Fall 2015 **Data Structures - Test 1** Name: ______________________

Question 1. (4 points) Consider the following Python code.

```
for i in range(n):
    j = 1
    while j < n:
        for k in range(n):
            print( i, j, k)
        j = j * 2
```

What is the big-oh notation $O(\,)$ for this code segment in terms of n?

Question 2. (4 points) Consider the following Python code.

```
for i in range(n):

    for j in range(n):
        print(j)

    k = n
    while k > 0:
        print(k)
        k = k // 2
```

What is the big-oh notation $O(\,)$ for this code segment in terms of n?

Question 3. (4 points) Consider the following Python code.

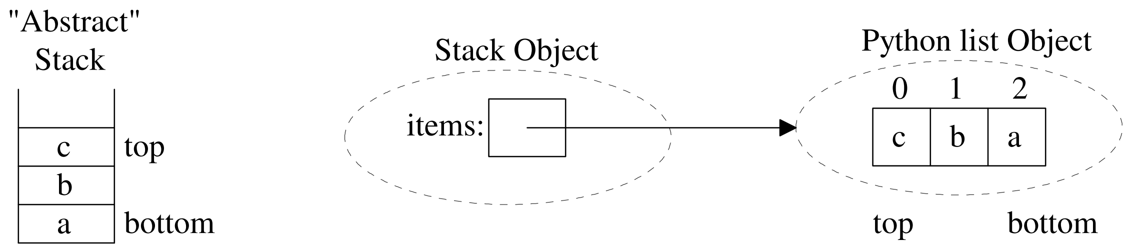
```
def main(n):
    for i in range(n):
        doSomething(n)
    doMore(n)

def doSomething(n):
    for k in range(n):
       print(k)

def doMore(n):
    for j in range(n * n * n):
        print(j)

main(n)
```

What is the big-oh notation $O(\,)$ for this code segment in terms of n?

Question 4. (8 points) Suppose a $O(n^4)$ algorithm takes 10 second when n = 100. How long would you expect the algorithm to run when n = 1,000?

Question 5. (10 points) Why should you design a program instead of "jumping in" and start by writing code?

Question 6. Consider the following Stack implementation utilizing a Python list:



a) (6 points) Complete the big-oh notation for the Stack methods assuming the above implementation: ("n" is the # items)

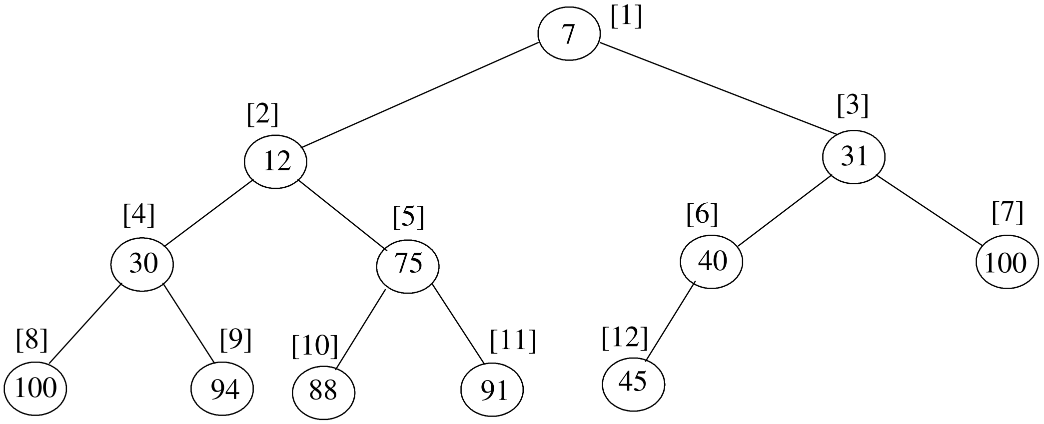
	push(item)	pop( )	peek( )	size( )	isEmpty( )	__str__
Big-oh						

b) (9 points) Complete the code for the `pop` method including the precondition check.

```
class Stack:

   def __init__(self):
      self._items = []

   def pop(self):
       """Removes and returns the top item of the stack
          Precondition:  the stack is not empty.
          Postcondition: the top item is removed from the stack and returned"""
```

c) (5 points) Suggest an alternate Stack implementation to speed up some of its operations.

Question 7. Consider the binary heap approach to implement a priority queue. A Python list is used to store a *complete binary tree* (a full tree with any additional leaves as far left as possible) with the items being arranges by *heap-order property*, i.e., each node is ≤ either of its children. An example of a *min* heap "viewed" as a complete binary tree would be:



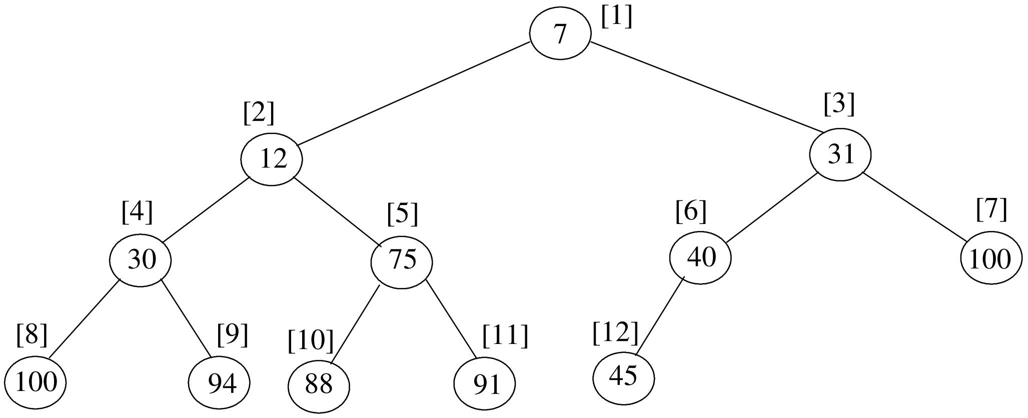
	0	1	2	3	4	5	6	7	8	9	10	11	12
Python List actually used to store heap items	not used	7	12	31	30	75	40	100	100	94	88	91	45

a) (3 points) For the above heap, the list indexes are indicated in [ ]'s. For a node at index *i*, what is the index of:

- its left child if it exists:
- its right child if it exists:
- its parent if it exists:

b) (7 points) What would the above heap look like after inserting 18 and then 9 (show the changes on above tree)

Now consider the `delMin` operation that removes and returns the minimum item.



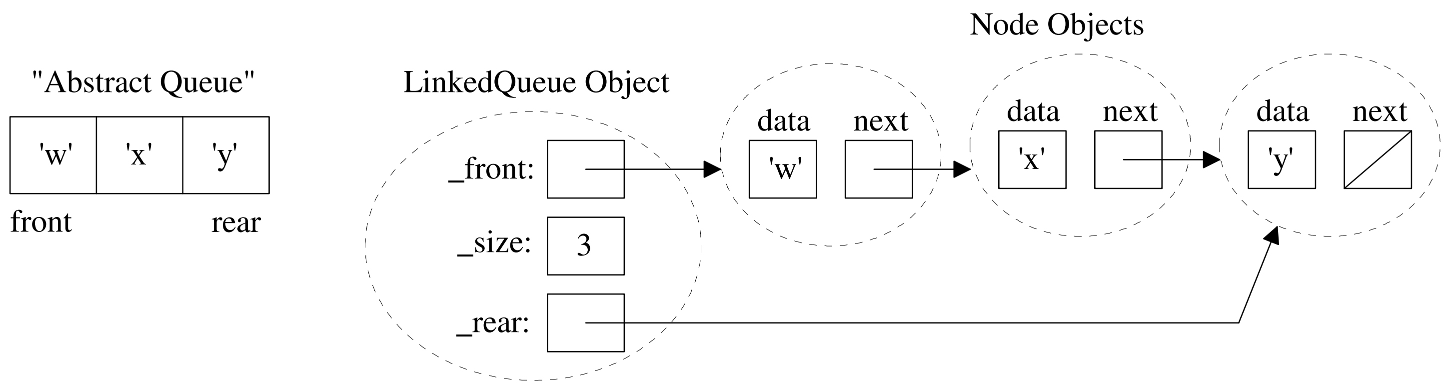
	0	1	2	3	4	5	6	7	8	9	10	11	12
Python List actually used to store heap items	not used	7	12	31	30	75	40	100	100	94	88	91	45

c) (2 point) What item would `delMin` remove and return from the above heap?

d) (7 points) What would the above heap look like after `delMin`? (show the changes on above tree)

e) (6 points) What is the big-oh notation for the `delMin` operation? (**EXPLAIN YOUR ANSWER)**

Question 8. The `Node` class (in `node.py`) is used to dynamically create storage for a new item added to the stack. Consider the following `LinkedQueue` class using this Node class. Conceptually, a `LinkedQueue` object would look like:



a) (13 points) Complete the `dequeue` method including the precondition check.

```
class LinkedQueue(object):
    """ Linked-list based queue implementation."""

    def __init__(self):
        self._front = None
        self._size = 0
        self._rear = None

    def dequeue(self):
        """ Removes and returns the front item in the queue.
            Precondition:  the queue is not empty. """
```

```
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
```

b) (7 points) Assuming the queue ADT described above. Complete the big-oh *O* ( ) for each queue operation. Let n be the number of items in the queue.

`__init__`	`enqueue(item)`	`dequeue( )`	`size()`	`__str__()`

c) (5 points) Would using doubly-linked nodes (i.e., `Node2way`) speed up some of the queue operations? Justify your answer.