Integer Representation

→ Decimal (10) : 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Binary (2) : 0, 1

Octal (8) : 0, 1, 2, 3, 4, 5, 6, 7

Hexa-decimal (16) : 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F.

→ $7965 = 7000 + 900 + 60 + 5$

$= 7 \times 1000 + 9 \times 100 + 6 \times 10 + 5$

$= 7 \times 10^3 + 9 \times 10^2 + 6 \times 10^1 + 5 \times 10^0$

$\overset{3}{7}\overset{2}{9}\overset{1}{6}\overset{0}{5}$ → 10 based

$7 \times 10^3 + 9 \times 10^2 + 6 \times 10^1 \times 5 \times 10^0$

→ Binary to Decimal

$(11011)_2 = (?)_{10}$

$\overset{4}{1}\overset{3}{1}\overset{2}{0}\overset{1}{1}\overset{0}{1}$ $\quad 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$

$= 27$

$(10101\,1111)_2 = (?)_{10}$

$\overset{8}{1}\overset{7}{0}\overset{6}{1}\overset{5}{0}\overset{4}{1}\overset{3}{1}\overset{2}{1}\overset{1}{1}\overset{0}{1}$ $\quad 1 \times 2^8 + 0 \times 2^7 + 1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$

$= 351$

→ Octal to Decimal

$(7016)_8 = (?)_{10}$

$\overset{3}{7}\ \overset{2}{0}\ \overset{1}{1}\ \overset{0}{6}$ $\quad 7\times8^3 + 0\times8^2 + 1\times8^1 + 6\times8^0$

$= 3598$

$(111)_8 = (?)_{10}$

$\overset{2}{1}\ \overset{1}{1}\ \overset{0}{1}$ $\quad 1\times8^2 + 1\times8^1 + 1\times8^0 = 73$

→ Hexadecimal to Decimal

0 - 9, 10 = A, 11 = B, 12 = C, 13 = D, 14 = E, 15 = F

$(2AE0B)_{16} = (?)_{10}$

$\overset{4}{2}\ \overset{3}{A}\ \overset{2}{E}\ \overset{1}{0}\ \overset{0}{B}$ $\quad 2\times16^4 + A\times16^3 + E\times16^2 + 0\times16^1 + B\times16^0$

$= 2\times16^4 + 10\times16^3 + 14\times16^2 + 0\times16^1 + 11\times16^0$

$= 175627$

$(E5)_{16} = (?)_{10}$

$\overset{1}{E}\ \overset{0}{5}$ $\quad E\times16^1 + 5\times16^0$

$= 14\times16^1 + 5\times16^0$

$= 229$

→ Decimal to Binary

$(87)_{10} = (?)_2$

2 | 87
2 | 43 – 1
2 | 21 – 1
2 | 10 – 1
2 | 5 – 0
2 | 2 – 1
2 | 1 – 0
0 – 1

$(1010111)_2$

$(39)_{10} = (?)_2$

2 | 39
2 | 19 – 1
2 | 9 – 1
2 | 4 – 1
2 | 2 – 0
2 | 1 – 0
0 – 1

$(100111)_2$

→ Decimal to Octal

$(12345)_{10} = (?)_8$

8 | 12345
8 | 1543 – 1
8 | 192 – 7
8 | 24 – 0
8 | 3 – 0
0 – 3

$(30071)_8$

→ Decimal to Hexadecimal

$(175627)_{10} = (?)_{16}$

16 | 175627
16 | 10976 – 11 (B)
16 | 686 – 0
16 | 42 – 14 (E)
16 | 2 – 10 (A)
0 – 2

$(2AE0B)_{16}$

→ Binary to Octal / Hexadecimal

$(11\ 1110\ 1011\ 1100)_2$

11 111 010 111 100

011 111 010 111 100

3 7 2 7 4

$(37274)_8$

11 1110 1011 1100

0011 1110 1011 1100

3 14 11 12

3 E B C

$(3EBC)_{16}$

→ Octal / Hexadecimal to Binary ...

$(ABCD)_{16} = (?)_2$

A B C D

10 11 12 13

1010 1011 1100 1101

$(1010\ 1011\ 1100\ 1101)_2$

A 1 2 3 = $(?)_2$

1010 0001 0010 0011

$(1010\ 0001\ 0010\ 0011)_2$

$(567)_8 = (?)_2$

5 6 7

101 110 111

$(101\ 110\ 111)_2$

$(5123) = (?)_2$

101 001 010 011

$(101\ 001\ 010\ 011)_2$

→ Fast Modular Exponentiation

$3^{644} \bmod 645$

$644 = 1010000100$

	1	2	3	4	5	6	7	8	9	10
bits	1	0	1	0	0	0	0	1	0	0
values	3	9	243	354	186	411	576	93	264	36

2 → $3^2 \bmod 645 = 9$

3 → $9^2 \bmod 645 = 81$

$81 \times 3 \bmod 645 = 243$

4 → $243^2 \bmod 645 = 354$

5 → $354^2 \bmod 645 = 186$

6 → $186^2 \bmod 645 = 411$

7 → $411^2 \bmod 645 = 576$

8 → $576^2 \bmod 645 = 246$

$246 \times 3 \bmod 645 = 93$

9 → $93^2 \bmod 645 = 264$

10 → $264^2 \bmod 645 = 36$