

BINARY NOTATION

JUNIOR CIRCLE 11/15/2011

Definition. Write the definitions below using what the teacher discussed on the board.

Decimal notation:

Binary notation:

Example. Do the following examples given by the teacher on the board.

- Convert the following number from decimal to binary:

- Convert the following number from binary to decimal:

Which method do you prefer to use more? Egyptian or Russian Peasant?

(1) Writing numbers in binary.

(a) Convert the following numbers to binary by finding the highest power of 2 first. (That is, write the number as the sum of powers of 2 but use the Egyptian Multiplication Method)

(i) 3

(ii) 8

(iii) 20

(iv) 45

(b) Convert the following numbers to binary by finding the lowest power of 2 first. (That is, write the number as a sum of powers of 2 but use the Russian Peasant Multiplication Method)

(i) 4

(ii) 7

(iii) 21

(iv) 47

(c) Convert the following numbers from binary to decimal.

(i) 110_2

(ii) 1001_2

(iii) 1111_2

(d) Write all numbers from 1 to 16 in binary. What is the pattern?

(2) Adding and subtracting in binary.

- Addition facts:

$$0 + 0 = 0$$

$$0 + 1 = 1$$

$$1 + 1 = 10$$

- Can you explain this phenomenon that $1 + 1 = 10_2$?

(a) Add the following binary numbers:

$$(i) \quad \begin{array}{r} \\ \\ \\ \\ \end{array}$$

$$(ii) \quad \begin{array}{r} \\ \\ \\ \\ \end{array}$$

$$(iii) \quad \begin{array}{r} \\ \\ \\ \\ \end{array}$$

$$(iv) \quad \begin{array}{r} \\ \\ \\ \\ \end{array}$$

- (v) When does carrying? List all possibilities.

(3) Multiplying in binary.

- Multiplication table

×	1
1	1

(a) Represent multiplication by 10_2 as addition. (Hint: $10_2 = \square$)

(i) $11_2 \times 10_2 = \square + \square$

(ii) $10101_2 \times 10_2 = \square + \square$

(b) Represent multiplication by 11_2 as addition. (Hint: $11_2 = \square$)

(i) $110_2 \times 11_2 = \square + \square + \square$

(ii) $1011_2 \times 11_2 = \square + \square + \square$

(5) More Multiplication Problems

(a) $111_2 \times 101_2 =$

(b) $10101_2 \times 110_2 =$

(c) $11100_2 \times 10_2 =$

(d) $10111_2 \times 11_2 =$

(6) Compare the following pairs of numbers in binary:

(a) 11_2 and 110_2

(b) 101_2 and 1010_2

(c) 111_2 and 1110_2

(d) How are these pairs of numbers related?

(e) How are the numbers $1abc_2$ and $1abc0_2$ related? Where a, b, c can be either 0 or 1. (That is how is any number in binary related to the same number with a 0 added to the end?)

(f) Compare this with numbers in decimal form:

(i) How are 23 and 230 related? What about 567 and 5670?

(7) CHALLENGE!! Write 2011 in binary notation.

- (8) **Make cards for a fun game as follows:** Using the numbers between 1 and 15 in binary form (Write all numbers so they have 4 digits, that is, if you have a binary number written as 11_2 , rewrite it as 0011_2 to ensure that all of your numbers have 4 digits)
- (a) First card:
 - Include all numbers in which the first digit is equal to 1 in binary form.
 - (b) Second card:
 - Include all numbers in which the second digit is equal to 1 in binary form.
 - (c) Third card:
 - Include all numbers in which the third digit is equal to 1 in binary form.
 - (d) Fourth card:
 - Include all numbers in which the fourth digit is equal to 1 in binary form.
- **GAME:** Ask a parent to think of a number between 1 and 15 and tell you on which cards the number appears.
 - You can immediately tell the number by adding the numbers in the corners of the card where their number appears. Can you explain the trick?