

Brian Bowers

1) $FA(3)_{16} = \boxed{1111 \ 1010 \ 1100 \ 0011}$

2) 13715 3162 125250 561 1003 2006 4012 8024 16048 32097

64195 = $\boxed{64195}$

3) $\oplus 1111 \ 1010 \ 1100 \ 0011 = 0000 \ 0101 \ 0011 \ 1101$
 $= 1 \ 2 \ 5 \ 10 \ 20 \ 41 \ 83 \ 167 \ 335 \ 670 \ 1340 = \boxed{-1341}$

4) $0064_{16} = \boxed{0000 \ 0000 \ 0110 \ 0100}$

5) $0064_{16} = 6 \cdot 16^1 + 8 \cdot 16^0 = 96 + 8 = \boxed{104}$

6) $\oplus 0064 = \boxed{100}$

7) $8000 = \boxed{1000 \ 0000 \ 0000 \ 0000}$

8) $8000 = 2^{13} = \boxed{32768}$

9) $\oplus 1000 \ 0000 \ 0000 \ 0000 = 0111 \ 1111 \ 1111 \ 1111 + 1 = 1000 \ 0000 \ 0000 \ 0000 = \boxed{-32768}$

10)
$$\begin{array}{r} 2 \overline{) 8000_{16}} \ 0 \\ 2 \overline{) 4000} \ 0 \\ 2 \overline{) 2000} \ 0 \\ 2 \overline{) 1000} \ 0 \\ 2 \overline{) 500} \ 0 \\ 2 \overline{) 250} \ 0 \\ 2 \overline{) 125} \ 1 \\ 2 \overline{) 62} \ 0 \\ 2 \overline{) 31} \ 1 \\ 2 \overline{) 15} \ 1 \\ 2 \overline{) 7} \ 1 \\ 2 \overline{) 3} \ 1 \\ 2 \overline{) 1} \ 1 \end{array}$$

11) $\oplus 8000_{16} = 0001 \ 1111 \ 0100 \ 0000$
 $= \boxed{1F40_{16}}$

$8000_{16} = 11111 \ 0100 \ 0000_{16}$

$= 0001 \ 1111 \ 0100 \ 0000$

$= 1 \ F \ 4 \ 0$

$= \boxed{1F40_{16}}$

12) $\oplus 11 = 0000 \ 0000 \ 0000 \ 1011 \rightarrow 1111 \ 1111 \ 1111 \ 0100 + 1 = 1111 \ 1111 \ 1111 \ 0101 = \boxed{FFFS}$

binary	hex	dec
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	A	10
1011	B	11
1100	C	12
1101	D	13
1110	E	14
1111	F	15

13) \ominus $732717 = 0111\ 1111\ 1100\ 1101 \rightarrow 1000\ 0000\ 0011\ 0010 + 1 = 1000\ 0000\ 0011\ 0011 = \boxed{8033}$

$$\begin{array}{r} 2 \sqrt{32717} \ 1 \\ 2 \sqrt{16358} \ 0 \\ 2 \sqrt{8179} \ 1 \\ 2 \sqrt{4089} \ 1 \\ 2 \sqrt{2044} \ 0 \\ 2 \sqrt{1022} \ 0 \\ 2 \sqrt{511} \ 1 \\ 2 \sqrt{255} \ 1 \\ 2 \sqrt{127} \ 1 \\ 2 \sqrt{63} \ 1 \\ 2 \sqrt{31} \ 1 \\ 2 \sqrt{15} \ 1 \\ 2 \sqrt{7} \ 1 \\ 2 \sqrt{3} \ 1 \\ 1 \end{array}$$

14) $1011\ 1101 = \boxed{BD}$

15) $1011\ 1101\ 0000\ 0001 = 12511\ 23\ 47\ 94\ 187\ 378\ 756\ 1512\ 3024\ 6048\ 12096\ 24192$
 $= \boxed{48385}$

16) \ominus $1011\ 1101\ 0000\ 0001 = 0100\ 0010\ 1111\ 1110 + 1 = 0100\ 0010\ 1111\ 1111 = 0124\ 816\ 33\ 66$

$133\ 267\ 535\ 1071\ 2143\ 4287\ 8575\ 17151 = \boxed{-17151}$

17) smallest 20 - when we invert it $\rightarrow 1$, $1000\ 0000\ 0000\ 0000\ 0000 = 0111\ 1111\ 1111\ 1111 + 1$

$= 1000\ 0000\ 0000\ 0000\ 0000 = 2^{19} = \boxed{-524288}$

18) positive so $0 \dots = 0111\ 1111\ 1111\ 1111\ 1111 = 2^{19} - 1 = \boxed{524287}$

19) Modular \rightarrow cutoff

$$\begin{array}{r} 0011\ 0101\ 0001\ 0001 \\ + 0100\ 1111\ 1111\ 1100 \\ \hline 1000\ 0101\ 0000\ 1101 \end{array}$$

$$\begin{array}{r} 3511 \\ + 4FFC \\ \hline 850D = 850D \end{array}$$

\rightarrow overflow error
 $1000\ 0100\ 0000\ 1101$

so $0000\ 0100\ 0000\ 1101 = \boxed{050D} \Rightarrow 850D$

0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

20) $850D$

sign $\rightarrow 1000$

$0111\ 1111\ 1111\ 1111 = \boxed{7FFF} \xrightarrow{FF \rightarrow 8} 850D$

$$\begin{array}{r} 3511 \\ + 4FFC \\ \hline 850D \end{array}$$

$$\begin{array}{r} 21 \\ -16 \\ \hline 5 \end{array}$$

① 0011
 ② 0100
 ③ 1000

$\boxed{N_0}$

22) $\boxed{\text{Yes}}$

B-level problems

$$\begin{array}{r} 2) \quad '6159 \quad 21 \\ + F702 \quad -16 \\ \hline \quad \quad \quad 5 \\ \times 585B \end{array}$$

585B

3) **FFFF**

4) **Yes**

5) $\begin{array}{r} 00110 \\ + 11111 \end{array}$ **No**

$$\begin{array}{r} 6) \quad 'EEEE \quad 14 \\ + C00C \quad +12 \\ \hline \quad \quad \quad 26 \\ -16 = 10 \\ \hline \quad \quad \quad 10 \\ \text{AEFA} \end{array}$$

AEFA

$$\begin{array}{r} 14 \\ +12 \\ \hline 26 \\ -16 \\ \hline 10 \end{array}$$

7) **FFFF**

$$\begin{array}{r} 8) \quad 'EEE \quad 14 \\ + ABOC \quad +12 \\ \hline \quad \quad \quad 26 \\ -16 \\ \hline \quad \quad \quad 10 \\ \hline \quad \quad \quad 10 \\ \text{4A0A} \end{array}$$

$$\begin{array}{r} 14 \\ +12 \\ \hline 26 \\ -16 \\ \hline 10 \end{array}$$

Yes

$$9) \quad \begin{array}{r} 01001 \\ + 01010 \\ \hline 01011 \end{array}$$
 Yes

0000	0	G
0001	1	
0010	2	
0011	3	
0100	4	
0101	5	
0110	6	
0111	7	
1000	8	
1001	9	
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

$$10) \quad B00F = 1011 \ 0000 \ 0000 \ 1111 \rightarrow 0101 \ 1111 \ 1111 \ 0001 = \text{4FFF}$$

$$11) \quad 2232 = 0010 \ 0010 \ 0011 \ 0010 \rightarrow 1101 \ 1101 \ 1100 \ 1101 = \text{DDC}$$

$$12) \quad 8000 = 1000 \ 0001 \ 0001 \ 0000 \rightarrow 0111 \ 1111 \ 1111 \ 1111 = \text{7FFF}$$

$$+1 = 1000 \ 0000 \ 0000 \ 0001 = 8000$$

$$13) \quad FFF329BA = \text{111DEF56}$$

$$\begin{array}{r} 1111 \ 1111 \ 1111 \ 0011 \ 0010 \ 1001 \ 1011 \ 1010 \\ 0000 \ 0000 \ 0000 \ 1100 \ 1101 \ 0110 \ 0101 \ 0101 \\ \hline 1111 \ 1111 \ 1111 \ 1111 \\ \hline 0000 \ 0101 \ 0101 \ 0101 \\ \hline 0110 \end{array} = 000C0646$$

$$14) \quad \begin{array}{l} s \quad e \quad f \\ 16\text{bit} \quad 8\text{bits} \quad 23\text{bits} \end{array}$$

$$96.03125$$

$$\begin{array}{r|l} .03125 \times 2 & .06250 \\ .06250 \times 2 & .125 \\ .125 \times 2 & .25 \\ .25 \times 2 & .5 \\ .5 \times 2 & 1.0 \end{array}$$

$$\begin{array}{r} 2 \sqrt{96} \ 0 \\ 2 \sqrt{48} \ 0 \\ 2 \sqrt{24} \ 0 \\ 2 \sqrt{12} \ 0 \\ \sqrt{6} \ 0 \\ 2 \sqrt{3} \ 1 \\ 1 \end{array}$$

$$96 = 1100000$$

$$.03125 = 00001$$

$$96.03125 = 1100000.00001 = 1.10000000001 \cdot 2^6$$

$$\Rightarrow 0100 \ 0010 \ 1100 \ 0000 \ 0001 \ 0000 \ 0000 \ 0000 \Rightarrow \text{42C01000}$$

$$\begin{array}{r} 6 \Rightarrow 1111 \ 11 \\ 0000 \ 0110 \\ + 0111 \ 1111 \\ \hline 1000 \ 0101 \\ \hline \uparrow \text{exponent} + 127 \end{array}$$

$$15) -16777216 = 1000\ 0000\ 0000\ 0000\ 0000\ 0000\ 1 \times 2^{24}$$

$$\Rightarrow 11001011000\ 000\ \dots$$

CB800000

$$16) 4370\ 0000 = 0100\ 0011\ 0111\ 0000\ 0000\ 0000\ 0000\ 0000$$

$$+ 1.1111 \times 2^7$$

$$11110000 = 137\ 15360\ 120\ 240 = \boxed{240}$$

$$17) 00FF\ 0000 = 0100\ 0000\ 1111\ 1111\ 0000\ 0000\ 0000\ 0000$$

$$-1.111111 \times 10^2$$

$$-111.1111 = \boxed{-7.96875}$$

$$\frac{129}{-127} = \frac{129}{2}$$

$$\frac{31}{32} = .96875$$

A-level problems

2) Exponent value of 11111111 is for NaN while 11111110 is 127

$$01111110 \rightarrow 28 = \boxed{7FFFFFFF}$$

$$3) 11111110 \rightarrow 28 = \boxed{FF7FFFFFFF}$$

4) Greatest $\neq 0 = 10000000\dots1 = \boxed{80000001}$
exponent $0 - 127$

$$5) 00000000\dots1 = \boxed{00000001}$$

6) $\ominus -5.125 \times 2^{a_0} = 101.001 \times 2^{a_0}$
 1.01001×2^{a_2}
 $\frac{117}{219}$
11011011 0100100...

$$\begin{array}{r|l} .125 \times 2 & 0.25 \\ .25 \times 2 & .5 \\ .5 \times 2 & 1 \end{array} \quad \begin{array}{l} 0 \\ 0 \\ 1 \end{array}$$

$$exp = 11011011$$

$$\begin{array}{r} 1 \\ 24 \\ +127 \\ \hline 151 \\ 2 \sqrt{151} \ 1 \\ 2 \sqrt{75} \ 1 \\ 2 \sqrt{37} \ 1 \\ \sqrt{18} \ 0 \\ \sqrt{9} \ 1 \\ \sqrt{4} \ 0 \\ 2 \ 0 \\ 1 \end{array}$$

$$\overline{E \ D \ A \ 4 \ 0000} = \boxed{E0A40000}$$

$$7) 1 \times 2^{-138}$$

$$\begin{array}{r} -138 \\ +127 \\ \hline -11 \end{array}$$

$$= 2^{-12} \text{ (written all zeros because } 2^{-138} \text{ too big)}$$

$$= .0000000000001 \text{ mantissa}$$

$$\text{exponent} = 00000000$$

$$= 2^{-126}$$

⊕

$$0 \ 00000000 \ 00000000 \ 000010 \dots = \boxed{00000800}$$

$$8) 1.5 \times 2^{-143}$$

$$\begin{array}{r} -143 \\ +127 \\ \hline -16 \end{array}$$

$$1.1 \times 2^{-145}$$

$$1.1 \times 2^{-17} \times 2^{-126}$$

$$.0000000000000000000000011$$

sign

$$\text{exponent } 2^{-126}$$

$$\begin{array}{ccccccc} 0 & 00000000 & 00000000 & 00000000 & 00000000 & 00000000 & 00000000 \\ \hline & 0 & 0 & 0 & 0 & 0 & 0 \end{array} \quad \begin{array}{c} 13 \\ 16 \times \dots 11 \\ 4 \quad 8 \quad 1 \end{array} \quad \begin{array}{c} 0110 \\ 2 \end{array} = \boxed{00000060}$$