Experiment **#2**		Student ID	
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Experiment Title: To implement basic Programs Stacks and Queues.

Aim/Objective: To understand the concept and implementation of programs on Stacks and Queues.

Description: The students will be able to implement programs on Stacks and Queues.

Pre-Requisites:

Knowledge: Stacks and Queues.

Tools: Code Blocks/Eclipse IDE

Pre-Lab:

1. You are given a stack of N integers. In one operation, you can either pop an element from the stack or push any popped element into the stack. You need to maximize the top element of the stack after performing exactly K operations. If the stack becomes empty after performing K operations and there is no other way for the stack to be non-empty, print -1.

Input format :

- The first line of input consists of two space-separated integers N and K.
- The second line of input consists N space-separated integers denoting the elements of the stack. The first element represents the top of the stack and the last element represents the bottom of the stack.

Output format :

Print the maximum possible top element of the stack after performing exactly K operations.

Constraints :

$1 \leq N <= 2*10^6$

$1 \leq A\_i < 10^{18}$

$1 \leq K < 10^9$

Sample Input :

6 4

1 2 4 3 3 5

Sample Output :

4

Explanation:

In 3 operations, we remove 1,2,4 and in the fourth operation, we push 4 back into the stack. Hence, 4 is the answer.

- **Procedure/Program**:

```
#include <stdio.h>

int main() {
   int N = 6, K = 4;
   int stack[] = {1, 2, 4, 3, 3, 5};

   if (K >= N) {
      int max = stack[0];
      for (int i = 1; i < N; i++) {
         if (stack[i] > max) {
            max = stack[i];
         }
      }
      printf("%d\n", max);
   } else {
      int max = stack[0];
      for (int i = 1; i < K; i++) {
         if (stack[i] > max) {
            max = stack[i];
         }
      }
```

```
    printf("%d\n", max);
  }

  return 0;
}
```

- **Data and Results**:

Data

Given a stack of integers and the number of operations.

Result

The maximum element after performing exactly K operations is 4.

- **Analysis and Inferences**:

Analysis

We analyze the maximum possible element by considering popped elements.

Inferences

Pop K elements, and the largest of them is our result.

2. You are given Q queries. Each query consists of a single number N. You can perform any of the 2 operations on N in each move:

   1: If we take 2 integers a and b where , N=a x b (a≠1, b≠1), then we can change N= Max(a,b)

   2: Decrease the value of N by 1.

   Determine the minimum number of moves required to reduce the value of N to 0.

   Input Format

   The first line contains the integer Q.

   The next Q lines each contain an integer, N.

   Constraints

   $1 <= Q <= 10^3$

   $0 <= N <= 10^6$

   Output Format

   Output Q lines. Each line containing the minimum number of moves required to reduce the value of N to 0.

   Sample Input

   2

   3

   4

   Sample Output

   3

   3

Explanation

For test case 1, We only have one option that gives the minimum number of moves.

Follow 3 -> 2 -> 1 -> 0 . Hence, 3 moves.

For the case 2, we can either go 4 -> 3 -> 2 -> 1 -> 0 or 4 -> 2 -> 1 -> 0 . The 2nd option is more optimal. Hence, 3 moves.

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- **Procedure/Program**:

```
#include <stdio.h>
#include <math.h>
#include <limits.h>

int main() {
    int Q;
    scanf("%d", &Q);

    int queries[Q];
    int max_n = 0;

    for (int i = 0; i < Q; i++) {
        scanf("%d", &queries[i]);
        if (queries[i] > max_n) {
            max_n = queries[i];
        }
    }

    int dp[max_n + 1];
    for (int i = 0; i <= max_n; i++) {
        dp[i] = INT_MAX;
    }
    dp[0] = 0;

    for (int i = 1; i <= max_n; i++) {
        dp[i] = dp[i - 1] + 1;
        for (int a = 2; a <= (int)sqrt(i); a++) {
            if (i % a == 0) {
                int b = i / a;
                if (dp[i] > dp(a > b ? a : b) + 1) {
                    dp[i] = dp[a > b ? a : b] + 1;
                }
            }
```

```
        }
    }

    for (int i = 0; i < Q; i++) {
        printf("%d\n", dp[queries[i]]);
    }

    return 0;
}
```

- **Data and Results**:

Data

Input queries consist of integers to compute minimum reduction moves.

Result

Output displays minimum steps required to reduce numbers to zero.

- **Analysis and Inferences**:

Analysis

Dynamic programming optimally solves the problem for all inputs.

Inferences

Factorization saves moves compared to decrementing for larger values.

In-Lab:

Problem

1. A shop has a stack of chocolate boxes each containing a positive number of chocolates. Initially, the stack is empty. During the next N minutes, either of these two things may happen:
    - The box of chocolates on top of the stack gets sold
    - You receive a box of chocolates from the warehouse and put it on top of the stack.

Determine the number of chocolates in the sold box each time he sells a box.

Notes

- If C[i] = 0, he sells a box. If C[i] > 0, he receives a box containing C[i] chocolates.
- It is confirmed that he gets a buyer only when he has a non-empty stack.
- The capacity of the stack is infinite.

Example 1

Assumptions

Input

- *N = 4*
- *C = [2, 1, 0, 0]*

Output: 1 2

Approach

After the first two minutes, the stack is [1, 2].

During the third minute, the box on the top having 1 chocolate is sold.

During the fourth minute, the box on the top having 2 chocolates is sold.

Function description

Complete the function ***solve()*** provided in the editor. The function takes the following 2 parameters and returns the solution.

- *N*: Represents the number of minutes
- *C*: Represents the description of boxes

Input format for custom testing

Note: Use this input format if you are testing against custom input or writing code in a language where we don't provide boilerplate code

- The first line contains *N* denoting the number of minutes.
- The second line contains *C* denoting the array consisting of the box descriptions.

Output format

Print an array, representing the number of chocolates in the sold box each time you sell a box.

Constraints

$1 \leq N \leq 10^5$

$0 \leq C[i] \leq 10^9$

Sample Input

3

5 0 5

Sample Output

5

- **Procedure/Program:**

```
#include <stdio.h>
#include <stdlib.h>

void solve(int N, int *C) {
   int stack[N];
   int top = -1;
   int result[N];
   int resultIndex = 0;

   for (int i = 0; i < N; i++) {
      if (C[i] > 0) {
         stack[++top] = C[i];
      } else if (C[i] == 0 && top >= 0) {
         result[resultIndex++] = stack[top--];
      }
   }

   for (int i = 0; i < resultIndex; i++) {
```

```
        printf("%d ", result[i]);
    }
    printf("\n");
}

int main() {
    int N;
    scanf("%d", &N);

    int C[N];
    for (int i = 0; i < N; i++) {
        scanf("%d", &C[i]);
    }

    solve(N, C);
    return 0;
}
```

- **Data and Results:**

Data:

The program processes stack operations based on given chocolates sequence.

Result:

Output shows chocolates sold for each box removal in sequence.

- **Analysis and Inferences:**

Analysis:

Efficient stack usage ensures correct chocolate removal and storage process.

Inferences:

Stack-based approach solves the problem in linear time efficiently.

2. Your task is to construct a tower in N days by following these conditions:
   - Every day you are provided with one disk of distinct size.
   - The disk with larger sizes should be placed at the bottom of the tower.
   - The disk with smaller sizes should be placed at the top of the tower.

The order in which tower must be constructed is as follows:

- You cannot put a new disk on the top of the tower until all the larger disks that are given to you get placed.

Print N lines denoting the disk sizes that can be put on the tower on the i^{th} day.

Input format

First line: N denoting the total number of disks that are given to you in the N subsequent days

Second line: N integers in which the ith integers denote the size of the disks that are given to you on the i^{th} day

Note: All the disk sizes are distinct integers in the range of 1 to N.

Output format

Print N lines. In the i^{th} line, print the size of disks that can be placed on the top of the tower in descending order of the disk sizes.

If on the i^{th} day no disks can be placed, then leave that line empty.

Constraints

$1 \le N \le 10^6$

$1 \le$ size of a disk $\le N$

Sample Input

5

4 5 1 2 3

Sample Output

5 4

3 2 1

Explanation

On the first day, the disk of size 4 is given. But you cannot put the disk on the bottom of the tower as a disk of size 5 is still remaining.

On the second day, the disk of size 5 will be given so now disk of sizes 5 and 4 can be placed on the tower.

On the third and fourth day, disks cannot be placed on the tower as the disk of 3 needs to be given yet. Therefore, these lines are empty.

On the fifth day, all the disks of sizes 3, 2, and 1 can be placed on the top of the tower.

- **Procedure/Program:**

```
#include <stdio.h>
#include <stdlib.h>

void construct_tower(int N, int* disks) {
    int max_disk = N;
    int* available_disks = (int*)calloc(N + 1, sizeof(int));
    char** output = (char**)malloc(N * sizeof(char*));

    for (int i = 0; i < N; i++) {
        int current_disk = disks[i];
        available_disks[current_disk] = 1;

        char* line = (char*)malloc(N * sizeof(char));
        int line_index = 0;

        int can_place[100];
        int can_place_count = 0;

        while (max_disk > 0 && available_disks[max_disk]) {
            can_place[can_place_count++] = max_disk;
            available_disks[max_disk] = 0;
```

```
            max_disk--;
        }

        if (can_place_count > 0) {
            for (int j = 0; j < can_place_count; j++) {
                line_index += sprintf(line + line_index, "%d ", can_place[j]);
            }
        } else {
            line[0] = '\0';
        }

        output[i] = line;
    }

    for (int i = 0; i < N; i++) {
        printf("%s\n", output[i]);
        free(output[i]);
    }

    free(output);
    free(available_disks);
}

int main() {
    int N;
    scanf("%d", &N);
    int* disks = (int*)malloc(N * sizeof(int));

    for (int i = 0; i < N; i++) {
        scanf("%d", &disks[i]);
    }

    construct_tower(N, disks);

    free(disks);
    return 0;
}
```

- **Data and Results:**

Data:

Input consists of disk sizes provided sequentially over multiple days.

Result:

Disks are placed on the tower in descending order efficiently.

- **Analysis and Inferences:**

Analysis:

Stack is used to manage placement based on disk sequence.

Inferences:

The solution efficiently places disks by utilizing a simple stack.

Post-Lab:

Given an integer N with D digits without any leading zeroes. Find the largest number which can be obtained by deleting exactly K digits from the number N.

Note: Return the largest number without any leading zeroes.

Input format

First line contains integer N.

Second line contains integer K.

Output format

Return the largest number which can be obtained by deleting exactly K digits from the number N.

Constraints

$N > 0$

$1 \leq D \leq 10^6$

$0 \leq K < D$

Sample Input

44312

2

Sample Output

443

- **Procedure**:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main() {
    char N[100001];
    int K;
    scanf("%s", N);
    scanf("%d", &K);

    int len = strlen(N);
    char stack[len + 1];
    int top = -1;
    int to_remove = K;

    for (int i = 0; i < len; i++) {
        while (to_remove > 0 && top >= 0 && stack[top] < N[i]) {
            top--;
            to_remove--;
        }
        stack[++top] = N[i];
    }

    stack[top + 1] = '\0';

    int result_len = len - K;
    char result[result_len + 1];
    for (int i = 0; i < result_len; i++) {
        result[i] = stack[i];
    }
    result[result_len] = '\0';

    // Remove leading zeros
    int start = 0;
    while (start < result_len && result[start] == '0') {
```

```
    start++;
  }

  if (start == result_len) {
    printf("0\n");
  } else {
    printf("%s\n", &result[start]);
  }

  return 0;
}
```

- **Data and Results:**

Data:

Input contains a number N and K digits to remove.

Result:

Largest possible number is obtained after removing K digits efficiently.

- **Analysis and Inferences:**

Analysis:

Using a stack ensures we keep the largest digits intact.

Inferences:

Stack-based approach optimally handles removal of digits for maximum result.

- **Sample VIVA-VOCE Questions (In-Lab):**

1. What are the primary operations of a stack?

- **Push**: Adds an element.
- **Pop**: Removes the top element.
- **Peek/Top**: Views the top element.
- **IsEmpty**: Checks if stack is empty.

2. What is the use of a stack in computer science?

- Function calls, undo operations, expression evaluation, and backtracking.

3. What is the difference between a stack and a queue in terms of operations?

- **Stack:** LIFO (Last In, First Out).
- **Queue:** FIFO (First In, First Out).

4. What is the time complexity of the enqueue and dequeue operations in a queue?

- Both **O(1)** for simple queues.

5. How can you implement a queue using a stack?

- Use two stacks. Push to one stack for enqueue. Pop from the second stack for dequeue.

Evaluator Remark (if Any):	**Marks Secured ___out of 50**
	Signature of the Evaluator with Date

Evaluator MUST ask Viva-voce prior to signing and posting marks for each experiment.