# Homework 3 Binary arithmetic Answers

1. Computers store data as bytes.
   1. How many bits make up a byte: [1]

* 8 bits
  1. Add the following unsigned 8-bit binary integers: Show your working. [2]

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

* 1. Explain the problem that has resulted from the calculation above using 8 bits. [1]

**1 mark** for:

* Result requires a ninth bit so an overflow error occurs since the computer cannot represent the result in one byte

1. Calculate the largest integer value that can be stored in three combined unsigned binary bytes: Show your working. [2]

**1 mark** for each point:

* Largest value is 2n – 1 so for 24 bits is 224 -1
* Answer is 16,777,215

1. Two’s complement can be used to perform subtraction. Calculate 12410 – 10110 using 8-bit two’s complement binary (marks awarded for showing working out): [4]

**1 mark** for each point:

* 124 represented as 01111100
* -101 represented as 10011011
* Numbers added to give 00010111
* Carries correctly marked as below (top row)

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

1. Multiply the following unsigned binary values: 111012 x 1102. [3]

**1 mark** for each point:

* 00000 added to 111010 added to 1110100 showing the shifts
* Numbers added to give 10101110
* Carries correctly marked as below (top row)

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

1. Using one byte to hold each number, with an imaginary binary point after the fourth digit, convert the following decimal numbers into binary: [3]
   1. (i) 4.75

(ii) 3.1875

(iii) 11.6875

(i) 01001100

(ii) 00110011

(iii) 10111011

* 1. Convert the following binary numbers to decimal, assuming three bits after the binary point: [2]

(i) 10001011

(ii) 00101101

(i) 17.375

(ii) 5.625

* 1. What are the largest and smallest positive numbers that can be stored in one byte assuming three bits after the point? [2]

Largest: 11111111 = 31.875

Smallest: 00000001 = 0.125

[Total 20 marks]