1. Following is the `HeapBottomUp` algorithm from your textbook. Apply this algorithm to the input `A[]` below. Show the array `A[]` after `HeapBottomUp` is complete. *Show your work.*

2. Assume that a queue is defined by the following operations: `enQueue(item)`, `deQueue()`, and `isEmpty()`.

   (a) Describe how you can use two of these queues to implement a stack.

   (b) Provide pseudocode for the `push(item)` and `pop()` stack operations.

   (c) Determine the (worst case) efficiency class of your `push` and `pop` algorithms. Justify your answer(s).

3. BCIT has decided to start a free text messaging service known as BCITalk. BCITalk users choose their favorite 8 digit number as their ID. For example, you might choose 92455702. To send a text message to someone you need to know their ID. Unfortunately people find it a bit tough to remember the ID's. Luckily, BCITalk provides a message redirection service. Whenever a message is sent to an invalid ID *x*, BCITalk finds the nearest valid ID *v*, that is, it finds a *v* that minimizes $|v-x|$, and it redirects the message to *v*. All IDs are stored in a sorted array.

   Provide detailed pseudocode for an algorithm that redirects a message in better than ***O(n)*** time.

4. You work at the Revenue Canada Taxation Centre. You have been given a file containing a list of *n* taxpayers and a list of *m* tax returns, where $m<n$.

   (a) Devise a efficient algorithm that prints the names of taxpayers who have not filed a return. You can assume that the input data contains only names and SIN numbers.

   (b) Determine the (worst case) efficiency class of your algorithm. Justify your answer(s).

   Sample Input:

```
Taxpayers:
720101232 Elvis
720222303 Tarzan
730111977 Bart
Returns:
730111977 Bart
720101232 Elvis
```

   Sample Output:

```
720222303 Tarzan
```

5. The Power Set of a set s is the set of all subsets of S, including the empty set and S. For example, if S={a d g}, s={ ∅ {a} {d} {g} {a d} {a g} {d g} {a d g} }.

   (a) Provide the outline for a ***Decrease-by-One*** algorithm to generate the power set of a set of n elements.

   (b) Give the pseudocode for your algorithm.

6. Consider the algorithm shown below. This is a relatively unknown sorting algorithm called "Cocktail Sort". This version has a major inefficiency.

```
algorithm cocktail_sort(A[1..n]
    bottom ← 1; top ← n
    swapped ← true
    while swapped is true do
        swapped ← false
        for i ← bottom to top do
            if A[i] > A[i+1]
                swap A[i] and A[i+1]
                swapped ← true
        for i ← top to bottom do
            if A[i] < A[i-1]
                swap A[i], A[i-1]
                swapped ← true
```

   (a) Identify the basic operation in the algorithm.

   (b) How many times is the basic operation executed?

   (c) What is the efficiency class of this algorithm?

   (d) Suggest an enhancement that will improve the overall efficiency of the algorithm.

7. Consider the java method shown below.

```
public static int BF(int n, int m, String X, String Y)
{
   int i, j;
   char [] x = X.toCharArray();
   char [] y = Y.toCharArray();

   for (j = 0; j <= n - m; ++j)
   {
      for (i = 0; i < m && y[i] == x[i + j]; ++i);
      if (i >= m)
         return j+1;
   }
   return -1;
```

   (a) Explain what the program does.

   (b) Identify the basic operation in the algorithm.

   (c) How many times is the basic operation executed?

   (d) What is the efficiency class of this algorithm? (justify your answer)