HW3 Yuzhong

problems:

1. $91_{10} + C6_{16}$

$= (1\times2^6+0\times2^5+1\times2^4+1\times2^3+0\times2^2+1\times2^1+1\times2^0) + 11000110_2$

$= 1011011_2 + 11000110_2$

$= 001011011_2 + 011000110_2$ (make the operand same number of bits)

$= 100100001_2 = 1\times2^8+1\times2^5+1\times2^0 = 256_{10}+32_{10}+1_{10} = \boxed{289_{10}}$

2. $11_8 - 11_{10}$

First, I will transform them into signed int.

$= 1001_2 + (-(1\times2^3+0\times2^2+1\times2^1+1\times2^0))$

$= 1001_2 + (-1011_2)$

Transform by performing 2's compliment, when $n=4$

$= 01001_2 + 10101_2$

$= 11110_2 = -00010_2 = -1\times2^1 = \boxed{-2_{10}}$

3. $12.3125_{10} + 0110_{I2Q2}$

(Since they are both positive, I will convert "I" to "U")

$= (1\times2^3+1\times2^2+0\times2^1+0\times2^0+0\times2^{-1}+1\times2^{-2}+0\times2^{-3}+1\times2^{-4}) + 110_{U1Q2}$

$= 11000101_{U4Q4} + 110_{U1Q2}$

performing "0" extension to make the two operands the same format

$= 11000101_{U4Q4} + 00011000_{U4Q4}$

$= 11011101_{U4Q4}$

$= (1\times2^3+1\times2^2+1\times2^0+1\times2^{-1}+1\times2^{-2}+1\times2^{-4})_{10}$

$= \boxed{13.8125_{10}}$

4. $5.75_{10} - 7.125_{10}$

Convert to binary

$= (1\times2^2+0\times2^1+1\times2^0+1\times2^{-1}+1\times2^{-2})_{10} - (1\times2^2+1\times2^1+1\times2^0+0\times2^{-1}+0\times2^{-2}+1\times2^{-3})_{10}$

$= 10111_{U3Q2} - 111001_{U3Q3}$

Convert them to "I" and same format

$= 0101110\ _{I4Q3} + (-0111001_{I4Q3})$

$= 0101110_{I4Q3} + 1000111_{I4Q3}$

$= 1110101_{I4Q3} = -0001011_{I4Q3} = -(1\times2^0 + 1\times2^{-2}+1\times2^{-3})_{10} = \boxed{-1.375_{10}}$

5. $9_{10} \times 3_{10}$

$= (1\times2^3+0\times2^2+0\times2^1+1\times2^0)_{10} \times (1\times2^1+1\times2^0)_{10}$

$= 1001_2 \times 11_2$

Convert to same format using "0" extension

$= 1001_2 \times 0011_2$

$$
\begin{array}{r}
1001 \\
= \times 0011 \\
\hline
1001 \\
1001 \\
0 \\
0 \\
\hline
\end{array}
$$

$= 11011_2 = (1\times2^4+1\times2^3+1\times2^1+1\times2^0)_{10} = (16+8+2+1)_{10} = \boxed{27_{10}}$

6. $(-5)_{10} \cdot (-6)_{10}$

$= (-(1\times2^2+0\times2^1+1\times2^0)_{10}) \cdot (-(1\times2^2+1\times2^1+0\times2^0))$

$= (-101_2) \cdot (-110_2)$

get rid of the negative sign

$= (101_2 \cdot 110_2)$

$$
\begin{array}{r}
101 \\
\times\, 110 \\
\hline
000 \\
101 \\
101 \\
\hline
\end{array}
$$

$= 11110_2 = (1\times2^4+1\times2^3+1\times2^2+1\times2^1)_{10} = (16+8+4+2)_{10} = \boxed{30_{10}}$

7. $9.5_{10} \cdot 2.625_{10}$

$= (1\times2^3+0\times2^2+0\times2^1+1\times2^0+1\times2^{-1})_{10} \cdot (1\times2^1+0\times2^0+1\times2^{-1}+0\times2^{-2}+1\times2^{-3})_{10}$

$= 10011_{U4Q1} \cdot 10101_{U2Q3}$

Change both to $U4Q3$

$= 1001100_{U4Q3} \cdot 0010101_{U4Q3} =$

$$
\begin{array}{r}
1001.100 \\
\times\, 0010.101 \\
\hline
1001100 \\
10011000 \\
100110000 \\
\hline
\end{array}
$$

$11000111100\ U_5Q_6 = 110001111\ U_5Q_4 = (1\times2^4+1\times2^3+1\times2^{-1}+1\times2^{-2}+1\times2^{-3}+1\times2^{-4})_{10}$

$= (16+8+0.5+0.25+0.125+0.0625)_{10}$

$= \boxed{24.9375_{10}}$

8. $(-1.25)_{10} \cdot 3.5_{10}$

$= (-(1\times2^0+0\times2^{-1}+1\times2^{-2})_{10}) \cdot (1\times2^1+1\times2^0+1\times2^{-1})_{10}$

$= (-101_{U1Q2}) \cdot 111_{U2Q1}$

Convert them to I3Q2

$= (-00101_{I3Q2}) \cdot 01110_{I3Q2}$

$= 11011_{I3Q2} \cdot 01110_{I3Q2}$

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     110.11
   × 011.10
-----------
0000000000
 111110110
 111101100
 111011000
 000000000
-----------
```

$= 0110111010_{I5Q4} = -001000110_{I5Q4} = -100.011_{U3Q3} = -(1\times2^2+1\times2^{-2}+1\times2^{-3})_{10}$

$= -(4+0.25+0.125)_{10}$

$= \boxed{-4.375_{10}}$

Challenge

1. $-5.6875_{10} = -(1\times2^2+0\times2^1+1\times2^0+1\times2^{-1}+0\times2^{-2}+1\times2^{-3}+1\times2^{-4})_{10}$

$= -101.1011_{U3Q4} = -1.011011_2 \times 2^2$

In the single-precission floating point format, the sign will be recorded as a sign bit. and exponent is biased by 127, so it is 129, and the mantissa is 011011

So the binary representation is : $\boxed{1|10000001|01101100000000000000000}$

And in Hexadecimal is $\boxed{0xC0B60000}$

2. $0x2E4B68DF = 0|01011100|00101101101000110111111_2$

So the sign is "+", Exponent is $2^{(01011100_2 - 127_{10})} = 2^{(1\times2^6+1\times2^4+1\times2^3+1\times2^2-127)}$

$= 2^{-35}$

And mantissa is $1.10010110110100011011111$

Get them together I get $\approx 4.625 \times 10^{-11}$