# Unit 3. Exercises about representation of information

**Add a few explanations to demonstrate how to perform each conversion. For example, from decimal to binary we use powers and then explain the corresponding operations.**

1. Convert from decimal to binary:

   **Explanation:** in order to convert a decimal to binary that are base 2 as her name says, you have two way the first one is dividing by two until you can't anymore and take the remainders in above orders, or you can make a simple table of two to the power of the n position starting from right to left and subtract the number from the power of two, this is the method that I will be following for each exercise.

| 2^10=1024 | 2^9=512 | 2^8=256 | 2^7=128 | 2^6=64 | 2^5=32 | 2^4=16 | 2^3=8 | 2^2=4 | 2^1=2 | 2^0=1 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

   a. 234 = 11101010

      234-128=106 →1
      234-128-64=42 →1
      234-128-64-32=10→1
      (this power exceeds the value)→0
      234-128-64-32-8=2→1
      (this power exceeds the value)→0
      234-128-64-32-8-2=0→1
      (this power exceeds the value)→0

   b. 555 = 1000101011

      **Explanation:** in this case I choose the division method, we take module of the division from bottom to top in order to write the decimal number.
      555 % 2 = 1
      277 % 2 = 1
      138 % 2 = 0
      69 % 2 = 1
      34 % 2 = 0
      17 % 2 = 1
      8 % 2 = 0
      4 % 2 = 0
      2 % 2 = 0
      1 % 2 = 1

c. 12321 = 11000000100001

12321-2^13=4129 →1
4129 – 2^12 = 33 →1
(this power exceeds the value)→0
(this power exceeds the value)→0
(this power exceeds the value)→0
(this power exceeds the value)→0
(this power exceeds the value)→0
(this power exceeds the value)→0
33-32=1→1
(this power exceeds the value)→0
(this power exceeds the value)→0
(this power exceeds the value)→0
(this power exceeds the value)→0
1-1=0→1

d. 152 = 10011000

152 – 128 = 24 → 1
(this power exceeds the value)→0
(this power exceeds the value)→0
24 – 16 = 8→1
8-8=0→1
(this power exceeds the value)→0
(this power exceeds the value)→0
(this power exceeds the value)→0

e. 32768 = 1000000000000000

32768 – 2^15 = 0→1
The rest are zero as they exceed the value of zero.

2. Convert from binary to decimal:

   **Explanation:** In order to convert from binary to decimal you have to multiply the n positioned number that could only be 0 or 1 for two elevated to n-1 and add each result → n*2^(n-1) + n*2^(n-1) …

   a. 100000000 = 256
      1*2^8+0*2^7+0*2^6+0*2^5+0*2^4+0*2^3+0*2^2+0*2^1+0*2^0=256
   b. 1011110100
      1*2^9+0*2^8+1*2^7+1*2^6+1*2^5+1*2^4+0*2^3+1*2^2+0*2^1+0*2^0=756
   c. 10011101
      1*2^7+0*2^6+0*2^5+1*2^4+1*2^3+1*2^2+0*2^1+1*2^0=157
   d. 11111111111 = 2047
      This kind of binary number has a trick, you could count the quantity of number in this case is 11 so 2^11 is 2048 but this is 100000000000 so now you can advise that the next minor binary number is 11111111111 so 2048-1 = 2047

3. Convert from hexadecimal to binary:

   **Explanation:** as hexadecimal has only 16 values (1-9 and A-F) has an associate binary number so is easy to made the conversion, for each number corresponds 4 binary numbers. So we use the upper table in order to make the conversion.

| Decimal | Binary | Octal | Hexadecimal |
|---|---|---|---|
| 0 | 0000 | 0 | 0 |
| 1 | 0001 | 1 | 1 |
| 2 | 0010 | 2 | 2 |
| 3 | 0011 | 3 | 3 |
| 4 | 0100 | 4 | 4 |
| 5 | 0101 | 5 | 5 |
| 6 | 0110 | 6 | 6 |
| 7 | 0111 | 7 | 7 |
| 8 | 1000 | 10 | 8 |
| 9 | 1001 | 11 | 9 |
| 10 | 1010 | 12 | A |
| 11 | 1011 | 13 | B |
| 12 | 1100 | 14 | C |
| 13 | 1101 | 15 | D |
| 14 | 1110 | 16 | E |
| 15 | 1111 | 17 | F |

   a. 45A0 = 0100010110100000
      4=0100
      5=0101
      A=1010
      0 = 0000

   b. CF =11001111
      C=1100
      F = 1111

   c. AAB2=1010101010110010
      A=1010
      A=1010
      B=1011
      2=0010

   d. 3020=001000000100000
      3=0011
      0=0000
      2=0010
      0=0000

4. Convert from binary to hexadecimal:

**Explanation:** in order to convert from binary to hexadecimal you have to group numbers by four from right to left and in the case there are number left in this ones have to add zeros at the left of this ones to complete the group of four numbers. Then we use the table to convert the digits.

a. 110001000= 188
   1000=8
   1000=8
   1=1
b. 100010110= 116
   0110=6
   0001=1
   1=1

| Decimal | Binary | Octal | Hexadecimal |
|---|---|---|---|
| 0 | 0000 | 0 | 0 |
| 1 | 0001 | 1 | 1 |
| 2 | 0010 | 2 | 2 |
| 3 | 0011 | 3 | 3 |
| 4 | 0100 | 4 | 4 |
| 5 | 0101 | 5 | 5 |
| 6 | 0110 | 6 | 6 |
| 7 | 0111 | 7 | 7 |
| 8 | 1000 | 10 | 8 |
| 9 | 1001 | 11 | 9 |
| 10 | 1010 | 12 | A |
| 11 | 1011 | 13 | B |
| 12 | 1100 | 14 | C |
| 13 | 1101 | 15 | D |
| 14 | 1110 | 16 | E |
| 15 | 1111 | 17 | F |

5. Complete the following conversions related to octal numeral system:

**Explanation:** the conversion to octal from binary are made straight of the table of values grouping by three from right to left.

a. Convert the numbers from exercise 4 to octal.
   110001000 = 610
   000=0
   001=1
   110=6
b. Convert the octal 3020 to binary.
   3020=011000010000
   0=000
   2=010
   0=000
   3=011

| Decimal | Binary | Octal | Hexadecimal |
|---|---|---|---|
| 0 | 0000 | 0 | 0 |
| 1 | 0001 | 1 | 1 |
| 2 | 0010 | 2 | 2 |
| 3 | 0011 | 3 | 3 |
| 4 | 0100 | 4 | 4 |
| 5 | 0101 | 5 | 5 |
| 6 | 0110 | 6 | 6 |
| 7 | 0111 | 7 | 7 |
| 8 | 1000 | 10 | 8 |
| 9 | 1001 | 11 | 9 |
| 10 | 1010 | 12 | A |
| 11 | 1011 | 13 | B |
| 12 | 1100 | 14 | C |
| 13 | 1101 | 15 | D |
| 14 | 1110 | 16 | E |
| 15 | 1111 | 17 | F |

6. Fill in the gaps, using all the conversions you need. You have to write the steps to transform each number.
   **Explanation:** For the first row I converted from decimal to binary using the table of exercise 1, from here I take the binary in order to make the hexadecimal and octal conversion grouping digits by four for the hexadecimal and by three for the octal, then I use the table of exercise 3. For second and third row I converted well the hexadecimal or the octal to binary with the table of exercise 3 and then to decimal using the table of exercise number 1. For the last row I use the table of the exercise 1 to convert in to decimal and the table of exercise 3 to convert the binary in to hexadecimal and octal.

| BINARY | DECIMAL | HEXADECIMAL | OCTAL |
|---|---|---|---|
| 10 0001 | **33** | 21 | 41 |
| 1111 1111 | 255 | **FF** | 377 |
| 1111 1111 | 255 | FF | **377** |
| **10 0001** | 33 | 21 | 41 |

7. How many bits do you need to represent the following numbers in binary?
   **Explanation:** In order to know the bits we need to know the binary number so we need to make the conversion as usual and then if there´s any zero on the left we can omit then because that not count like a bit.
   (The 0 that in bold letter doesn´t count as a bit)
   a. hexadecimal: 4B, 4AA, FF4FA, 345F
      4B = **0**100 1011 = 7bits
      4 = 0100
      B = 1011
      4AA= **0**100 1010 1010 = 11bits
      4 = 0100
      A = 1010
      A = 1010
      FF4FA=20bits
      345F=15bits
   b. decimal: 100, 256, 255, 32, 31, 3, 4350, 1024, 45, $2^{30}$, 63
      100 = **0**110 0100 =7bits
      1*2^6 + 1*2^5 +0*2^4+0*2^3 +1*2^2 +0*2^1+0*2^0=1100100
      256 = 9bits
      255 = 8bits
      32 = 6bits
      31 = 5bits
      3 = 2bits
      4350 = 13bits
      1024=11bits
      45 = 6bits
      2^30=31bits
      63 = 6bits

8. Solve the following parts using ASCII extended (8 bits).
    a. Write a random text, which contains letters, numbers and other alphanumeric characters.
       L0*,4r
    b. Encode to hexadecimal, according ASCII table.
       4C302A2C3472
    c. Convert to binary.
       100 1100 0011 0000 0010 1010 0010 1100 0011 0100 0111 0010