

Unit 1 Section 2 : Adding and Subtracting Binary Numbers

It is possible to add and subtract binary numbers in a similar way to base 10 numbers.

For example, $1 + 1 + 1 = 3$ in base 10 becomes $1 + 1 + 1 = 11$ in binary.

In the same way, $3 - 1 = 2$ in base 10 becomes $11 - 1 = 10$ in binary.

When you add and subtract binary numbers you will need to be careful when 'carrying' or 'borrowing' as these will take place more often.

Key Addition Results for Binary Numbers

$$\begin{array}{rclcl} 1 & + & 0 & = & 1 \\ 1 & + & 1 & = & 10 \\ 1 & + & 1 & + & 1 = 11 \end{array}$$

Key Subtraction Results for Binary Numbers

$$\begin{array}{rclcl} 1 & - & 0 & = & 1 \\ 10 & - & 1 & = & 1 \\ 11 & - & 1 & = & 10 \end{array}$$

Example 1

Calculate, using binary numbers:

(a) $111 + 100$ 1011

(b) $101 + 110$ 1011

(c) $1111 + 111$ 10110

Example 2

Calculate the binary numbers:

- (a) $111 - 101$
- (b) $110 - 11$
- (c) $1100 - 101$

Question 1

Calculate the binary numbers:

- (a) $11 + 1$
- (b) $11 + 11$
- (c) $111 + 11$
- (d) $111 + 10$
- (e) $1110 + 111$
- (f) $1100 + 110$
- (g) $1111 + 10101$
- (h) $1100 + 11001$
- (i) $1011 + 1101$
- (j) $1110 + 10111$
- (k) $1110 + 1111$
- (l) $11111 + 11101$

Question 2

Calculate the binary numbers:

(a) $11 - 10$

(b) $110 - 10$

(c) $1111 - 110$

(d) $100 - 10$

(e) $100 - 11$

(f) $1000 - 11$

(g) $1101 - 110$

(h) $11011 - 110$

(i) $1111 - 111$

(j) $110101 - 1010$

(k) $11011 - 111$

(l) $11110 - 111$

Question 3

Calculate the binary numbers:

(a) $11 + 11$

(b) $111 + 111$

(c) $1111 + 1111$

(d) $11111 + 11111$

What will be the next number that will fit this pattern?

Question 4

Calculate the binary numbers:

(a) $10 + 10$

(b) $100 + 100$

(c) $1000 + 1000$

(d) $10000 + 10000$

What is the next number that will continue your binary pattern?

Question 5

Solve the following equations, where all numbers, including x , are binary:

(a) $x + 11 = 1101$ $x =$

(b) $x - 10 = 101$ $x =$

(c) $x - 1101 = 11011$ $x =$

(d) $x + 1110 = 10001$ $x =$

(e) $x + 111 = 11110$ $x =$

(f) $x - 1001 = 11101$ $x =$

Question 6

Calculate the binary numbers:

(a) $10 - 1$

(b) $100 - 1$

(c) $1000 - 1$

(d) $10000 - 1$

What will be the next number that will fit this pattern?

Question 7

A 4-digit binary number has 2 zeros and 2 ones.

(a) Convert the binary numbers 11101 and 1110 to base 10.

and

(b) Add together the two base 10 numbers.

(c) Add together the two binary numbers.

(d) Convert your answer to base 10 and compare with your answer to (b).



Question 8

A binary number has 8 digits and is to be converted to base 10.

- (a) Convert the binary numbers 11101 and 10111 to base 10.

and

- (b) Calculate the difference between the two base 10 numbers.

- (c) Convert your answer to (b) into a binary number.

- (d) Calculate the difference between the two binary numbers and compare with your answer to (c)

Question 9

Here are 3 binary numbers:

1110101

1011110

1010011

Working in binary,

- (a) add together the two smaller numbers,

- (b) add together the two larger numbers,

- (c) take the smallest number away from the largest number,

- (d) add together all three numbers.

Question 10

Calculate the binary numbers:

- (a) $111+101+100$

- (b) $11101+10011+110111$