TWOS COMPLEMENT COMPLEMENTARY ADDITION

PERFORM THE FOLLOWING SUBTRACTION USING EIGHT-BIT BINARY TWO'S COMPLEMENT COMPLEMENTARY ADDITION:

	CONVERT TO BINARY	MAKE EACH NO. 8 BITS LONG
77_{10}	1001101	01001101 ← (A) = +77
-66_{10}	1000010	01000010

INVERT NEGATIVE NO.	ADD 1 TO NEGATIVE NO.
10111101 →	10111101
	1 +
	10111110 ← (B)

(B) = −66

- ADD (A) AND (B)
- IGNORE OVERFLOW (IF PRESENT)

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 01001101
 10111110  +
1)
 00001011
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ANSWER: 00001011_2

PERFORM THE FOLLOWING SUBTRACTION USING 8 BIT BINARY TWO'S COMPLEMENT COMPLEMENTARY ADDITION

	CONV. TO BINARY	MAKE 8 BITS LONG
29_{10}	11101	00011101 ← (A) = +29
-93_{10}	1011101	01011101

INVERT NEGATIVE NO.	ADD 1 TO NEG NO.
10100010	10100010
	1 +
	10100011 ← (B) = -93

ADD (A) AND (B)

(A) 00011101

(B) 10100011 +

11000000

NO OVERFLOW

IN THIS EXAMPLE ANSWER: 11000000

PROVING THE ANSWERS CORRECT

FIRST QUESTION

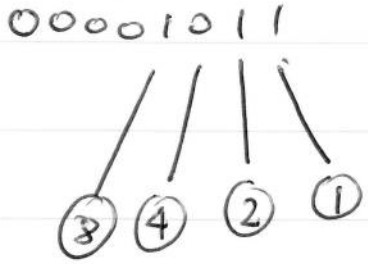
77
−66 →

TWOS COMPLEMENT ANSWER

00001011

0 => POS

1 => NEG



1 x 1 = 1

1 x 2 = 2

0 x 4 = 0

1 x 8 = 8 +

11_{10}

POSITIVE OR NEGATIVE $+11_{10}$

PROVING THE ANSWERS CORRECT

④

29

-93

11000000

↑

1 ⇒ NEG

0 ⇒ pos

11000000

INVERT

00111111

ADD 1 + 1

01000000

01000000

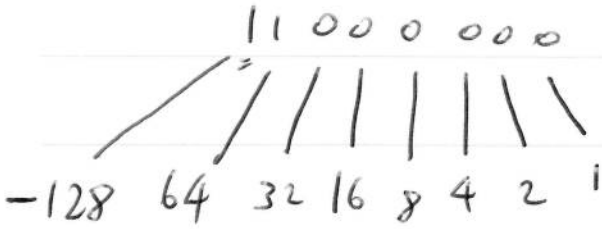
64 32 16 8 4 2 1

1 × 64 = 64

pos or neg

ANSWER: −64

ANOTHER WAY



0x 1	=	0
0x 2	=	0
0x 4	=	0
0x 8	=	0
0x 16	=	0
0x 32	=	0
1x 64	=	64
1x -128	=	-128 +
		64

pos or NEG.

1 => NEG. => -64

(6)

Q. 10110111 — 2's complement no.

What integer value does it represent?

10110111

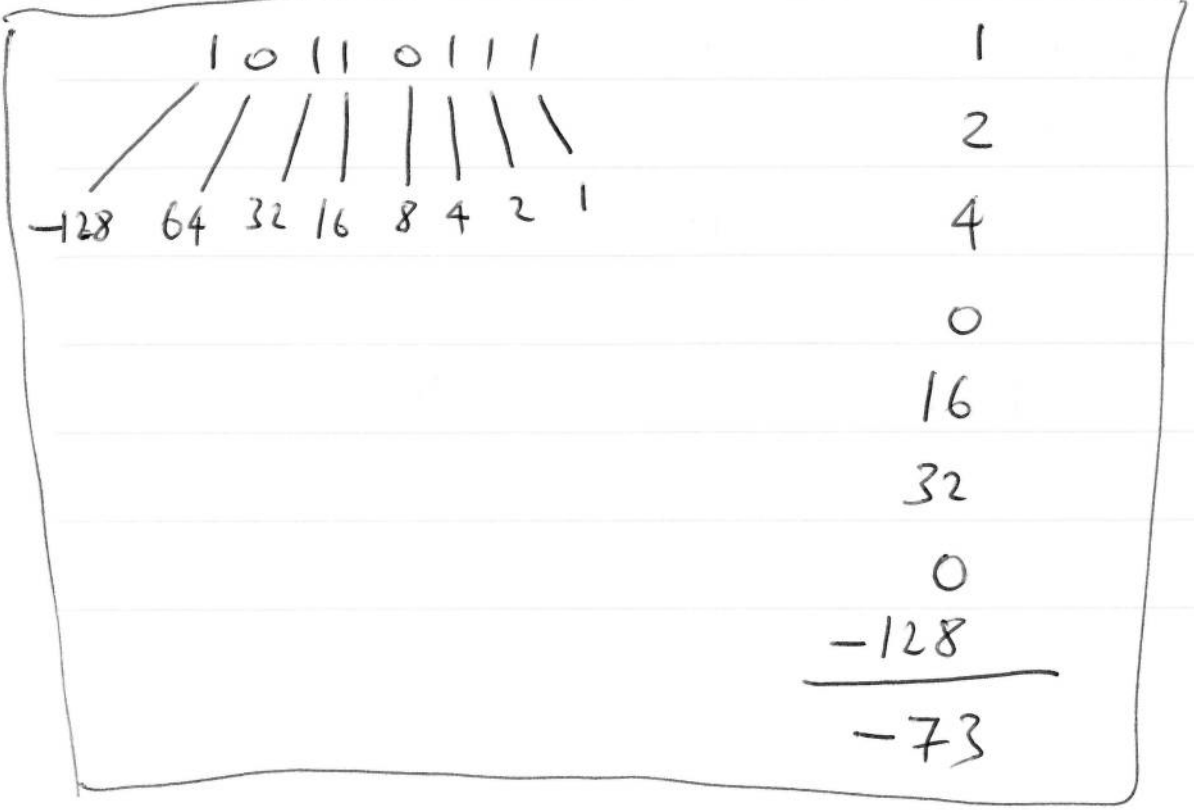
INVERT 01001000

ADD 1 +1

01001001

64 + 8 + 1 = 73

pos or neg -73



(7)

1011 0111

−1 −1

1011 0110

INVERT ↓↓↓↓ ↓↓↓↓

0100 1001

64 + 8 + 1 = 73

POS OR NEG? −73

Q. 0111 1111 — 2's COMPLEMENT NO.

What integer value does it represent?

POSITIVE: SO CONVERT IT BACK USING POWERS OF 2

0 1 1 1 1 1 1 1

64 32 16 8 4 2 1

1 × 1 = 1

1 × 2 = 2

1 × 4 = 4

1 × 8 = 8

1 × 16 = 16

1 × 32 = 32

1 × 64 = 64 +

127

ANSWER +127

(8)

$$\begin{array}{r} 723 \\ -\ 685 \\ \hline 38 \end{array} \qquad \begin{array}{r} 7573 \\ -\ 3898 \\ \hline 3675 \end{array}$$

$$\begin{array}{r} 723 \\ -685 \\ \hline \end{array} \qquad \begin{array}{r} 999 \\ -685 \\ \hline 314 \end{array}$$

$$\begin{array}{r} 723 \\ 1)\ 314 \quad + \\ \hline 037 \\ \quad\ 1 \\ \hline 038 \end{array}$$

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(9)

$$\begin{array}{r} 723 \\ -685 \\ \hline \end{array}$$

$$\begin{array}{r} 999 \\ -685 \\ \hline 314 \\ \quad\quad 1 \; + \\ \hline 315 \end{array}$$

10's complement of 685

$$\begin{array}{r} 723 \\ \cancel{1}315 \; + \\ \hline 038 \end{array}$$

Ignore

$$\begin{array}{r} 7573 \\ -3898 \\ \hline \end{array}$$

$$\begin{array}{r} 9999 \\ -3898 \\ \hline 6101 \\ \quad\quad\quad 1 \; + \\ \hline 6102 \end{array}$$

10's complement of 3898

$$\begin{array}{r} 7573 \\ \cancel{1}6102 \; + \\ \hline 3675 \end{array}$$

Ignore

TWOS COMPLEMENT — DETERMINING THE RANGE OF VALUES THAT CAN BE REPRESENTED

3 BITS	$2^3 = 8$
000	0
001	+1
010	+2
011	+3
100	-4
101	-3
110	-2
111	-1

001 +1

−1

001 ✓

110 • INVERT

1 • ADD 1

111 −1

CALCULATION

WITH 3 BITS: ① TOTAL NOS THAT CAN BE REPRESENTED = 8

② POSITIVE NOS = 3

③ NEGATIVE NOS = 4

1 ZERO

DO THE SAME TYPE OF CALCULATION FOR 4 BITS

TWO'S COMPLEMENT

TOTALS FOR 4 BITS

$2^{④} = 16$

① TOTAL NO.S THAT CAN BE REPRESENTED = 16

② POSITIVE NO.S = 7

③ NEGATIVE NO.S = 8

RANGE FOR 4 BITS

$-8\ -7\ -6\ -5\ -4\ -3\ -2\ -1\ 0\ 1\ 2\ 3\ 4\ 5\ 6\ 7$

-8 to -1, 0, $+1$ to $+7$

Do the same calculation for 8 bits and 16 bits.

SIZE OF BITS	TOTAL NOS	POSITIVE NOS	NEGATIVE NOS	MAX VALUE	MIN VALUE
8	256 $2^8 = 256$	127	128	+127	-128
16	65536	32767	32768	+32767	-32768
32	4,294,967,296	2147483647	2147483648		

MAX VALUE: + 2147483647

MIN VALUE: − 2147483648

FLOATING POINT NUMBERS

IEEE 32 BIT FLOATING POINT FORMAT

Sign bit	Exponent	Mantissa
1 BIT	8 BITS	23 BITS

0: POSITIVE

1: NEGATIVE

IT USES THE IDEA OF SCIENTIFIC NOTATION.

EXPRESS THE FOLLOWING NUMBERS USING SCIENTIFIC NOTATION

EXPONENT

$200 = 2 \times 10^{2}$

$2 = 2 \times 10^{0}$

$20 = 2 \times 10^{1}$

$20931450000000 = 2.093145 \times 10^{12}$

MANTISSA

EXPONENT

1×10^{-10} metre

1×10^{-2} metre

=

=

=

-2 =>
BACK TWO PLACES

.01 metre = 1 cm

$1 \times .10^{-10}$ =

.0000000001 metre
