Homework

1. Given a (very) tiny computer that has a word size of 5 bits, what are the smallest negative numbers and the largest positive numbers that this computer can represent in each of the following representations?
Hint: show your answers in binary and decimal forms.

a. One's complement
The largest: 01111 = 15
The smallest: 10000 = -15
b. Two's complement
The largest: 01111 = 15
The smallest: 10000 = -16

2. Show how the floating point value of 26.625 would be stored using IEEE-754 double precision with excess-1023 exponent (be sure to indicate the sign bit, the exponent, and the significand fields):

First step, Convert 26.625 to binary.
$(26)_{10} = (11010)_2$
$(0.625)_{10} = (0.101)_2$
$(26.625)_{10} = (11010)_2 + (0.101)_2$
$= (11010.101)_2 * 2^0$
$= (1.1010101)_2 * 2^4$

2 | 26 - 26 = 0
2 | 13 - 12 = 1
2 | 6 - 6 = 0
2 | 3 - 2 = 1
2 | 1 - 0 = 1
0

Second step, finding the exponent by adding 1023 to the exponent of our binary.
4 + 1023 = 1027
Convert $(1027)_{10} = (10000000011)_2$

Final step, Because of the IEEE-754 double precision, we need a mantissa of 52 bits.
1010101 add 0 for 45 times =
1010101000000000000000000000000000000000000000000000

We will get answer is:
Sign = 0
Exponent = 10000000011
Mantissa = 1010101000000000000000000000000000000000000000000000

IEEE-754 double precision:

0	10000000011	1010101000000000000000000000000000000000000000000000
Sign [1]	Exponent [11]	Mantissa [52]

3. Suppose a computer uses 4-bit one's complement representation. Ignoring overflows, what value will be stored in the variable j after the following pseudocode routine terminates?

-2 → j // Store -2 in j.
6 → k // Store 6 in k.
while k ≠ -6
j = j-1
k = k+1
end while

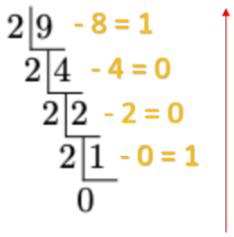
First step, One complement:
6 = 0110 =====> -6 = 1001

Second step, start the loop:
Start from > 0110 + 1
1st run: 0110 + 1 = 0111
2nd run: 0111 + 1 = 1000
3rd run: 1000 + 1 = 1001

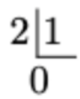
Final step, We need to add 3 times. In the while loop, it will run 3 times:
j = j + [(-1) 3 times]
j = -2 + (-3)
j = -5

4. Convert 9.5 and 1.25 to unsigned binary, then compute the multiplication of the two values. Answer in 14-bit floating point model with bias-16 exponent.

First step, Convert 9.5 to unsigned binary:
$(9)_{10} = (1001)_2$
$(0.5)_{10} = (0.1)_2$
$(9 + 0.5)_{10} = (1001)_2 + (0.1)_2$
$= (1001.1)_2 * 2^0$
$= (1.0011)_2 * 2^3$

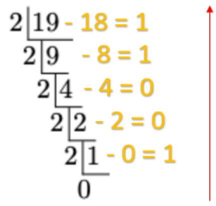


Second step, Convert 1.25 to unsigned binary:
$(1)_{10} = (0001)_2$
$(0.25)_{10} = (0.01)_2$
$(1 + 0.25)_{10} = (0001)_2 + (0.01)_2$
$= (0001.01)_2 * 2^0$



Third step, Multiply the binary numbers:
$(1.0011 * 2^3) * (0001.01 * 2^0) = (1.0011 * 1.01 * 2^{(3+0)})$
$= (1.011111 * 2^3)$

Fourth step, Biassed exponent for 3:
16 + 3 = 19
$(19)_{10} = (10011)_2$



We will get answer is:
Sign = 0
Exponent = 10011
Mantissa = 01111100

IEEE-754 double precision:

0	10011	01111100
Sign [1]	Exponent [5]	Mantissa [8]

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