(1) \)
   - str(): \( O(n) \)