

3. Find Missing Number

EASY

■ What You Will Learn

- ✓ The math formula trick: sum of 1..n
- ✓ The XOR bit-manipulation approach
- ✓ Why both work and which is safer with large numbers

■ Intuition First

You have numbers 1 to N but one is missing. Simple math: the sum of 1 to N is $N*(N+1)/2$. Subtract the actual sum of the array — the difference is the missing number.

■ Two Approaches

- Formula: $\text{missing} = N*(N+1)/2 - \text{sum}(\text{arr})$
- XOR: XOR all array elements AND all 1..N values — same numbers cancel out, leaving missing

■ Visual — [1,2,4,5] with N=5

Array — 3 is missing

1	2	4	5
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Expected sum = $5*6/2 = 15$

Actual sum = $1+2+4+5 = 12$

Missing = $15 - 12 = 3$ ✓

XOR approach: $1^2^3^4^5 \wedge 1^2^4^5 = 3$ ✓

(each number appears twice – XOR cancels them, leaving only 3)

■ Java Code — Both Approaches

```
// Approach 1: Formula (can overflow for large n – use long)
```

```
public static int missingNumber(int[] arr, int n) {  
    long expected = (long)n * (n + 1) / 2;  
    long actual = 0;  
    for (int x : arr) actual += x;  
    return (int)(expected - actual);  
}
```

```
// Approach 2: XOR (overflow-safe)
```

```
public static int missingNumberXOR(int[] arr, int n) {
    int xor = 0;
    for (int i = 1; i <= n; i++) xor ^= i; // XOR 1 to n
    for (int x : arr) xor ^= x; // XOR array
    return xor; // Remaining = missing number
}
```

■ ■ Complexity

Case	Time	Space	What happens?
Both	O(n)	O(1)	Single pass each — formula and XOR both identical

■ ■ Common Mistakes

- Using int for large n causes overflow — always use long for the sum
- Array contains 0 to n: use $n*(n+1)/2$ — check problem constraints carefully

■ Pro Tips

- XOR is preferred in interviews — no overflow risk
- This pattern extends to: find duplicate, find two missing numbers

■ Practice Problems

[Easy] Find missing in [0,1,3] where range is 0 to 3

[Med] Find the duplicate in an array of n+1 elements containing 1 to n

[Med] Find both the missing and the repeating number

■ Quick Revision

- Formula: $N*(N+1)/2$ minus actual sum = missing
- XOR: XOR all 1..N with all arr elements — missing survives
- Use long to avoid overflow in formula approach
- O(n) time, O(1) space