

H.W

$$\min((a \wedge x) + (b \wedge x)) = ?$$

$x$  can be any value you want..

$$x = a \wedge b$$

ans =  $a \wedge b$

$$0 \rightarrow 1$$

$$\text{if } x = 0$$

$$\begin{array}{r} a = \\ + b = \\ \hline \end{array}$$

$x = \dots \overbrace{\dots}^0 \dots$

$1 \wedge 1 = 0$

$0 \wedge 1 = 1$

$1 \wedge 0 = 0$

$0 \wedge 0 = 0$

$1 \wedge 1 = 0$

$0 \wedge 1 = 1$

$1 \wedge 0 = 0$

$0 \wedge 0 = 0$

$$\begin{array}{r} \text{sum}/2 \\ 1 \quad 0 \quad 0 \quad 1 \\ 0 \quad 1 \quad 1 \quad 1 \\ \hline D \end{array}$$

$$1+1$$

$$\begin{array}{r} 0 + 1 = 1 \\ \swarrow \quad \downarrow \quad \searrow \\ 1 + 0 \end{array}$$

$a \rightarrow$

$b \rightarrow$

$\text{Take XOR with } 1$

$\text{Take XOR with } 0$

$\text{sum}/2$

$1 \text{ bit}$

$0 \wedge 0$

$1 \wedge 0$

$0 \wedge 1$

$1 \wedge 1$

$= 0$

$1 \wedge 0$

$1 \wedge 0$

$1 \wedge 0$

$1 \wedge 1$

$0+1=1$

$1+0=1$

$A \wedge 0 = A$

$\wedge x = 0$

$\wedge x$

$\text{Take XOR with } 0$

$1 \wedge 1$

$1 \wedge 0 = 1$

$1 \wedge 0 = 1$

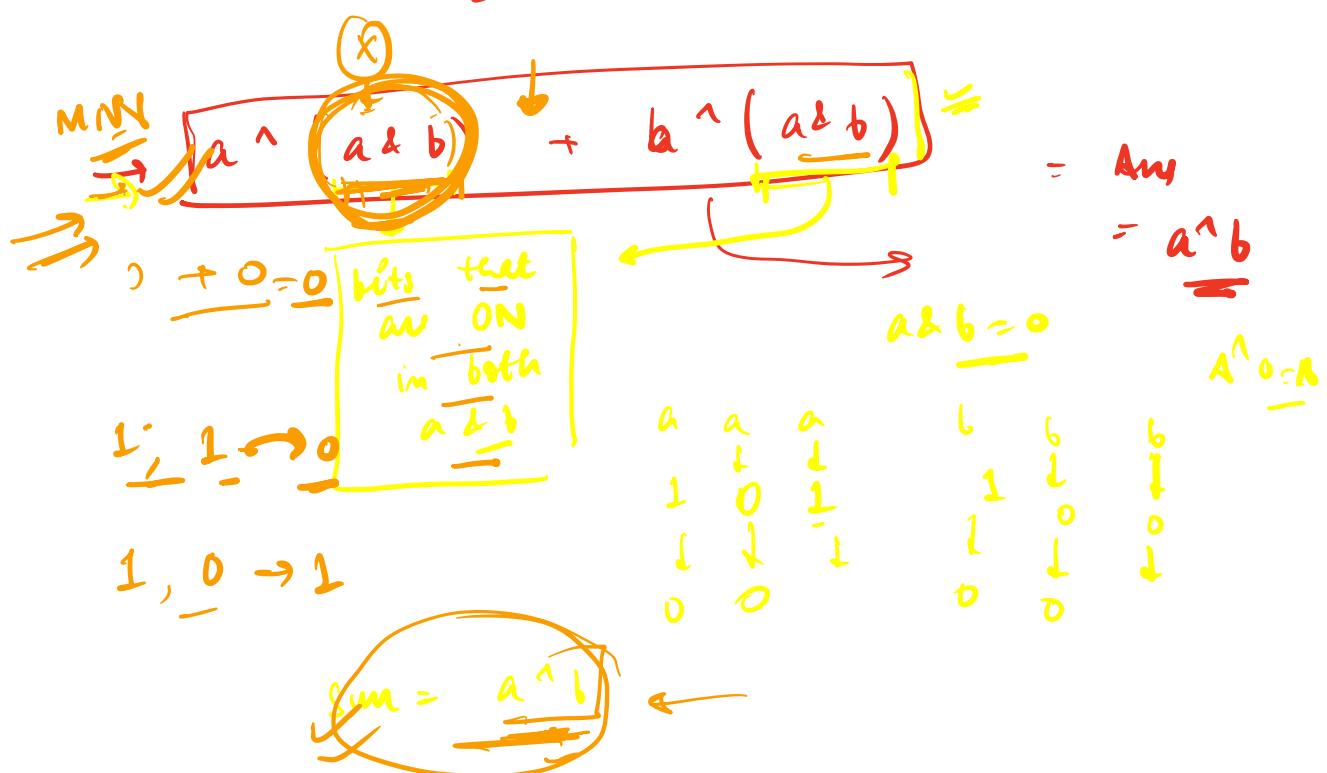
$(10)_{\underline{2}}$

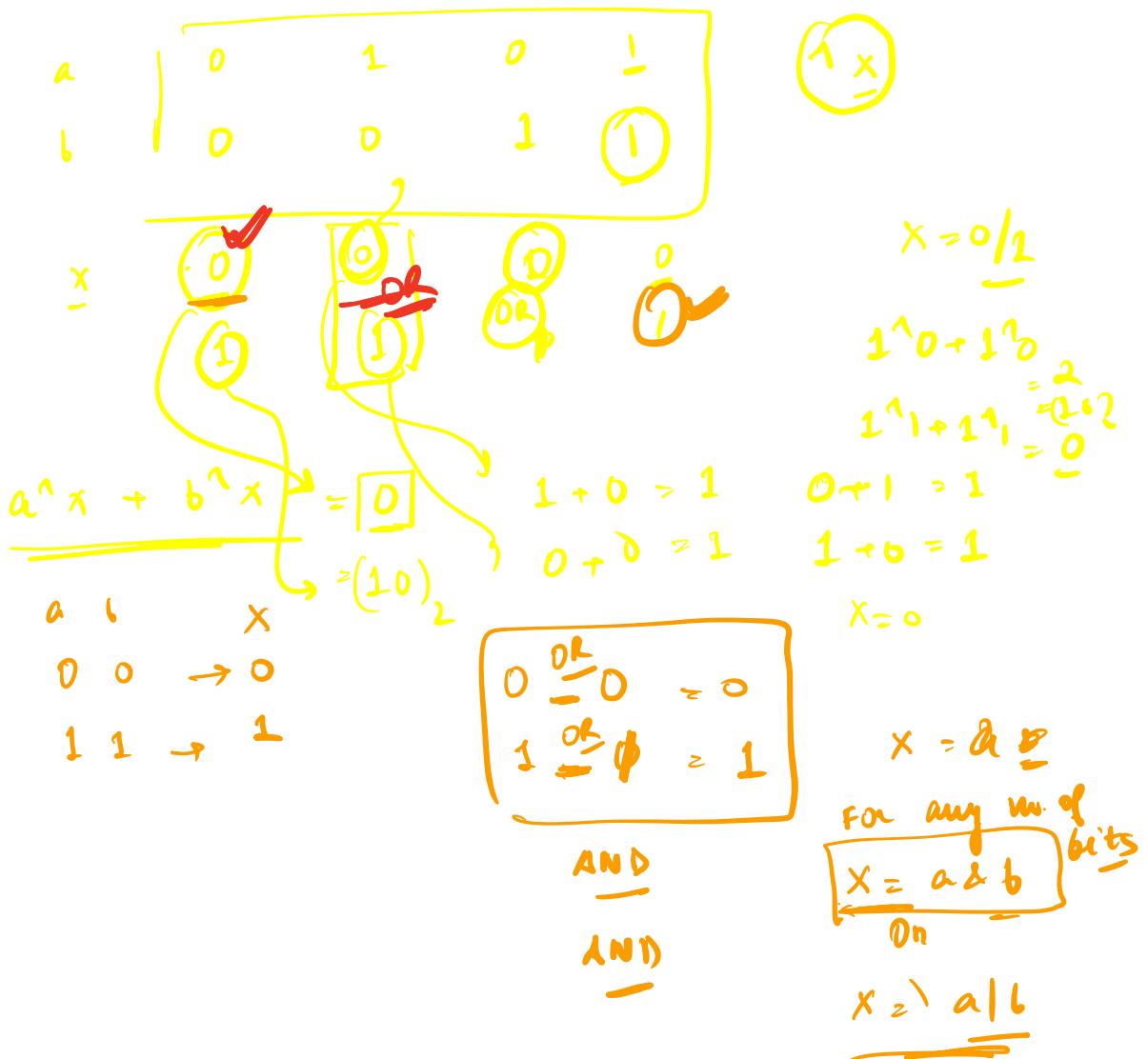


$$a = 1 \quad b = 0$$

$$\min (a^n x + b^n x) = ?$$

$$\begin{aligned} 1^n 0 + 0^n 0 &= 1 \\ 1^n 1 + 0^n 1 &= 1 \end{aligned}$$





## Left shift operator ( $<<$ )

$a = (10)_{10} \rightarrow \text{binary } (1010)_2$

8 bit system  $\rightarrow$

$a << 1$

*Diagram*  
 $(00001010)_2$   
 $(00010100)_2$

$a << 2 \quad (00101000)_2 = (40)_{10}$

$a << 3$   
 $a << i = a * 2^i$

$(15)_{10} \quad (15 << 2)$

$(00001111)_2$

$(00111100)_2 = (60)_{10}$

int  $a = 5;$   
 int  $b = (a << 2);$   
 $\text{cout} \ll b$

$a << n$

$a * \underline{\text{power}}(2, -)$

$\underline{\underline{a^b = \text{power}(a, b)}}^2$

## 0 overflow

$$a = (01010000)_2 =$$

$$\boxed{a \ll 2} \rightarrow (01000000)_2$$

$$\rightarrow (64)_{10}$$

## Right shift Operator ( $>>$ )

$$a = (10)_2 = (0000\ 1010)_2$$

$$\boxed{a >> 1} = (0000\ 0100)_2 = (5)$$

$$\boxed{a >> 2} = (000000010)_2$$

integer division by 2

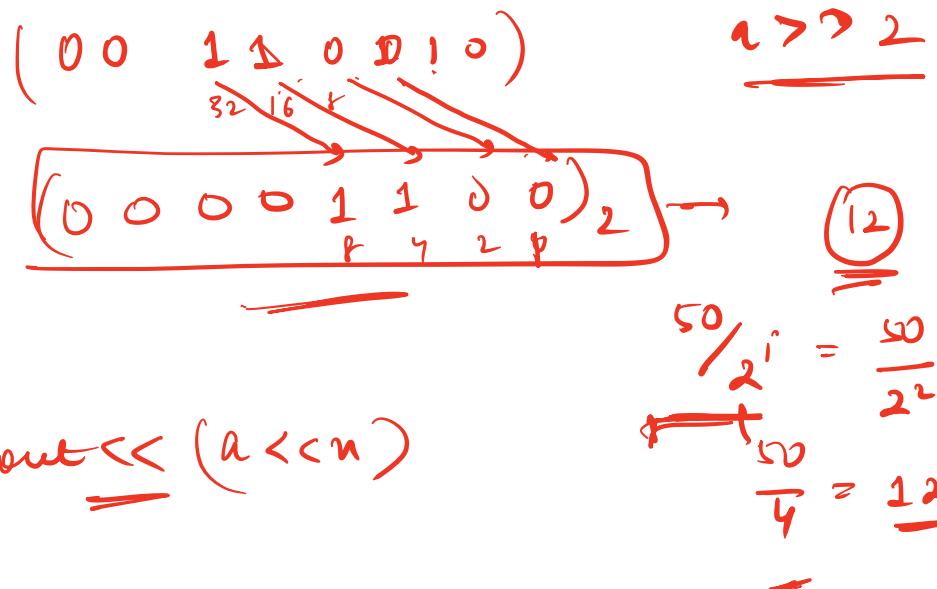
$$a >> n = \left( \frac{a}{2^n} \right) \text{ Integer division}$$

$\text{cout} \ll (a \gg n);$

$a \gg b$

$a = 50$

$a >> 2$



cont  $\ll (a < n)$

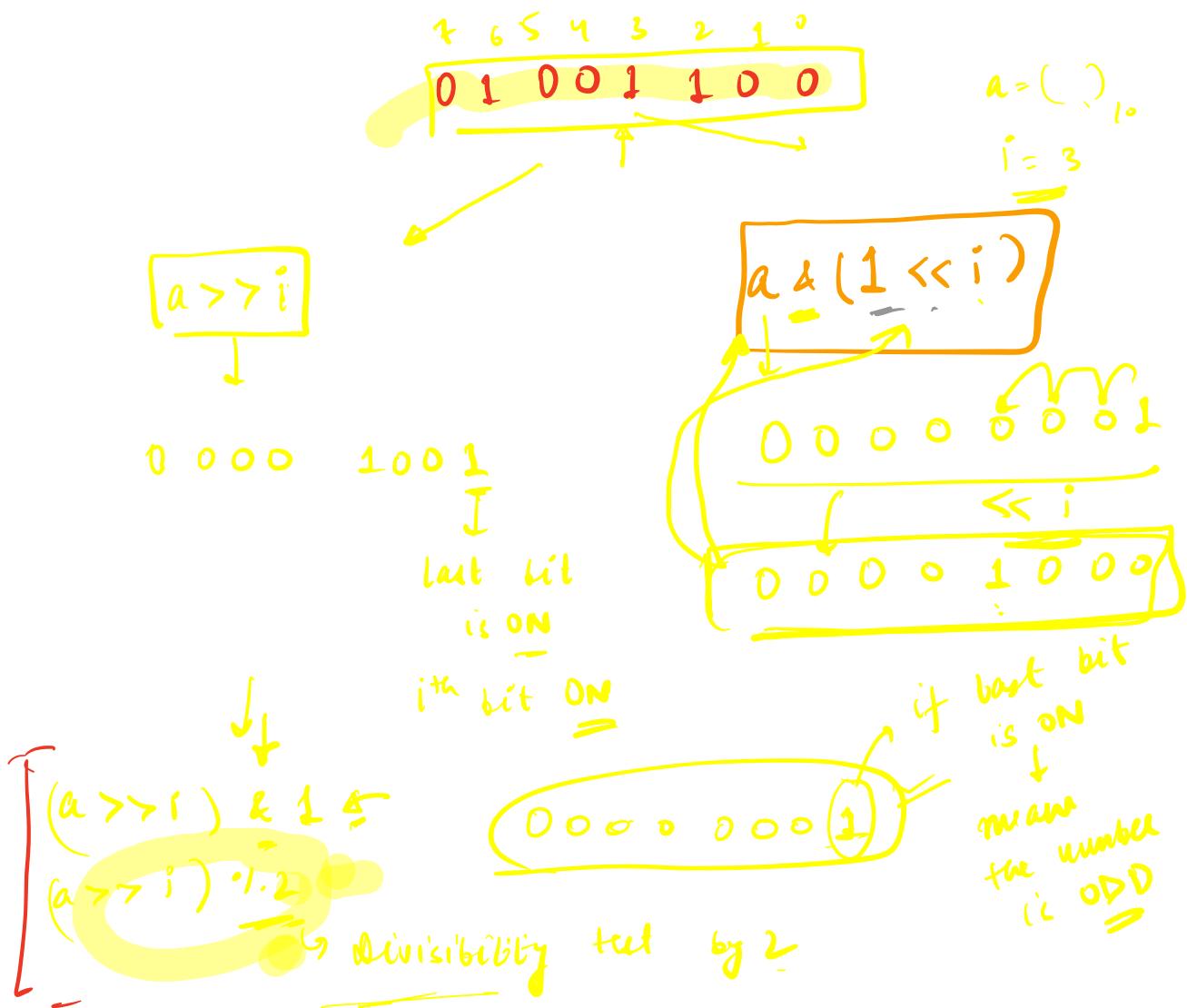
Given a number (Decimal Number System)  
 Return True if its  $i^{th}$  bit is ON  
 False if its  $i^{th}$  bit is OFF

$\Rightarrow$  base is  $i^{th}$  bit On ( int a , int i );

10, 1       $\begin{array}{r} *_{6543210} \\ 00001010 \\ \downarrow \end{array}$

sol 1  $\boxed{a \& (1 \ll i)}$

sol 2  $\boxed{(a >> i) \& 1}$  then check the last bit sol 1



~~break~~  
~~→ minus~~

$$\begin{array}{r}
 0100\ 1100 \\
 \& 0000\ 1000 \\
 \hline
 0000\ 1000
 \end{array}$$

~~NON zero~~  $\Rightarrow$  It means that  $i^{\text{th}}$  bit was set.

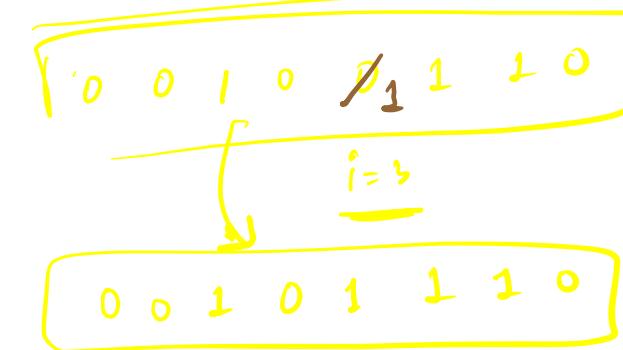
set a bit

int subbit( int a, int i )

Set bit at  $i^{th}$  position

$+ 6 \leftarrow 1 \rightarrow 2 \quad 1 \ 0$

Example:



Ans  
=  
return

a | (1 << i)

~~a | (1 << i) ← a | (2^i)~~

$1 << i = 2^i$

~~2^i~~

$a << i = a * 2^i$

$1 << i =$   $a = 1$

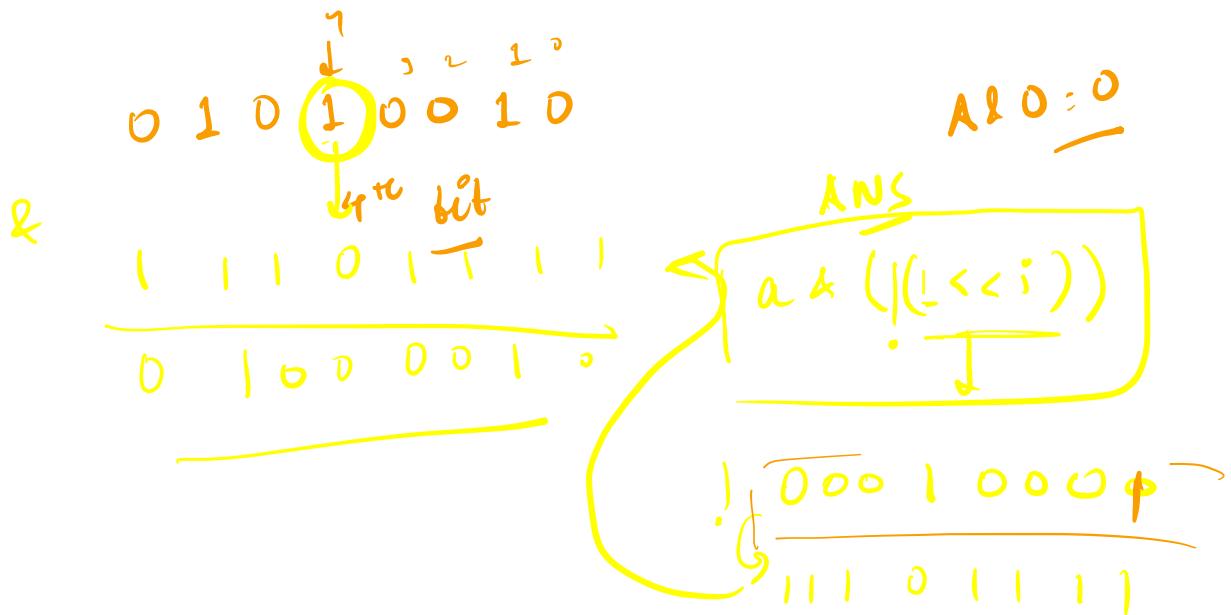
$0 0 0 0 1 0 0 0$

$0 1 1 0 1 1 0 0$

$0 1 1 0 0 1 0 0$  ← Turn off the bit

Clear a bit (unset a bit)

int clearbit (int a, int i)



Toggle bit

$a \wedge (1 \ll i)$

$a \wedge 2^i$

Given a number, tell if the number has  
only a single bit switched ON.

OR Find if no. is power of 2  
or NOT.

1, 2, 4, 8, 16 ...  $1024 \downarrow$   
 $0000\ 0010 \ 1000000000000000$

Code B.F

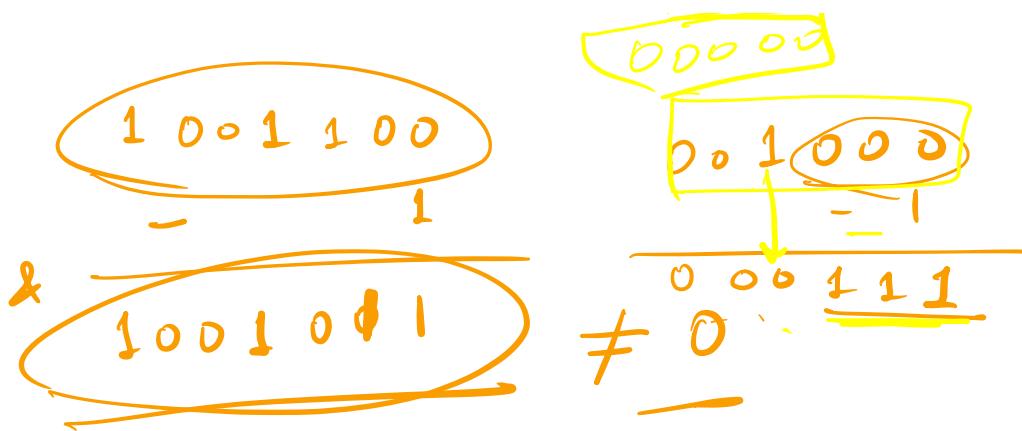
```
count = 0
for ( i=0 → 32 )
    if( a & ( 1<<i ) ) count++
if( count == 1 ) return true
else return false
```

$x = \dots \ 1 \dots$        $a \& !a = 0$   
 $x = \underline{1}0110$

$\underline{x} = \underline{\underline{0}}111$

$\begin{array}{r} 111 \\ + 0 \\ \hline 1000 \end{array}$

$\begin{array}{r} 0000b \\ - 1 \\ \hline 1 \end{array}$   
 $0 \boxed{1011}$



If a number has a single bit turned ON

subtracting -1 will toggle the number

$$a \& (a-1) == 0$$

Count set bits in a number

1101

H.W

$$(13)_{10} \rightarrow \underline{\textcircled{3}}$$

can you solve it  $O(\text{no. of set bits})$

$$O(32)$$

no. of bits

You are given an array of  $N$  numbers.  
 All the numbers are in range of  $[1 - N+1]$  and occurring only once.  
 except one number that is missing.

Find out that number

$$\text{arr} = [5 \quad 4 \quad 1 \quad 2] \quad \begin{matrix} N=4 \\ 1 \rightarrow N+1 \end{matrix}$$

- (1) sort and check
- (2) Hash Map
- (3)  $\frac{(N+1)(N+2)}{2}$

$$1 \ 2 \ 4 \ 5$$

actual sum

sum of arr

$$\rightarrow 1 + 2 + 3 + 4 + 5 - 5 - 4 - 1 - 2$$

long long =

$$n/10 \quad \text{ans} = 0$$

for ( $i = 1 \rightarrow n+1$ )  
 $\text{ans}^i = i;$

for ( $i = 0 \rightarrow n$ )

$$\underline{\text{ans}}^i = (\underline{\text{arr}}[i]^{(i+1)})$$

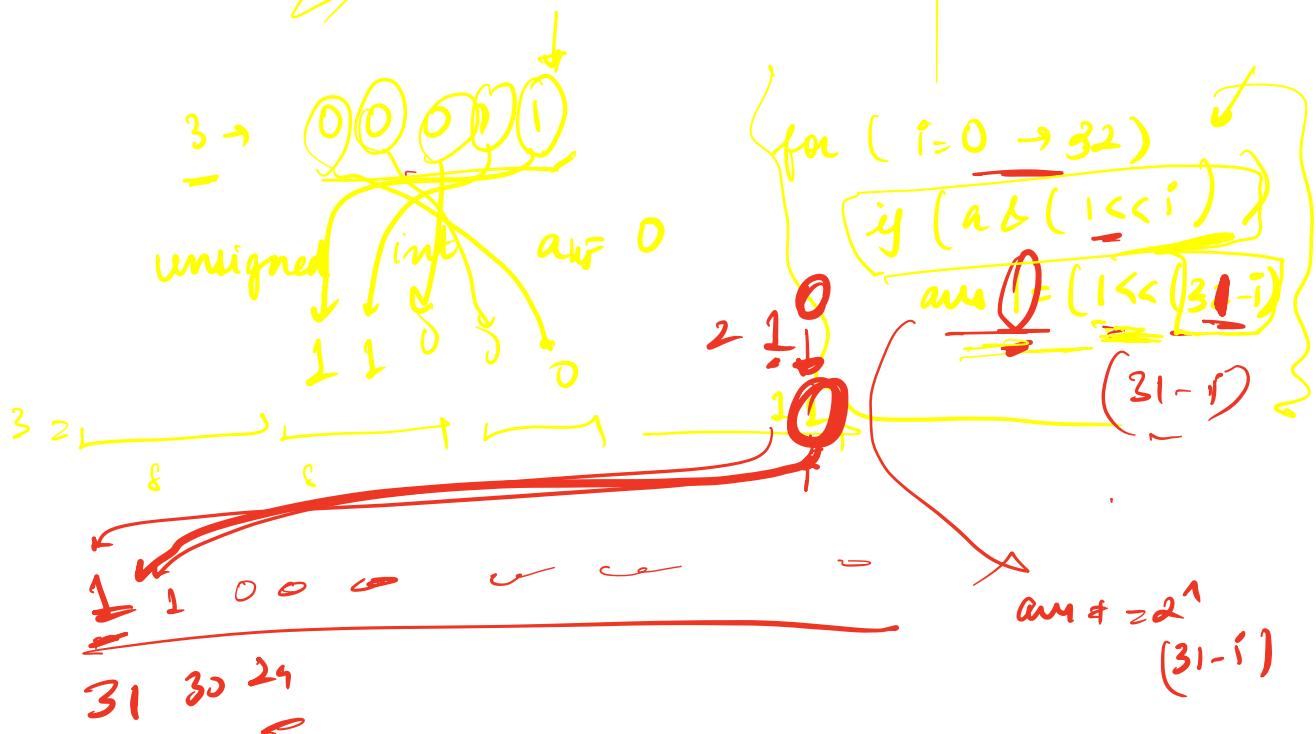
$$\underline{\text{ans}}^n = N+1$$

for ( $i = 0 \rightarrow n$ )  
 $\underline{\text{ans}}^i = \underline{\text{arr}}[i]$   
 return  $\underline{\text{ans}}$ ,

$$\rightarrow \underline{\text{ans}} = 2^0 \times 3^1 \times 4^2 \times 5^3$$

$\begin{cases} 0000 \rightarrow \\ 0001 \rightarrow 4^k \\ 0110 \rightarrow 3^k \\ 0011 \rightarrow 4, 3 \end{cases}$

Revers Bits



$$a = 10000000$$

$$b = 11000000$$

$$i = a.size()$$

$$j = b.size$$

String

1

$i = -$   
 $j = -$

$$\begin{aligned}
 ans &= (a+b) * 1/2 = ans \\
 \text{Carry} &= (a+b) / 2
 \end{aligned}$$

$$2^0 + 2^1 + \dots + 2^6 = 2^7 - 1$$

$$\underbrace{1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0}_{\text{Binary}} = -2^7$$

$$(-1)^7 = ?$$

$$\begin{array}{r} 1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 1 \\ \downarrow \qquad \qquad \qquad \downarrow \\ -2^7 + 2^0 = ? \end{array}$$

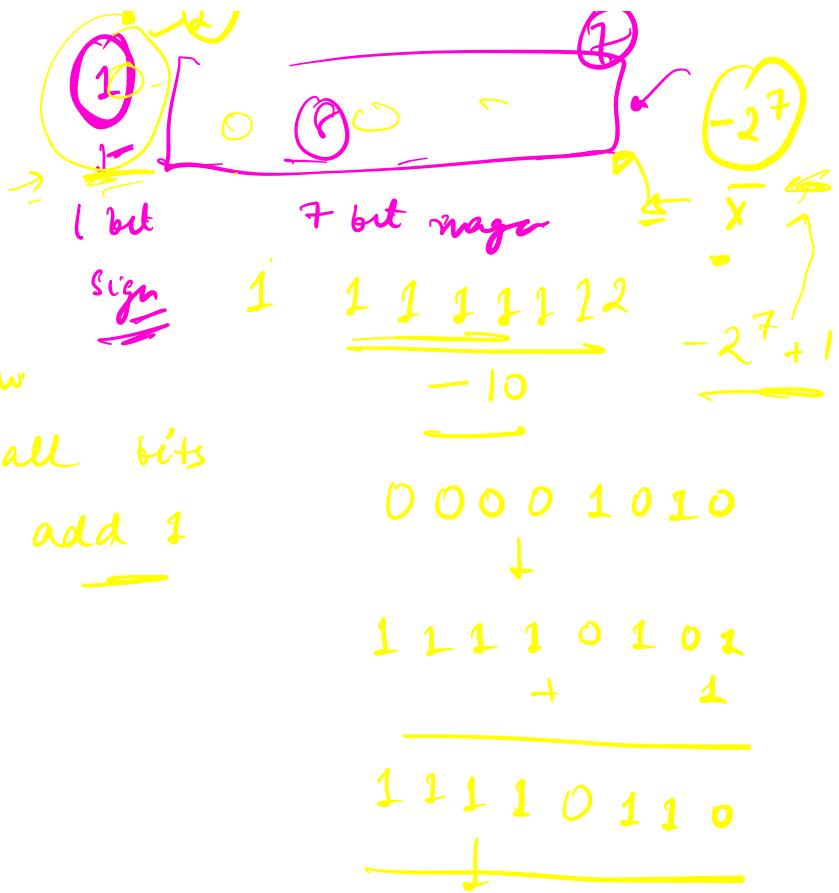


$$\begin{array}{r} 1 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 1 \\ \downarrow \qquad \qquad \qquad \downarrow \\ -2^7 + 2^4 + 2^0 \\ + 1 \\ -128 + 16 + 1 \\ = (-111)_10 \end{array}$$

$$\begin{array}{r} 1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1 \\ \downarrow \qquad \qquad \qquad \downarrow \\ -2^3 + (2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 2^0) = -(-1) \end{array}$$

$2^s$  complement

[ Take a no  
invert all bits  
and add 1 ]



$$-128 + \underline{64} + \underline{32} + \underline{16} + \underline{4} + \underline{2}$$

$$80 \quad \underline{38}$$

$$118 - 128$$

$$= -\underline{10}$$

