$N \mid (1 \ll i)$:- sets the i^{th} bit in N

$N \,\&\, (1 \ll i)$:- check if i^{th} bit is set

$N \wedge (1 \ll i)$:- Toggles the i^{th} bit in N

$N \,\&\, (N-1)$: unset the last set bit

$\boxed{8 \text{ bit}}$

signed

MSB

10 : 0 0 0 0 1 0 1 0

-10 : 1 0 0 0 1 0 1 0

$\boxed{-10}$

8 bits

-4 : 1 0 0 0 0 1 0 0

10 : 0 0 0 0 1 0 1 0

+

1 0 0 0 1 1 1 0 → -14

0 → 14

-4 + 10 ?

6

signed bit

0 0 0 0 0 0 0 0 → 0

1 0 0 0 0 0 0 0 → -0 ?

−ve number ⟹ 2's compliment of it's positive number

−a

$a \xrightarrow{\text{1's compli}} \sim a \xrightarrow{+1} \sim a+1$

~a: toggle each & every bit

~a+1: 2's compliment (−ve no)

8 bits

−10

10 :- 0 0 0 0 1 0 1 0

~10 1 1 1 1 0 1 0 1

+1 0 0 0 0 0 0 0 1

1 1 1 1 0 1 1 0 — −10

MSB

-2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0

$\underbrace{-128} \underbrace{+64+32+16+4+2}_{118} = -10$

−4 :-

4 ≡ 0 0 0 0 0 1 0 0

~4 = 1 1 1 1 1 0 1 1

+1 1

1 1 1 1 1 1 0 0 — −4

−128 64 32 16 8 4

−4 : 1 1 1 1 1 1 0 0

10 : 0 0 0 0 1 0 1 0

0 0 0 0 0 1 1 0 ⟹ 6

-ve → decimal

1 MSB ⇒ -2^{-}

all ⇒ $+2^{-}$

$32+2$

-34 :-

34:-	0	0	1	0	0	0	1	0	
~34	1	1	0	1	1	1	0	1	
+1								1	
	1	1	0	1	1	1	1	0	= -34

-128

4 bits

$-2^3 \quad 2^2 \quad 2^1 \quad 2^0$

-1

1:	0	0	0	1
~1:	1	1	1	0
+1				1
	1	1	1	1

$-2^3 \quad 2^2 \quad 2^1 \quad 2^0$

$-8 + 4 + 2 + 1 = -1$

-10   10

-x

0   _ _ _ x _ _ _ _

n-1 . . . 4 3 2 1 0

n bits

-2^{n-1} $2^{n-1} - 1$

+127

10

117

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

$$\rightarrow -x \cancel{-1} \cancel{+1}$$

$-x$

x

$$\begin{array}{cccccccc} \cancel{0} & \phi & \phi & \phi & \cancel{x} & \phi & \cancel{x} & \phi \\ 7 & 6 & 5 & 4 & 3 & 2 & 1 & 0 \end{array}$$

1

-2^7

$\underbrace{}_{127}$

$2^7 - 1$

8 bits

7 bits

$2^0 (2^7 - 1)$

$127 - 10 = 117$

$$\cancel{2^{n-1}} - 1 - x - \cancel{2^{n-1}}$$

$$\cancel{-1} -x \cancel{+1}$$

-ve num ≡ 2' complimet

12

4 bits

$$\begin{array}{cccc} 1 & 1 & 0 & 0 \\ -2^3 & & & \\ -8 & 4 & & \end{array} \Rightarrow -4$$

_ _ _ _ _ _ _ _ _ _ n bits

-ve base value

n-1 bits

+ve value

2 bits available

2 2

0/1 0/1

0	0
0	1
1	0
1	1

→ 4

2 2 2

_ _ _ 3 bits

0/1 0/1 0/1

0	0	0	= 0
0	0	1	= 1
0	1	0	= 2
0	1	1	= 3
1	0	0	= 4
1	0	1	= 5
1	1	0	= 6
1	1	1	= 7

different combinations

$\boxed{n \text{ bits} \to 2^n}$

+ve numbers including 0

_ _ 4 options

00 → 0

01 → 1

10 → 2

11 → 3

0 - 3

_ _ _ 8 options

0 - 7

n bits $\equiv$ 2^n

Range (only +ve nu) incl 0 $=$ $\boxed{0 \rightarrow 2^n - 1}$

include −ve numbers

-2^1 2^0 2 bits

−ve base value

$4 = 2^2$

0	0	= 0
0	1	= 1
1	0	= −2
1	1	= −1

$\boxed{-2 \rightarrow 1}$

8 total

-2^2	2^1	2^0	
0	0	0	= 0
0	0	1	= 1
0	1	0	= 2
0	1	1	= 3
1	0	0	= −4
1	0	1	= −3
1	1	0	= −2
1	1	1	= −1

$\boxed{-4 \text{ to } 3}$

$n-1 \quad \ldots \quad 2 \quad 1 \quad 0$

$\_\ \_\ \_\ \_\ \_\ \_\ \_$

$\downarrow$

-2^{n-1}

n bits

$\downarrow$

$0 \to 2^n - 1$

if only +ve

for +ve no

$\underline{0}$ $\_\ \_\ \_\ \_\ \_\ \_\ \_$

$2^{n-2} \quad \ldots \quad 2^2 \quad 2^1 \quad 2^0$

$$\boxed{0 \le x \le 2^{n-1} - 1} \quad \text{--- (1)}$$

$n = 8$ bits

$2^8 = 256$

+ve ≡ 0–255

$\underline{1}$ $\_\ \_\ \_\ \_\ \_\ \_\ \_$

-2^{n-1}

$0 \ \_\_\_\_ \ \cancel{2^{n-1}} - 1$

$-2^{n-1} \qquad -\cancel{2^{n-1}}$

$$\boxed{-2^{n-1} \le x \le -1} \quad \text{--- (2)}$$

+ve = 0–127

−ve = −128 (2^7)

$-128 \to +127$

$-2^7 \to 2^7 - 1$

n bits

$$\boxed{-\left(2^{n-1}\right) \le x \le 2^{n-1} - 1}$$

4 bits $\Rightarrow$ $\boxed{-8 \longrightarrow 7}$

3 bits $\Rightarrow$ $-4 \longrightarrow 3$

1 byte = 8 bits

int :- 4 bytes = 32 bits

2147483648

$$-2^{31} \longrightarrow 2^{31}-1$$ ⟵ decimal vale

long ≡ 8 bytes ≡ 64 bits

$$-2^{63} \longrightarrow 2^{63}-1$$

⇒ overflow occurs

~~128~~

8 bits ⇒ $-128 \longrightarrow 127$

127 + 1

1 1 1 1 1 1 1

0 1 1 1 1 1 1 1

+1

1 0 0 0 0 0 0 0 — -128

1 1 1 1 1 1 1 1 ⇒ -1

+1

~~1~~ 0 0 0 0 0 0 0 0 → 0

$$2^{10} = 1024 \approx 10^3$$

$$2^{10} \approx 10^3$$

$$(2^{10})^3 \approx (10^3)^3$$

$$2 * 2^{30} \approx 10^9 * 2$$

$$\boxed{2^{31} \approx 2*10^9}$$

$$-2*10^9 \le x \le 2*10^9-1$$

$$2^{10} = 10^3$$

$$(2^{10})^6 = (10^3)^6$$

$$2^{60} \approx 10^{18}$$

$$2^3 * 2^6 \approx 2^3 * 10^{18}$$

$$\boxed{2^{63} \approx 8*10^{18}}$$

$1 \le n \le 10^5$

$1 \le arr[i] \le 10^6$

$10^5 * 10^6 = 10^{11}$

```
long ~~int~~ total = 0;   — 2*10^9
for( int i=0; i<n; i++)
    total += arr[i];
```

```
int a, b;

int prod = a*b;

long prod = a*b;

long(a)*b;

long(a*b);
```

$1 \le a \le 10^6$
$1 \le b \le 10^6$

int 10^6 int 10^6

int ~~X~~ 10^{12}

ow

long int

long

0 — target

a

a+1

a*2

6

0 *2 +1

0*2 *2

1<<i

18

1 1 0 1

0 +1

1

0 0 0 1 0 0 0

1