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1. U2B , w = 8

a) 157_{10} / 2 = 78 R 1
78 / 2 = 39 R 0
39 / 2 = 19 R 1
19 / 2 = 9 R 1
9 / 2 = 4 R 1
4 / 2 = 2 R 0
2 / 2 = 1 R 0
1 / 2 = 0 R 1

$= 10011101_2$
$= 0x9D$

b) 248_{10} / 2 = 124 R 0
124 / 2 = 62 R 0
62 / 2 = 31 R 0
31 / 2 = 15 R 1
15 / 2 = 7 R 1
7 / 2 = 3 R 1
3 / 2 = 1 R 1
1 / 2 = 0 R 1

$= 11111000_2$
0x F8

Signed → two's complement.

a) 123_{10} step 1 123 to binary

123/2 = 61 R 1
61/2 = 30 R 1
30/2 = 15 R 0
15/2 = 7 R 1
7/2 = 3 R 1
3/2 = 1 R 1
1/2 = 0 R 1

this number is positive
01111011 = Answer
0x 7B

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b) -74_{10} /2 = 37 R0 → sign 11001010

37 /2 = 18 R1

18 /2 = 9 R0

9 /2 = 4 R1

4 /2 = 2 R0

2 /2 = 1 R0

1 /2 = 0 R1

1's comp = 10110101

2's comp +1

[10110110]

=0xB6

b20 ; U -> S, 2's complement

a) 11101001_2 $1\times2^7 + 1\times2^6 + 1\times2^5 + 1\times2^3 + 1\times2^0 = 233$ unsigned

Signed 1's comp = 10010110 2's comp = 10010111

[= -(23)]

b) 10010110_2 $1\times2^7 + 1\times2^4 + 1\times2^2 + 1\times2^1 = 150$ unsigned

Signed: 1's comp = 11101001, 2' comp: 11101010

$-(1\times2^1 + 1\times2^3 + 1\times2^5 + 1\times2^6) = [-106]$

unsigned to signed no binary

$247_{10} - 256 = [-9]_{10}$

signed to unsigned

$-112_{10} + 256 = [144_{10}]$

unsigned w = 8 0 - 255 signed w = 8 -127 -128

2.

a) convert to unsigned binary and perform addition.

i) $74_{10} + 63_{10}$

63_{10} + 74_{10} = 137_{10} true sum

carry in: 100111111

01001010 + 10001001 = 137 Actual sum

carry out

True = Actual? yes!

63/2 =	31	- 1	74/2 =	37	- 0
31/2 =	15	- 1	37/2 =	18	- 1
15/2 =	7	- 1	18/2 =	9	- 0
7/2 =	3	- 1	9/2 =	4	- 1
3/2 =	1	- 1	4/2 =	2	- 0
1/2 =	0	- 1	2/2 =	1	- 0
			1/2 =	0	- 1

ii) $123_{10} + 157_{10}$

123 + 157 = 280 true sum

carry in: 01111011

01111011 + 10011101 = 24 actual sum

carry out

True = Actual? NO! overflow.

123 = 01111011 (calculated previously)

157/2 =	78	- 1
78/2 =	39	- 0
39/2 =	19	- 1
19/2 =	9	- 1
9/2 =	4	- 1
4/2 =	2	- 0
2/2 =	1	- 0
1/2 =	0	- 1

10011101

256

b) signed to 2' comp, then perform addition w = 8

i) $28_{10} + -74_{10}$

28
+ -74
-46 true sum

128

carry in

	1	1	1	0	0	1	0	0
+	1	1	0	0	1	0	1	0
1	1	0	1	0	1	1	0	= -46 Actual sum

carry out

True = Actual? yes!

28/2 = 14 - 0
14/2 = 7 - 0
7/2 = 3 - 1
3/2 = 1 - 1
1/2 = 0 - 1

= 0011100

1's comp: 1 1100011
2's: 11100100

-74/2 = 37 - 0
37/2 = 18 - 1
18/2 = 9 - 0
9/2 = 4 - 1
4/2 = 2 - 0
2/2 = 1 - 0
1/2 = 0 - 1

= 1001010
2's: 1001110

ii) -117 + 126 true sum = actual sum

117/2 = 58 1
58/2 = 29 0
29/2 = 14 1
14/2 = 7 0
7/2 = 3 1
3/2 = 1 1
1/2 = 0 1

126
+ -117
9 true sum

carry in

	0	1	1	1	1	1	1	0
+	1	0	0	0	1	0	1	1
1	0	0	0	0	1	0	0	1 = 9

carry out

126/2 = 63 0
63/2 = 31 1
31/2 = 15 1
15/2 = 7 1
7/2 = 3 1
3/2 = 1 1
1/2 = 0 1 = 0111110

-117 1's: 10001010
2's: 10001011

iii) 74 + 63

74
+ 63
137 true

	1	0	1	1	0	1	1	0
+	1	1	0	0	0	0	0	1
1	0	1	1	1	0	1	1	1

= 119 Actual

True = Actual
NO!
res overflow.

74/2 = 37 0
37/2 = 18 1
18/2 = 9 0
9/2 = 4 1
4/2 = 2 0
2/2 = 1 0
1/2 = 0 1

= 01001010
1's: 10110101
2's: 10110110

63/2 = 31 1
31/2 = 15 1
15/2 = 7 1
7/2 = 3 1
3/2 = 1 1
1/2 = 0 1

= 00111111
1's: 11000000
2's: 11000001

iv) -119 + -105

-119:
+ -105
-224 true

carry in

	1	1	1	1	0	1	1	1
+	1	1	1	1	0	1	0	0	1
1	1	1	1	0	0	0	0	0

= -96

true = actual
NO!
res overflow.

carry out

119/2 = 59 1
59/2 = 29 1
29/2 = 14 1
14/2 = 7 0
7/2 = 3 1
3/2 = 1 1
1/2 = 0 1
= 1110111

105/2 = 52 1
52/2 = 26 0
26/2 = 13 0
13/2 = 6 1
6/2 = 3 0
3/2 = 1 1
1/2 = 0 1
= 11101001