2 Extra practice for Block 1

This section offers extra practice relating to activities in Sections 9, 14 and 15 of Block 1. There are answers to every part of every question at the end of this booklet. Where a part of a question has an asterisk (*) alongside, full working is shown with some explanation. This is more detailed than your personal working needs to be in some types of calculation. Where this is the case, one part of the question has a dagger (†) alongside and its answer will be laid out in the way I suggest you lay yours out.

Don't feel you need to try all parts of all of the questions; just do as many as you need to gain confidence in the manipulation you are practising, both as you study Block 1 and when you come to revise for the exam.

2.1 Converting unsigned binary integers to denary

These questions relate to Section 9.1.2 of Block 1, and to Activities 20 and 21.

Question 1

Convert each of these to denary:

* (a) 0010

(b) 0100

* (c) 1010

† (d) 1011

* (e) 1111

Question 2

Convert each of these to denary:

(a) 0000 1101

* (b) 1000 1100

* (c) 1101 0001

† (d) 0011 1101

* (e) 1100 1001

2.2 Converting unsigned denary integers to binary

This question relates to Section 9.1.3 of Block 1 and to Activity 23.

Question 3

Convert each of these to 8-bit binary:

* (a) 25

* (b) 139

† (c) 41

* (d) 200

(e) 157

(f) 226

(g) 102

(h) 91

(i) 251

(j) 120

2.3 Converting signed binary integers to denary

This question relates to Section 9.3 of Block 1 and to part (a) of Activity 29.

Question 4

Convert each of these 2's complement binary numbers to denary:

* (a) 1010 1100
* (b) 1100 0101

(c) 1000 0000

† (d) 1011 1000

(e) 1100 0001

(f) 1011 1001

(g) 1101 0111

* (h) 0101 1001

(i) 0001 1111

(j) 1111 1111

2.4 Converting signed denary integers to binary

This question relates to Section 9.3 of Block 1 and to part (b) of Activity 29.

Question 5

Convert each of these negative denary numbers to 2's complement binary:

* (a) –23
* (b) –120

† (c) –57

(d) –31

(e) –100

* (f) –5

(g) –115

(h) –75

(i) –12

(j) –90

Answers to questions

Question 1

In each of parts (a) to (e) you need to write the given binary number into four columns, headed as follows:

2^3	2^2	2^1	2^0
(8)	(4)	(2)	(1)

Then you can work out its value.

(a) 0010 is to be converted.

2^3	2^2	2^1	2^0
(8)	(4)	(2)	(1)
0	0	1	0

Here there are no 8s, 4s or 1s. But there is one 2. So the denary equivalent of 0010 is 2.

(b) The denary equivalent of 0100 is 4.

(c) 1010 is to be converted.

2^3	2^2	2^1	2^0
(8)	(4)	(2)	(1)
1	0	1	0

Here there are no 4s or 1s. But there is one 8 and one 2. So the denary equivalent of 1010 is

$$(1 \times 8) + (1 \times 2) = 8 + 2$$

which is denary 10.

(d) 1011 is to be converted.

2^3	2^2	2^1	2^0
(8)	(4)	(2)	(1)
1	0	1	1

This is

$$8 + 2 + 1$$

which is denary 11.

(e) 1111 is to be converted.

2^3	2^2	2^1	2^0
(8)	(4)	(2)	(1)
1	1	1	1

Here there is one 8 and one 4 and one 2 and one 1. So the denary equivalent of 1111 is

$$(1 \times 8) + (1 \times 4) + (1 \times 2) + (1 \times 1) = 8 + 4 + 2 + 1$$

which is denary 15.

Question 2

This is very similar to Question 1, except that now you need to use eight columns, headed as follows:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)

(a) The denary equivalent of 0000 1101 is 13.

(b) 1000 1100 is to be converted.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	0	0	1	1	0	0

Here there are no 64s, 32s, 16s, 2s or 1s. But there is one 128, one 8 and one 4. So the denary equivalent of 1000 1100 is

$$(1 \times 128) + (1 \times 8) + (1 \times 4) = 128 + 8 + 4$$

which is denary 140.

(c) 1101 0001 is to be converted.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	0	1	0	0	0	1

Here there are no 32s, 8s, 4s or 2s. But there is one 128, one 64, one 16 and one 1. So the denary equivalent of 1101 0001 is

$$(1 \times 128) + (1 \times 64) + (1 \times 16) + (1 \times 1) = 128 + 64 + 16 + 1$$

which is denary 209.

(d) 0011 1101 is to be converted.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0	0	1	1	1	1	0	1

This is

$$32 + 16 + 8 + 4 + 1$$

which is 61.

(e) 1100 1001 is to be converted.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	0	0	1	0	0	1

Here there are no 32s, 16s, 4s or 2s. But there is one 128, one 64, one 8 and one 1. So the denary equivalent of 1100 1001 is

$$(1 \times 128) + (1 \times 64) + (1 \times 8) + (1 \times 1) = 128 + 64 + 8 + 1$$

which is denary 201.

Question 3

Here you need to work out where to put 1s and where to put 0s in the following eight columns:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)

in order for the binary number to be equivalent to the given denary number.

(a) The given denary number is 25.

The given number, 25, is clearly smaller than the largest weighting, 128. So a 0 goes into the '128' column (there are no 128s in 25):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0							

The given number, 25, is also smaller than 64. So a 0 goes into the ‘64’ column (there are no 64s in 25):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0	0						

The given number, 25, is also smaller than 32. So a 0 goes into the ‘32’ column (there are no 32s in 25):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0	0	0					

However, the given number, 25, is larger than 16. So a 1 goes into the ‘16’ column and 16 is subtracted from the given number. That leaves the new number 9. So far, the binary number is:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0	0	0	1				

The new number, 9, is larger than 8. So a 1 goes into the ‘8’ column and 8 is subtracted from the 9. That leaves the new number 1. So far, the binary number is:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0	0	0	1	1			

The new number is 1. Clearly, therefore, there are no 4s and no 2s and one 1. So values for the last three bits can be inserted:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0	0	0	1	1	0	0	1

The binary equivalent of 25 is therefore 0001 1001.

(b) The given denary number is 139.

The given number, 139, is larger than the largest weighting, 128. So a 1 goes into the ‘128’ column. 128 is then subtracted from 139, to leave the new number 11. So far, the binary number is:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1							

The new number, 11, is smaller than 64. So a 0 goes into the ‘64’ column (there are no 64s in 11):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0						

The new number, 11, is also smaller than 32. So a 0 goes into the ‘32’ column (there are no 32s in 11):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	0					

The new number, 11, is also smaller than 16. So a 0 goes into the ‘16’ column (there are no 16s in 11):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	0	0				

The new number, 11, is larger than 8. So a 1 goes into the ‘8’ column and 8 is subtracted from the 11. That leaves the new number 3. So far, the binary number is:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	0	0	1			

The new number, 3, is smaller than 4. So a 0 goes into the ‘4’ column (there are no 4s in 3):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	0	0	1	0		

The new number, 3, is larger than 2. So a 1 goes into the ‘2’ column and 2 is subtracted from the 3. That leaves 1. Hence a 1 also goes into the 1 column:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	0	0	1	0	1	1

The binary equivalent of 139 is therefore 1000 1011.

(c) The given denary number is 41.

41 smaller than 128: 0 goes into ‘128’ column.

41 smaller than 64: 0 goes into ‘64’ column.

41 larger than 32: 1 goes into ‘32’ column. Also, $41 - 32 = 9$.

9 smaller than 16: 0 goes into ‘16’ column.

9 larger than 8: 1 goes into ‘8’ column. Also, $9 - 8 = 1$.

1 smaller than 4: 0 goes into ‘4’ column.

1 smaller than 2: 0 goes into ‘2’ column.

1 exactly equal to 1: 1 goes into ‘1’column.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0	0	1	0	1	0	0	1

The binary equivalent of 41 is therefore 0010 1001.

(d) The given denary number is 200.

The given number, 200, is larger than the largest weighting, 128. So a 1 goes into the '128' column. 128 is then subtracted from 200, to leave the new number 72. So far, the binary number is:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1							

The new number, 72, is larger than 64. So a 1 goes into the '64' column. 64 is then subtracted from 72 to leave the new number 8. So far, the binary number is:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1						

The new number, 8, is smaller than 32. So a 0 goes into the '32' column (there are no 32s in 8):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	0					

The new number, 8, is also smaller than 16. So a 0 goes into the '16' column (there are no 16s in 8):

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	0	0				

The new number, 8, is exactly equal to 8. So a 1 goes in the '8' column and there is nothing left. All of the remaining columns after the '8' must therefore be zero, and the binary number is as follows:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	0	0	1	0	0	0

The binary equivalent of 200 is therefore 1100 1000.

(e) The binary equivalent of 157 is 1001 1101.

(f) The binary equivalent of 226 is 1110 0010.

(g) The binary equivalent of 102 is 0110 0110.

(h) The binary equivalent of 91 is 0101 1011.

(i) The binary equivalent of 251 1111 1011.

(j) The binary equivalent of 120 is 0111 1000.

Question 4

Here you need to use eight columns, headed as follows:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(−128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)

(a) 1010 1100 is to be converted.

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(−128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	1	0	1	1	0	0

Here there is a 1 in the '−128' column, so the number will turn out to be negative. It works out as –128 (from the leftmost column) plus the following:

$$(1 \times 32) + (1 \times 8) + (1 \times 4) = 32 + 8 + 4 = 44$$

The result is therefore –128 + 44 = –84. So the signed denary equivalent of the 2's complement binary number 1010 1100 is –84.

(b) 1100 0101 is to be converted.

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(−128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	0	0	0	1	0	1

Here there is again a 1 in the '−128' column, so the number will again turn out to be negative. It works out as –128 (from the leftmost column) plus the following:

$$(1 \times 64) + (1 \times 4) + (1 \times 1) = 64 + 4 + 1 = 69$$

The result is therefore –128 + 69 = –59. So the signed denary equivalent of the 2's complement binary number 1100 0101 is –59.

(c) The signed denary equivalent of 1000 0000 is –128.

(d) 1011 1000 is to be converted.

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(−128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	1	1	1	0	0	0

This is

$$-128 + 32 + 16 + 8$$

which is –72.

(e) The signed denary equivalent of 1100 0001 is –63.

(f) The signed denary equivalent of 1011 1001 is –71.

(g) The signed denary equivalent of 1101 0111 is –41.

(h) 0101 1001 is to be converted.

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
0	1	0	1	1	0	0	1

Here the leftmost column is 0. So this is a *positive* number. It works out as follows:

$(1 \times 64) + (1 \times 16) + (1 \times 8) + (1 \times 1) = 64 + 16 + 8 + 1 = 89$

So the signed denary equivalent of the 2's complement binary number 0101 1001 is 89. (Note that it is equally correct, but less conventional, to write +89.)

(i) The signed denary equivalent of 0001 1111 is 31.

(j) The signed denary equivalent of 1111 1111 is –1.

Question 5

This is rather like Question 3, in that you need to work out where to put 1s and where to put 0s in the following eight columns:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)

in order for the binary number to be equivalent to the given denary number.

All of the given denary numbers are negative, so for all of them a 1 will go into the leftmost, '–128', column.

(a) The given denary number is –23. First, 1 is put in the '–128' column:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1							

Next, –23 is expressed as

–128 + (a positive number)

The appropriate positive number is 105. So 105 must be placed into the remaining columns, in exactly the same way as positive denary numbers were converted to binary in Question 3.

The largest positive weighting is 64, and 105 is larger than 64, so a 1 is put into the '64' column. 64 is then subtracted from 105, to give the new number 41. So far, the binary number is:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1						

The new number, 41, is larger than 32, so a 1 is put into the '32' column. 32 is then subtracted from 41, to give the new number 9. So far, the binary number is:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1					

The new number, 9, is smaller than 16, so a 0 will be put in the '16' column:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1	0				

The new number, 9, is larger than 8, so a 1 will be put in the '8' column. 8 will then be subtracted from 9, to leave the new number 1. So far, the binary number is:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1	0	1			

As the new number is 1, a 0 must go into both the '4' column and the '2' column, and a 1 into the '1' column:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1	0	1	0	0	1

So the 2's complement binary equivalent of –23 is 1110 1001.

(b) The given denary number is –120. First, 1 is put in the '–128' column:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1							

Next, –120 is expressed as

–128 + (a positive number)

The appropriate positive number is 8. So 8 must be placed into the remaining columns.

The number 8 is easy to allocate to the columns; a 1 must be placed in the '8' column and a 0 in all other columns:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	0	0	1	0	0	0

So the 2's complement binary equivalent of –120 is 1000 1000.

(c) The given denary number is –57.

1 is put into '–128' column.

$-57 = -128 + 71$

71 larger than 64: 1 is put into '64' column. Also, $71 - 64 = 7$.

7 smaller than each of 32, 16 and 8: 0 is put into each of '32', '16' and '8' columns.

7 larger than 4: 1 is put into '4' column. Also, $7 - 4 = 3$.

3 larger than 2: 1 goes into '2' column. Also, $3 - 2 = 1$.

1 exactly equal to 1: 1 goes into '1' column.

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	0	0	0	1	1	1

So the 2’s complement binary equivalent of –57 is 1100 0111.

(d) The 2’s complement binary equivalent of –31 is 1110 0001.

(e) The 2’s complement binary equivalent of –100 is 1001 1100.

(f) The given denary number is –5. First, 1 is put in the ‘–128’ column:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1							

Next, –5 is expressed as

–128 + (a positive number)

The appropriate positive number is 123. So 123 must be placed into the remaining columns.

The largest positive weighting is 64, and 123 is larger than 64, so a 1 is put into the ‘64’ column. 64 is then subtracted from 123, to give the new number 59. So far, the binary number is:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1						

The new number, 59, is larger than 32, so 1 is put into the ‘32’ column. 32 is then subtracted from 59, to give the new number 27. So far, the binary number is:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1					

The new number, 27, is larger than 16, so 1 is put into the ‘16’ column. 16 is then subtracted from 27, to give the new number 11. So far, the binary number is:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1	1				

The new number, 11, is larger than 8, so 1 is put into the ‘8’ column. 8 is then subtracted from 11, to give the new number 3. So far, the binary number is:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1	1	1			

The new number, 3, is smaller then 4, so a 0 will be put in the ‘4’ column:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1	1	1	0		

The new number, 3, is larger than 2, so a 1 will be put in the '2' column. A 1 will also be put in the '1' column. So the binary number is:

-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(–128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	1	1	1	1	0	1	1

So the 2's complement binary equivalent of –5 is 1111 1011.

(g) The 2's complement binary equivalent of –115 is 1000 1101.

(h) The 2's complement binary equivalent of –75 is 1011 0101.

(i) The 2's complement binary equivalent of –12 is 1111 0100.

(j) The 2's complement binary equivalent of –90 is 1010 0110.