# Worksheet 3 Binary arithmetic

**Task 1**

Carry out the following binary sums showing your working out:

1. 1012 + 1112

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| Carry row: |  |  |  |  |
|  |  | 1 | 0 | 1 |
|  |  | 1 | 1 | 1 |
| **Total** |  |  |  |  |

1. 101102 + 101112

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|  |  |  |  |  |  |
|  | 1 | 0 | 1 | 1 | 0 |
|  | 1 | 0 | 1 | 1 | 1 |
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1. 112 + 1000012 +1012

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|  |  |  |  | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 |
|  |  |  | 1 | 0 | 1 |
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1. 101012 + 1110112 + 10012

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Show how the following values can be stored as binary bytes within a computer system and determine the answer that would be calculated and stored:

1. 1210 + 1310

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| **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |
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1. 17410 + 25510

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1. 1910 + 6610 + 7410

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Answer the following question:

1. A computer has been designed to work only in single bytes of data. Describe the problem that will be encountered when carrying out the sum 011110012 + 111110012 if the answer is only allocated one byte of storage.

# Task 2 Binary multiplication

Carry out the following binary multiplications showing your working out:

1. 10112 x 102

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| --- | --- | --- | --- | --- | --- |
|  |  | 1 | 0 | 1 | 1 |
|  |  |  |  | 1 | 0 |
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1. 111002 x 1012

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|  |  |  | 1 | 1 | 1 | 0 | 0 |
|  |  |  |  |  | 1 | 0 | 1 |
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1. 1100112 x 11102

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|  |  |  |  | 1 | 1 | 0 | 0 | 1 | 1 |
|  |  |  |  |  |  | 1 | 1 | 1 | 0 |
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1. 101012 x 1000112

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1. 10101112 x 1011112

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1. 1110102 x 1010012

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For each of the previous questions, convert the values into decimal and check they are correct.

# Task 3 Binary subtraction

Convert these decimal values into two’s complement binary bytes:

1. -5010
2. -12010
3. 12710
4. -12810
5. Show that -5010 gives the same result as in (a) above using the following alternative method:

Assume the left-most bit represents -128. Start at -128 and then add the remaining values:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| -128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|  |  |  |  |  |  |  |  |

Carry out the following calculations in two’s complement binary bytes:

1. -5010 -3010 *or* -5010 + -3010

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| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
|  |  |  |  |  |  |  |  |

1. -6610  + 3410

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1. -8810 - 1210

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1. 2210 - -1410

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# Task 4 Fixed point binary

Convert these decimal values into a fixed-point binary byte where the first 4 bits represent the whole number part and the the last 4 bits represent the fractional part:

1. 8.510
2. 14.2510
3. 0.12510
4. 5.562510
5. 1.937510
6. 0.062510

Convert these fixed-point binary bytes to decimal where the first 3 bits represent the whole number part and the the last 5 bits represent the fractional part:

1. 101010102
2. 101110112
3. 001110112
4. 111110002
5. 000111112
6. 111111112