Information as Bits Worksheet.

a) 0 0 1 1 0 1 0 1
128 64 32 16 8 4 2 1
32 + 16 + 4 + 1
48 + 5
$$\boxed{53}$$

b) 1 0 0 1 0 1 1 0
128 + 16 + 4 + 2
128 + 16 + 6
128 + 22
$$\boxed{150}$$

c) 1 1 0 0 1 1 0 0
128 + 64 + 8 + 4
128 + 64 + 12
128 + 76
$$\boxed{204}$$

3) a)   1 0 1 0 1 1 1 1
       + 1 1 0 1 1 0 1 1
       1 1 0 0 0 1 0 1 0
       ↑ overflow

b)   1 0 0 1 0 1 1 1
    + 1 1 1 1 1 1 1 1
    1 1 0 0 1 0 1 1 0
    ↑ overflow

c)   0 1 1 1 0 1 0 1
    + 1 0 1 0 1 1 0 0
    1 0 0 1 0 0 1 0 1
    ↑ overflow

0 0 0 0 1 1 0 1
0 0 0 0 0 1 1 1
─────────────
     20

0 0 0 0 1 1 0 1
− 0 0 0 0 0 1 1 1
─────────────
     0 0

4)
$$0000\ \overset{0\ 2}{\cancel{1}\cancel{1}\cancel{0}}\ 101$$
$$-\ 0000\ 0111$$
$$\boxed{\ 110\ }$$

1) Most significant bit is the leftmost bit.

Ex $[\cancel{1}]1001101$
   $\longleftarrow$ MSB

5) a) Word - 16 bits
   DW - 32 bits
   QW - 64 bits
   DQW - 128 bits

(b) a) 4095 $\rightarrow$ $\cancel{4095}$ $\frac{2047\ R5}{2\sqrt{4095}}$ ... $\frac{1023\ R5}{2\sqrt{2047}}$ ... $\frac{511\ R5}{2\sqrt{1023}}$

1011011101

6) a) $4095 \rightarrow$ $2\overline{)4095}$ $\overset{2047}{}$ R1 $2\overline{)2047}$ $\overset{1023}{}$ R1

$\boxed{12 \text{ bits}}$

$2\overline{)4023}$ $\overset{511}{}$ R1 $2\overline{)511}$ $\overset{255}{}$ R1

$2\overline{)255}$ $\overset{127}{}$ R1 $2\overline{)127}$ $\overset{63}{}$ R1

b) 65534

$2\overline{)65534}$ $\overset{32767}{}$ R0 ..?

$2\overline{)63}$ $\overset{31}{}$ R1 $2\overline{)31}$ $\overset{15}{}$ R1

$2\overline{)15}$ $\overset{7}{}$ R1 $2\overline{)7}$ $\overset{3}{}$ R1 $2\overline{)3}$ $\overset{1}{}$ R

$\begin{array}{c} 04 \\ 15 \\ 14 \\ \overline{13} \\ 12 \\ \overline{14} \end{array}$

$2\overline{)32767}$ $\overset{16383}{}$ R1 $2\overline{)16383}$ $\overset{8191}{}$ R1 $2\overline{)8191}$ $\overset{4095}{}$ R$\boxed{1}$

$\begin{array}{c} 32 \\ 7 \\ 6 \\ \overline{16} \end{array}$ $\begin{array}{c} 16 \\ 5 \\ 2 \\ 18 \\ 8 \\ \overline{03} \end{array}$ $\begin{array}{c} 808 \\ 3 \, 0 \\ 19 \\ 18 \\ \overline{11} \end{array}$

$\boxed{16 \text{ bits}}$

c) 42319 per b) $2^{15} < 42319 < 2^{16}$

$\boxed{16 \text{ bits}}$

7) Bin to Hex

a) 0011 0101 1101 1010 $\boxed{35DA}$

   $\underset{3}{\downarrow}$ $\underset{5}{\downarrow}$ $\underset{13=D}{\downarrow}$ $\underset{10=A}{\downarrow}$

b) 1100 1110 1010 0011 $\boxed{CEA3}$

   $\underset{12=C}{\downarrow}$ $\underset{14=E}{\downarrow}$ $\underset{A}{\downarrow}$ $\underset{3}{\downarrow}$

7) c) 1111 1110 1101 1011 $\boxed{FEDB}$

$\quad\downarrow\quad\quad\downarrow\quad\quad\downarrow\quad\quad\downarrow$

$\quad 15=F \quad 14=E \quad 13=D \quad 11=B$

8) Hex to Bin

a) 0126F9D4 $4 \cdot 2^0 = 4 \to 0100$

   or $D = 13 \cdot 2^1 = 26$

$4 \to 0100 \quad\quad D \Rightarrow 13 \to 1101$

$9 \to 1001 \quad\quad F \to 15 \to 1111$

$6 \to 0110 \quad\quad 2 \to 0010$

$1 \to 0001 \quad\quad 0 \to 0000 ?$

$\boxed{0001\ 0010\ 0110\ 1111\ 1001\ 1101\ 0100}$

b) 6ACDFA95

$6 \quad\quad A \to 10 \quad C \to 12 \quad D \to 13$

$0110 \quad\quad 1010 \quad\quad 1100 \quad\quad 1101$

$F \to 15 \quad A \to 10 \quad 9 \quad\quad 5$

$1111 \quad\quad 1010 \quad\quad 1001 \quad 0101$

$\boxed{0110\ 1010\ 1100\ 1101\ 1111\ 1010\ 1001\ 0101}$

8)   c) $F69BDC2A$

F → 15   6 ~   9   B → 11
1111   0110   1001   1011

D → 13   C → 12   2   A → 10
1101   1100   0010   1010

| 1111 0110 1001 1011 1101 1100 0010 1010

9) Hex to dec
a) $3A \rightarrow$ 3   10
$$3 \times 16^1 + 10 \times 16^0$$
48 + 10
58

b) $1BF \rightarrow$ 1   11   15
$$1 \times 16^2 + 11 \times 16 \sim 15$$
256 + 176 + 15
447

c) $1001 \rightarrow$ 1   0   0   1
$$16^3 + 1$$
4097

(1) b) -331 ← ~~XXXXX~~

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    1  0  1 0 0 1 0 1 1    →  1010 1011
512 256 128 64 32 16 8 4 2 1            A    B
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↳ 0000 0001 0100 1011

1111 1110 1011 0100

                + 1

1111 1110 1011 0101

| F | E | B | 5 |

c) -24 → 0001 1000

0000 0000 0001 1000

1111 1111 1110 0111

              + 1

1111 1111 1110 1000

| F | F | E | 8 |

(2) a) -21 → 0001 0101

0000 0000 0001 0101

1111 1111 1110 1010

              + 1

1111 1111 1110 1011

| F | F | E | B |

12) b) $-45 \rightarrow$ 0 0 1 0 0 1 0 1
                  128 64 32 16 8 4 2 1

0000 0000 0010 0101

1111 1111 1101 1010

1111 1111 1101 1011

F   F   D   B

13) a) 6BF9 → 0110 1011 1111 1001
          6   B   F   9

$6 \times 16^3 + 11 \times 16^2 + 15 \times 16 + 9$

0110 1011 1111 1000

1001 0100 0000 0111

$6 \times 16^3 + 11 \times 16^2 + 15 \times 16 + 9$

24576 + 2816 + 240 + 9

27641

b) C123 → 1100 0001 0010 0011

$13 \times 16^3 + 16^2 + 2 \times 16 +$ $12 \times 16^3 + 16^2 + 2 \times 16$

53248 + 256 + 32 +   49 1527 256 + 32

53,539   49,443

Hex to dec

a) 4CD2

$$4 \times 16^3 + 12 \times 16^2 + 13 \times 16 + 2$$

$$16384 + 3072 + 208 + 2$$

$$\boxed{19\,666}$$

b) 8230

$$8 \times 16^3 + 2 \times 16^2 + 3 \times 16 + 0$$

$$32768 + 512 + 48$$

$$\boxed{33\,328}$$

Bin to dec

a) 10110101 →

1	0	1	1	0	1	0	1
128	64	32	16	8	4	2	1

$$128 + 32 + 16 + 4 + 1$$

$$\boxed{181}$$

b) 00101010 →

0	0	1	0	1	0	1	0
128	64	32	16	8	4	2	1

$$32 + 8 + 2$$

$$\boxed{42}$$

c) 11110000 → 128 + 64 + 32 + 16

$$\boxed{240}$$

16) Bin to dec

a) 1000 0000 → [128]

b) 1100 1100 → 128 + 64 + 8 + 4

64 + 12

128 + 76

[204]

c) 1011 0111 → 128 + 32 + 16 + 4 + 2 + 1

4 + 3

48 + 7

128 + 55

[183]

17) Dec to 8-bit Bin

a) -5   +5 = 0101 → 1010

+ 1

[0000 1011] ← [1011] ← 0101 0100

b) -42   +42 → 0 0 1 0 1 0 1 0

↳ 128 64 32 16 8 4 2 1

0010 1101 → 1101 0010

+ 1

[1101 0011]

17) c) $-16 \rightarrow$ 0 0 0 1 0 0 0 0
↳ 1 1 1 0 1 1 1 1
+ 1
[1 1 1 1 0 0 0 0]

18) Dec to 8-bit Bin

a) $-72 \rightarrow$ 0 1 0 0 1 0 0 0
↳ 128 64 32 16 8 4 2 1
0100 1000
↳ 1011 0111
+ 1
[1011 1000]

b) $-48 \rightarrow$ 0110 0000
↳ 1001 1101
+ 1
[1001 1110]

c) $-26 \rightarrow$ 0001 1010
↳ 1110 0101
+ 1
[1110 0110]

19) a) 6B4 + 3FE → 0110 1011 0100
                    + 0011 1111 1110
                    ———————————————
                      1010 1011 0010
                       A   B   2

[AB2]

b) A49 + 6BD → 1010 0100 1001
             + 0110 1011 1101
             ————————————————
             0001 0001 0000 0110
                1   1   0   6

[1106]

20) (q) 7C4 + 3BE → 0111 1100 0100
                  + 0011 1011 1110
                  ———————————————
                     1011 1000 0010
                      B   8   2

[B82]

b) ~~A49 + 6BD~~
   B69 + 7AD → 1011 0110 1001
             + 0111 1010 1101
             ————————————————
             0001 0011 0001 0110
                1   3   1   6

[1316]

20) "B" to Hex + Bin

$\boxed{Bin \to 0100\ 0010}$
  4   2

$\boxed{Hex \to 42}$

22) "G" to Hex + Bin

$\boxed{Bin \to 0100\ 0111}$
  4   7

$\boxed{Hex \to 47}$

Pt 2

1) $11.11 \to 3 + \frac{1}{2} + \frac{1}{4} \to 3\frac{2}{4} + \frac{1}{4} \to \boxed{3\frac{3}{4} \mid 3.75}$

$1.1 \to 1 + \frac{1}{2} \to \boxed{1\frac{1}{2} \mid 1.5}$

$101.001 \to 5 + \frac{1}{8} \to \boxed{5\frac{1}{8} \mid 5.125}$

$1101.0101 \to 13 + \frac{1}{4} + \frac{1}{16} \to 13 + \frac{4}{16} + \frac{1}{16} \to \boxed{13\frac{5}{16} \mid 13.3125}$

$1110.00111 \to 14 + \frac{1}{8} + \frac{1}{16} + \frac{1}{32}$
$\to 14 + \frac{4}{32} + \frac{2}{32} + \frac{1}{32} \to \boxed{14\frac{7}{32} \mid 14.21875}$

$10000.101011 \to 16 + \frac{1}{2} + \frac{1}{8} + \frac{1}{32} + \frac{1}{64}$
BD
$\to 16 + \frac{32}{64} + \frac{8}{64} + \frac{2}{64} + \frac{1}{64}$
$\to \boxed{16\frac{43}{64} \mid 16.671875}$

$111.0000011 \to 7 + \frac{1}{64} + \frac{1}{128}$
$\to 7 + \frac{2}{128} + \frac{1}{128} \to \boxed{7\frac{3}{128} \mid 7.0234375}$

11.000101
$\to 3 + \frac{1}{16} + \frac{1}{64} \to 3 + \frac{4}{64} + \frac{1}{64} \to \boxed{3\frac{5}{64} \mid 3.078125}$

2) Exp to Bin

2 → 1000 0001

5 → 5+127 = 132
    | 1000 0100 |

0 → 0+127 = 127
    | 0111 1111 |

-10 → 127-10 = 117
    | 0111 0101 |

128 → 128+127 = 255
    | 1111 1111 |

-1 → 127-1 = 126
    | 0111 1110 |

3)

1101.101 →	Normalized:	Exp:
	1.101101	3

.00101 →	Normalized:	Exp:
	1.01	-3

1.0001 →	Normalized:	Exp:
	1.0001	1

10000011.0 →	Normalized:	Exp:
	1.0000011	7

.000001001 →	Normalized:	Exp:
	1.001	-6

4) Example: S: Exp: Man:

−1.11   1   01111111   11000000......

+1101.101 → +1.101101 × 2³   127+3 = 130

| S: Exp: Man: |
| +0   1000 0010   1.101101 |

−.00101 → −1.01 × 2⁻³   127·3 = 124

| S: Exp: Man: |
| −1   01111100   1.01000.. |

+100111.0 → +1.001110 × 2⁵   127+5 = 132

| S: Exp: Man: |
| 0   1000 0100   1.001110.~ |

+.000000110101 → +1.101011 × 2⁻⁷   127 * −7 = 120

| S: Exp: Man: |
| 0   01111000   1.101011. |