Compliments of base

* Arithmetic operations in different base

○ Addition

$\begin{array}{c|c} 8 & 13 \\ \hline 8 & 1 \end{array}$ 5 ↑

→ Base 8

$$\begin{array}{r} 47 \\ + 36 \\ \hline 105 \end{array}$$

$$\begin{array}{r} {}^{1}{}_{1}\ 1\ 1\ 1 \\ 3\ 6\ 7\ 6\ 5\ 4 \\ +\ 1\ 2\ 3\ 6\ 7\ 5 \\ \hline 5\ 1\ 3\ 5\ 5\ 1 \end{array}$$

Base 12 → 0 to B

$$\begin{array}{r} 1\ \ 1\ \ 1\ 1 \\ 1\ B\ A\ 9\ 6 \\ +\ 6\ A\ B\ 5\ 9 \\ \hline 8\ A\ A\ 3\ 3 \end{array}$$

A — 10
B — 11
C — 12
D — 13
E — 14
F — 15

Base 16

$$\begin{array}{r} 1\ \ \ 1\ 1 \\ 1\ A\ B\ F\ C\ D \\ +\ 5\ 1\ F\ 3\ 2\ 1 \\ \hline 6\ C\ B\ 2\ E\ E \end{array}$$

$$\begin{array}{r} {}^{1}1{}^{1}0{}^{1}1{}^{1}0{}^{1}1{}^{1}0{}^{1}1\,01 \\ 1101\,1011 \\ \hline 1100'0010\,0 \end{array}$$

$$1+1 \Rightarrow 10$$
$$1+0 \Rightarrow 1$$
$$0+1 \Rightarrow 1$$
$$0+0 \Rightarrow 0$$

$$\begin{array}{r} 10110001\,1101 \\ +\ 101101\ 111111 \\ \hline 10110100\,11100 \end{array}$$

$$38 + 43 = 80 \qquad \text{base ?}$$

$$(38)_x + (43)_x = (80)_x$$

$$3x + 8 + 4x + 3 = 8x$$

$$11 = x \quad \underline{\underline{Ans}}$$

$$4 + 4 = 14 \qquad \underline{\text{base } x}$$

$$(4)_x + (4)_x = (14)_x$$

$$4 + 4 = x + 4$$

$$x = 4 \quad \times \quad \text{No Solution}$$

$$4 + 4 = 9 \qquad \underline{\text{base ?}}$$

$$(4)_x + (4)_x = (9)_x$$

$$4 + 4 = 9 \quad \times$$

$4 + 4 = 10$ base ?

$(4)_n + (4)_n = (10)_n$

$4 + 4 = n$
$8 = n$

$4 + 4 = 11$
$(4)_n + (4)_n = (11)_n$

$8 = 2n + 1$

$7 = n$

* Rules

1) Assume digit in base 10
2) Add them and divide by base quotient on LHS & remainder on RHS

* Subtraction

$$\begin{array}{r} 1\,4 \\ -\,5 \\ \hline 9 \end{array}$$

• Base 8

$$\begin{array}{r} 3\,4\,4 \\ -1\,7 \\ \hline 2\,5 \end{array} \text{ Ans}$$

$8 \leftarrow \begin{array}{c} 8+4 \\ 12 \\ -7 \end{array}$

→ same we do in base

$$\begin{array}{r} 4\,3\,6\,2\,7\,1\,4 \\ 1\,1\,2\,5\,6\,7\,7 \\ \hline 3\,2\,3\,5\,0\,1\,5 \end{array}$$

* Base 9

$$\begin{array}{r} 1\,0\,0\,0\,0\,0 \\ -\ \ 1\,4\,5\,6\,7 \\ \hline 7\,4\,3\,2\,2 \end{array}$$

* Base 16

$$
\begin{array}{cccccccc}
 & & & {}^9 & {}^1 {}^2 {}^6 {}^6 & & & \\
1 & A & 2 & 3 & 7 & 6 & 9 & \\
0 & 1 & C & F & D & B & A & \\
\hline
1 & 8 & 5 & 3 & 9 & A & F & \text{Anw}
\end{array}
$$

A	— 10
B	— 11
C	— 12
D	— 13
E	— 14
F	— 15

Binary basis

$$
\begin{array}{cccccccc}
 & {}^{1} & {}^{\backsim 1} & {}^{0} & {}^{.1} & & & {}_2\\
1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1\\
-0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1\\
\hline
0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0
\end{array}
$$

Rule for subtraction

① if we need borrow then subtract 1 from LHS & we will add to the current digit and then perform subtraction.

* Multiplication
↳ Recursive procedure of addition

$2 * 3 = 2+2+2 = \mathbf{6}$

$$
\begin{array}{r}
\underline{\text{Base 8}} \quad 3^{\,6} \\
47 \\
74 \\
\times \\
\hline
2 3 4 \\
4\ 2\ 1\ \times \\
\hline
4 4 4 4
\end{array}
$$

$$
\begin{array}{r}
36 \\
\times 15 \\
\hline
180 \\
336 \times \\
\hline
540
\end{array}
\quad = (36 \times 5) + (36 \times 10)
$$

○ Base 12

A - 10
B - 11
C - 12

$$\overset{3\,3}{1\,A\,B\,3\,4}$$
$$X \quad \underline{5\,B\,A}$$
$$\underline{8\ 0\ 4}$$

$$\overset{2\ 3}{1\,A\,B\,3\,4}$$
$$\underline{5\,B\,A}$$
$$1\ 7\ 1\ 4\ 9\ 4$$
$$1\ 9\ 0\ 4\ 0\ 8\ X$$
$$\underline{9\ 6\ 8\ 4\ 8\ \ X\,X}$$
$$\underline{B\ 5\ 3\ A\ 1\ 5\ 4}$$