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HW3

1. $91_{10} = \underset{6}{64} + \underset{4}{16} + \underset{3}{8} + \underset{1}{2} + \underset{0}{1} = 1011\,011\,1_2$

$C6_{16} \Rightarrow$ Convert C, 6 to 4 bit binary $= 1100\,0110_2$

$$\begin{array}{r} 1011011_2 \\ +\ 11000110_2 \\ \hline 100100001 \end{array} = 2^8 + 2^5 + 2^0 = 256 + 32 + 1 = \boxed{289_{10}}$$

2. $11_8 \Rightarrow$ Convert 1, 1 to 3 bit binary $= 001001_2 \Rightarrow A$
$= 1001_2$

$11_{10} = 2^3 + 2^1 + 2^0 = 1011_2 \Rightarrow B$

$A - B = A + \bar{B} + 1 = 1001_2 + 0100_2 + 1_2 = 1110_2$

1110_2 — 2's complement $= 0001 + 1 = 0010$
leftmost is 1 so negative $= \boxed{-2_{10}}$

3. $12.3125_{10} = 2^3 + 2^2 + 2^{-2} + 2^{-4} = 1100\ 0101_2$ I4Q4

$0110_{I2Q2} = 0001\ 1000$ I4Q4

Adding both
$$\begin{array}{r} 1100\ 0101 \\ +\ 0001\ 1000 \\ \hline 1101\ 1101_{I4Q4} \end{array}$$
$2^3 + 2^2 + 2^0 + 2^{-1} + 2^{-2} + 2^{-4}$

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

4. $5.75_{10} = 2^2 + 2^0 + 2^{-1} + 2^{-2} = 101\ 110$ I3Q3

$7.125_{10} = 2^2 + 2^1 + 2^0 + 2^{-3} = 111\ 001$ I3Q3

$$
\begin{array}{rr}
 & A - B \\
 & 101\ 110 \\
- & 111\ 001
\end{array}
\Rightarrow
\begin{array}{rr}
 & A + \overline{B} + 1 \\
 & 101\ 110 \\
+ & 000\ 110 \\
+ & 1 \\
\hline
 & 110\ 101_2
\end{array}
$$

↑ Negative number

Converting to decimal ie find the two's complement then

$110101_2 = -001\ 011_2 = -(2^0 + 2^{-2} + 2^{-3})_{10}$

$= -(1 + 0.25 + 0.125)_{10}$

$= \boxed{-1.375_{10}}$

5. $9_{10} = 2^3 + 2^0 = 1001_2$

$3_{10} = 2^1 + 2^0 = 11_2$

Using I4Q0

$$
\begin{array}{rl}
 & 1001. \quad I4Q0 \\
* & 0011 \quad I4Q0 \\
\hline
 & 1001 \\
 & 10010 \\
+ & 0 \\
+ & 0 \\
\hline
 & 11011 \quad I8Q0
\end{array}
$$

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

6. $(-5)_{10} = -(2^2 + 2^0)_{10} = -(0101)_2 = 1011_2 = 1111011_2$

Adding extra sign bits
sign extend

$(-6)_{10} = -(0110)_2 = 1010_2 = 1111010_2$

$$
\begin{array}{r}
1111011 \\
1111010 \\
\hline
0 \\
11110110 \\
00 \\
1111011000 \\
10110 \\
0110
\end{array}
$$

$\ldots 011110_2$

$011110_2 = 2^4 + 2^3 + 2^2 + 2^1 = 16 + 8 + 4 + 2$

$= \boxed{30_{10}}$

7. $9.5_{10} = 2^3 + 2^0 + 2^{-1} = 1001.100$ I4Q3

$2.625_{10} = 2^1 + 2^{-1} + 2^{-3} = 0010.101$ I4Q3

```
        1001.100
      * 0010.101
   1   1001 100
              0
       1001100
            0
     1001100
          0
  011000.111100   I8Q6
```

$= 2^4 + 2^3 + 2^{-1} + 2^{-2} + 2^{-3} + 2^{-4}$

$= 24 + 0.875 + 0.0625$

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

8. $-1.25_{10} = -(2^0 + 2^{-2})_{10} = -(001.01) = \underset{\text{2's complement}}{110.11_2}$ I3Q2

$3.5_{10} = (2^1 + 2^0 + 2^{-1})_{10} = 011.10_2$ I3Q2

```
      00011 10     I3Q2
   1111110.11      I3Q2
10 10 10 10 1 1 1 1
       00 1110
       01 110
          0
     01110
    01110
   01110
  110
  110
  10
```

Negative

111011.1010_2 I6Q4

↓ 2's complement

$-(100.0110)_2 = -(2^2 + 2^{-2} + 2^{-3})$

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