Prob
① = Count set Bits bit of all natural No. for till Given No.

Given $n = 11$

So we have to count all set bits from 1 to 11.

Let's make patterns

0 — 0 0 0 0
1 → 0 0 0 1
2 → 0 0 1 0
3 → 0 0 1 1
4 → 0 1 0 0
5 → 0 1 0 1
6 → 0 1 1 0
7 → 0 1 1 1
8 → 1 0 0 0
9 → 1 0 0 1
10 → 1 0 1 0
11 → 1 0 1 1

Step I:-

Find the largest no $N \leq 11$ such that it is having largest power of 2

So in this $2^3 \leq 11$

benifit :- all set bits from 1 to $2^3 - 1$ can be calculated at once.

i) look at first place bit
4 → ON, 8 → OFF → total = 8
set = $8/2^4$

ii) 2nd place
↳ 2ON → 2OFF → total set = 4.
2ON → 2OFF

iii) 3rd place → 4ON → 4OFF
set bit = 4.

So total set bits = 4+4+4 = 8

total set bit formula = $2^{x-1} * x$ if $x=3$

total set bit formula in step 1 = $2^{3-1} * 3 = 4 * 3 = 12$

Step II :- Now find the set MSB from 2 to N in this Example it is 4

from

formula :- SET MSB from 2^x to n

$\Rightarrow$ ② $(n - 2^x + 1)$

till now total number of set bits

$\Rightarrow 2^{x-1} * x + (n - 2^x + 1)$

Step III calculate the remaining set bit

Now values converted as-

$8 \rightarrow * 000$

$9 \rightarrow * 001$

$10 \rightarrow * 010$

$11 \rightarrow * 011$

→ this is a sub problem which we are solving so we can call our function recursively. for 3 numbers $(n - 2^x)$

So complete formula

$\Rightarrow \underbrace{2^{x-1} * x}_{①} + \underbrace{(n - 2^x + 1)}_{②} + \underbrace{\text{solve}(n - 2^x)}_{③}$