

Covid 19 weekly school – Grade 9 – January 2nd week

Binary Numbers

Show the numbers given in base ten as binary numbers

$$\begin{array}{rcl} 1. \ 10_{\text{ten}} & 2 \overline{)10} & \\ & 2 \overline{)5} \text{ -----} & \text{Remainder 0} \\ & 2 \overline{)2} \text{ -----} & \text{Remainder 1} \\ & 2 \overline{)1} \text{ -----} & \text{Remainder 0} \\ & 0 \text{ -----} & \text{Remainder 1} \end{array}$$

Write down the remainders bottom to top gradually and obtain the binary number

$$10_{\text{ten}} = 1010_{\text{two}}$$

2. Show 13_{ten} as a binary number

$$\begin{array}{rcl} & 2 \overline{)13} & \\ & 2 \overline{)6} \text{ -----} & \text{Remainder 1} \\ & 2 \overline{)3} \text{ -----} & \text{Remainder 0} \\ & 2 \overline{)1} \text{ -----} & \text{Remainder 1} \\ & 0 \text{ -----} & \text{Remainder 1} \end{array}$$

$$13_{\text{ten}} = 1101_{\text{two}}$$

Do the exercise 2.1

Convert the given binary numbers to numbers with base ten

1. Show 1011_{two} as a decimal number (number with base ten)

$$\begin{array}{cccc} 1 & 0 & 1 & 1 \\ \text{Place value:} & & & \\ 2^3 & 2^2 & 2^1 & 2^0 \\ \text{Value of the number} & & & \\ 8 & 4 & 2 & 1 \end{array}$$

First multiply the value of the number by the place value and add all the values to obtain the decimal number

$$\begin{aligned} &= (8 \times 1) + (4 \times 0) + (2 \times 1) + (1 \times 1) \\ &= 11_{\text{ten}} \end{aligned}$$

2. Show 100100_{two} as a decimal number

$$\begin{array}{cccccc} 1 & 0 & 0 & 1 & 0 & 0 \\ \text{Place value:} & & & & & \\ 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \\ \text{Value of the number} & & & & & \\ 32 & 16 & 8 & 4 & 2 & 1 \end{array}$$

$$\begin{aligned} &= (32 \times 1) + (16 \times 0) + (8 \times 0) + (4 \times 1) + (2 \times 0) + (1 \times 0) \\ &= 36_{\text{ten}} \end{aligned}$$

Do the exercise 2.2

Addition of binary numbers

1. $10_{\text{two}} + 1_{\text{two}}$

$$\begin{array}{r} 2^1 \quad 2^0 \\ 1 \quad 0_{\text{two}} \\ + \quad 1_{\text{two}} \\ \hline 1 \quad 1_{\text{two}} \end{array}$$

So $10_{\text{two}} + 1_{\text{two}} = 11_{\text{two}}$

$1_{\text{two}} + 0_{\text{two}} = 1_{\text{two}}$
$1_{\text{two}} + 1_{\text{two}} = 10_{\text{two}}$
$1_{\text{two}} + 1_{\text{two}} + 1_{\text{two}} = 11_{\text{two}}$

2. Find the value of $11_{\text{two}} + 1_{\text{two}}$

$$\begin{array}{r} 2^2 \quad 2^1 \quad 2^0 \\ \quad 1 \quad 1_{\text{two}} \\ + \quad 1_{\text{two}} \\ \hline 1 \quad 0 \quad 0_{\text{two}} \end{array}$$

Here place value of 2^0 is $1 + 1 = 2$, but $2 = 10_{\text{two}}$, so that 1 add to the (line of 2^1) left side

So $11_{\text{two}} + 1_{\text{two}} = 100_{\text{two}}$

Do the exercise 2.3

Subtraction of binary numbers

1. Find the value of $111_{\text{two}} - 10_{\text{two}}$

$$\begin{array}{r} 2^2 \quad 2^1 \quad 2^0 \\ 1 \quad 1 \quad 1_{\text{two}} \\ - \quad 1 \quad 0_{\text{two}} \\ \hline 1 \quad 0 \quad 1_{\text{two}} \end{array}$$

2. Find the value of $110_{\text{two}} - 1_{\text{two}}$

$$\begin{array}{r} 2^2 \quad 2^1 \quad 2^0 \\ 1 \quad 1 \quad 0_{\text{two}} \\ - \quad \quad 1_{\text{two}} \\ \hline 1 \quad 0 \quad 1_{\text{two}} \end{array}$$

2 out of 0 cannot be deducted. Therefore brings 1 from left side. Then place value of 2^0 is 2. Then subtract 1 out of 2. After that the place value of 2^1 is 0.

Do the exercise 2.4