

Task 01

Let's consider a Pancake stack with N Pancakes.

- 1) First go through the stack from top to down and select the largest pancake.
- 2) Then, including that Pancake (the largest) flips all above from it. Now largest Pancake is at the top.
- 3) Now flip the whole stack completely in order to get the largest Pancake to the bottom of the stack.
- 4) Since the largest Pancake is already at bottom, no need to touch it again. So select the N-1 Pancakes from the top of the stack.
- 5) Then on, repeat the process until the selecting stack (at an instance) becomes 1.

Eg:

1 5 3 4 2 → 5 1 3 4 2 → 2 4 3 1 5 → 4 2 3 1 5 → 1 3 2 4 5 → 3 1 2 4 5 → 2 1 3 4 5 → 1 2 3 4 5

No. of flips = 7

Task 02

To get a pancake to the bottom of the stack (instantaneous stack), we have to perform 2 flips. But there are N pancakes. Even though intuition guides us that there should be **2N flips for the worst case**, if we look closely we can see that it's not the real case.

There are few special corner cases to consider. When it comes to the top most pancake, it is obvious that we do not have to perform any flips since it is in the exact position where it should be. Because according to the algorithm, stack should be already sorted. Thus, there should be **2 less flips**. Now flips at worst case is **2N - 2**.

But there is another special case. When it comes to the top 2 pancakes, to get the larger pancake under the smaller pancake, we need perform 1 flip only, not 2. Now it should be **1 less flips** for the worst case.

From then on, there are no special cases. Thus, we can conclude that **Number flips for the worst should be 2N - 3**.

Worst cases for N = 3, 4, 5, 6, 7, 8, 9, 11 are come under a pattern. They are mentioned below.

Stack size = 3, 1 3 2 → Flips 3

Stack size = 4, 3 2 4 1 → Flips 5

Stack size = 5, 1 5 3 4 2 → Flips 7

Stack size = 6, 3 6 2 4 5 1 → Flips 9

Stack size = 7, 4 2 7 1 6 3 5 → Flips 11

Stack size = 8, 1 8 5 2 3 6 7 4 → Flips 13

Stack size = 9, 2 8 7 1 5 3 9 6 4 → Flips 15

Stack size = 11, 6 2 10 5 9 4 8 1 11 3 7 → Flips 19

To provide more solid proof than above examples we can use induction to prove that, for N pancakes, number of **flips at the worst case is 2N - 3**, where N>1.

From Induction,

T(3) = 3,

T(4) = 5,

T(P) = 2P - 3,

Therefore T(P+1) = T(P) + 2,

$$= 2P - 3 + 2$$

$$= 2(P+1) - 3$$

Thus, by mathematical induction it is proved that the pattern $(2N-3)$ works for all $N > 1$.

Number of flips at the Worst Case of Stack with N Pan Cakes (Where $N > 1$) = $2N - 3$

Task 03

For flipping '*Stack*' and '*ArrayDeque*' are used. It is in the code itself. Please refer the program code.