★ Cyclic Sort : (Vvvv important pattern / Algo).

- It's a sorting algorithm.

when to use cyclic sort?

- Solve in one pass or one for-loop or one 'N' comparision ★★★

★★★ when given no.s 1 to 'N' Range → use Cyclic Sort.
★★★

- Algorithm of Cyclic Sort :

→ w.k.t Array has 1 to 'N' no.s

ideal case of sorted Array :

0	1	2	3	4
1	2	3	4	5

index value = value - 1; // : 1 to N Range

- To sort, we need to solve in one pass.

⇒ for each loop :

- we check if it is at its correct place
- If not at crct place, replace / swap the element to its crct position.
- The element it is swapped with can also not be in its crct place so, we check again.
- If in crct place, moves on to next element.

→ This way, sorted in one pass.

→ Every unique no. is swapped once

Eg:

3, 5, 2, 1, 4

swap

2, 5, 3, 1, 4 (check for 2)

5, 2, 3, 1, 4 (check for 5)

swap

4, 2, 3, 1, 5 (check for 4)

1, 2, 3, 4, 5 Ans (check for 1)

If in crct place move to check next element.

* Worst Case :- How many swaps to be made.

Above is a example of worst case where we made (N-1) swaps & 'N' swaps made

⇒ (N-1) + N

⇒ (2N-1) ⇒ O(N) - linear //.

Pseudo :-

; starts at '0'.

while (i < length of Array) {

- check if 'i' is at crct index (If not, swap).

→ else i++ (next element)

* Problems based on cyclic Sort :-

~~Q1~~) find missing no. from [0,n] array. //.

(Amazon)

Given, from no.s Array 0 to N ⇒ N+1 no.s

one element/no. is missing.

→ Here, we can see that in sorted array, element == index

→ So ignore index(N)

So, Sort the array and then

Search for element in array i.e not in its place

• A edge case can be if 'N' element is the one missing, then ans = 'N'.

Pseudo:-

• To ignore the x^{th} element, we just add a condition

if 'i' element < length of Array //.

remaining Same.

• Then perform linear Search for missing no.

Q3) Find all no.s disappeared in a Array. (Google)

Tip:-

If range = [0,N] (look at Sorted Array Version)

→ Every element will be at index = value

If range = [1,N]

→ Every element will be at - index = Value - 1.

: Array can contain duplicates.

→ Duplicates are automatically taken care of by the cyclic sort algo (if condi check) :-

→ once the array is sorted, perform linear search check to see if all elements are at their corresponding indexes. If they are not, they are missing / disappearing elements.

- The return type is list as the ans can be of variable length.

The list is used to add all missing elements.

```
check() {
    if not
    then ~~~~.list.add(i);
    }
return list; // returns list of missing no.s
```

~~2~~ 3) Find the repeated / Duplicate no. (Amazon) //.

4) . Perform Cyclic Sort. (Microsoft) //.

But here check for two things / element,

(i) if element at 'i' != ~~~~ element - 1

&&

(ii) ~~~~~~ if elements crct position == element,

if (above 2 conds true) → Duplicate element found.

if (above 2 not true) → Swap / cyclic sorting //.

Pseudo:

```
while (i < arr.length) {
    if (arr[i] != i+1) {
        correct = arr[i]-1;
        if (arr[i] != arr[correct]) {
            swap(arr, start, end);
        } else {
            return i; // duplicate found.
        }
    } else {
        i++;
    }
return -1; // if no duplicates.
}
```

Q4) find all duplicates in an array.

Tip: when Question states return "All" duplicates or similar to it.

→ Perform cyclic Sort normally.

→ Then perform linear search on sorted array and add the duplicates (elements not at their correct position) in form of a list (ArrayList).

↓

Variable length

~~#5~~) Set mismatch.

=> one no. is duplicated to another.

-> one no. repeated, one is lost [Ans req].

Eg: [3, 1, 4, 2, 6, 5]

To repeat one no., one no. is to be removed.

[2, 1, 4, 2, 6, 5] (3 removed, 2 duplicated)

[0 1 2 3 4 5
1, 2, 4, 2, 6, 5]

[1 to N] => index = value - 1

[1, 2, 2, 4, 6, 5]

[1, 2, 2, 4, 5, 6] -> Sorted

Now, create a list and perform linear search to get repeated no. & missing no. //.

So, cyclic sort & linear search //.

~~#6~~) find first missing positive from Array. (Amazon).

- Cyclic Sort when it's not directly hinted.

Note: ignore -ves, as positive is asked.

ignore using if condition edge case

PRO TIP: Always first try & do cyclic Sort then break down to required conds.