Hardware - Tutorial 0 - Correction
Numeration

Exercice 1: Powers

Give the values of the following **positives** powers of two:

- $2^0 = 1$
- $2^1 = 2$
- $2^2 = 4$
- $2^3 = 8$
- $2^4 = 16$
- $2^5 = 32$
- $2^6 = 64$
- $2^7 = 128$
- $2^8 = 256$
- $2^9 = 512$
- $2^{10} = 1024$
- $2^{11} = 2048$
- $2^{12} = 4096$
- $2^{13} = 8192$
- $2^{14} = 16384$
- $2^{15} = 32768$
- $2^{16} = 65536$
- $2^{17} = 131072$
- $2^{18} = 262144$
- $2^{19} = 524288$
- $2^{20} = 1048576$

From now on, you must know the first 16 powers of two by heart.

Now give the values of the following **negatives** powers of two:

- $2^{-1} = 0.5$
- $2^{-2} = 0.25$
- $2^{-3} = 0.125$
- $2^{-4} = 0.0625$
- $2^{-5} = 0.03125$
- $2^{-6} = 0.015625$
- $2^{-7} = 0.0078125$
- $2^{-8} = 0.00390625$
- $2^{-6} = 0.001953125$
- $2^{-10} = 0.0009765625$

From now on, you must know the first 5 negatives powers of two by heart.

Exercice 2: Divisons

Let's dive back into these middle school maths !

Give the quotient and remainder of the following Euclidean divisions:

- $386 \div 7 = 55$ R 1
- $2860 \div 16 = 178$ R 12
- $51862 \div 25 = 2074$ R 12
- $160853 \div 120 = 1340$ R 53

Give the quotient of the following divisions with 0.001 precision

- $521 \div 14 = 37.214$
- $632 \div 15 = 42.133$

Exercice 3: Data Quantification

How many bits is there in a byte ? ⇒**8**

How many grams is there in a kilogram ? What is the numerical value of the 'kilo' prefix (as a power of 10) ? ⇒$1000g$ **in a Kg, kilo is the prefix for** 10^3

Now give the numerical value of the following decimal and binary prefixes:

- Kilo (K): 1000 (= 10^3)
- Mega (M): 1000000 (= 10^6)
- Giga (G): 1000000000 (= 10^9)
- Tera (T): 1000000000000 (= 10^{12})
- Kibi (Ki): $2^{10} = 1024$
- Mibi (Mi): $2^{20} = 1048576$
- Gibi (Gi): 2^{30}
- Tebi (Ti): 2^{40}

How many bits is there in a 256 MiB ? Give your answer with the closest binary prefix.
256 MiB = $2^8 * 2^{20} * 2^3$ **bits** $= 2^{31}$ **b** $= 2$ **Gib**

Exercice 4: Base to decimal

Convert the following **binary** and **hexadecimal** numbers into there decimal representations:

- $1101_2 = 2^3 + 2^2 + 2^0 = 13_{10}$
- $11110000_2 = 240_{10}$
- $BAC_{16} = 2988_{10}$
- $1234_{16} = 4660_{10}$
- $10101010_2 = 170_{10}$
- $110110011110_2 = 3486_{10}$
- $CAFE_{16} = 51966_{10}$
- $1101_{16} = 4353_{10}$

Exercice 5: Base to base

Convert the following numbers into the given base:

- $42_{10} \rightarrow$ Base 2 = 10 1010_2
- $432_{10} \rightarrow$ Base 2 = 1 1011 0000_2
- $1234_{10} \rightarrow$ Base 2 = 100 1101 0010_2
- $4321_{10} \rightarrow$ Base 2 = 1 0000 1110 0001_2
- $99_{10} \rightarrow$ Base 16 = $0x63_{16}$
- $777_{10} \rightarrow$ Base 16 = $0x309_{16}$
- $3201_{10} \rightarrow$ Base 16 = $0xC81_{16}$
- $12345_{10} \rightarrow$ Base 16 = $0x3039_{16}$

Convert the following numbers into the given base **using the fast convert method**:

- $11010101_2 \rightarrow$ Base 16 = $D5_{16}$
- $11110010_2 \rightarrow$ Base 16 = $F2_{16}$
- $101011011001_2 \rightarrow$ Base 16 = $AD9_{16}$
- 11011111000100 $\rightarrow$ Base 16 = $37C4_{16}$
- $12_{16} \rightarrow$ Base 2 = 0001 0010_2
- $9A_{16} \rightarrow$ Base 2 = 1001 1010_2
- $1234_{16} \rightarrow$ Base 2 = 0001 0010 0011 0100_2
- $CAFE_{16} \rightarrow$ Base 2 = 1100 1010 1111 1110_2

Exercice 6: Operations

Perform the following additions in binary:

- $1101 + 1110 = 1101$
- $10\ 1011 + 1101 = 11\ 1000$
- $1001\ 1110 + 0110\ 1110 = 1\ 0000\ 1100$
- $1111\ 0000 + 1000\ 0001 = 1\ 0111\ 0001$

Perform the following additions in hexadecimal:

- $1234 + FA78 = 10CAC$
- $ABCD + DCBA = 18887$

Perform the following subtractions in binary:

- $1101\ 1111 - 1\ 0101 = 1100\ 1010$
- $1100\ 0010 - 1\ 1111 = 1010\ 0011$
- $1011\ 1001 - 111\ 0010 = 100\ 0111$
- $1001\ 1000 - 1001\ 1001 = 11111111111...$ This is infinite because the first number is smaller than the second.

Perform the following subtractions in hexadecimal

- $345 - 2AF = 96$
- $73A2 - 6FFB = 3A7$