1.1 Data Representation - Number Systems
QUESTIONS

1 - Data Representation

1.1 Number Systems				
1	Understand how and why computers use binary to represent all forms of data			
2	(a) Understand the denary, binary and hexadecimal number systems			
2	(b) Convert between (i) positive denary and positive binary (ii) positive denary and positive hexadecimal (iii) positive hexadecimal and positive binary			
3	Understand how and why hexadecimal is used as a beneficial method of data representation			
4	(a) Add two positive 8-bit binary integers			
4	(b) Understand the concept of overflow and why it occurs in binary addition			
5	Perform a logical binary shift on a positive 8-bit binary integer and understand the effect this has on the positive binary integer			
6	Use two's complement to represent positive and negative 8-bit binary integers			

More Guidance:

1.1 Number systems

Candidates should be able to:	Notes and guidance
1 Understand how and why computers use binary to represent all forms of data	• Any form of data needs to be converted to binary to be processed by a computer • Data is processed using logic gates and stored in registers
2 (a) Understand the denary, binary and hexadecimal number systems	• Denary is a base 10 system • Binary is a base 2 system • Hexadecimal is a base 16 system
(b) Convert between (i) positive denary and positive binary (ii) positive denary and positive hexadecimal (iii) positive hexadecimal and positive binary	• Values used will be integers only • Conversions in both directions, e.g. denary to binary or binary to denary • Maximum binary number length of 16-bit
3 Understand how and why hexadecimal is used as a beneficial method of data representation	• Areas within computer science that hexadecimal is used should be identified • Hexadecimal is easier for humans to understand than binary, as it is a shorter representation of the binary
4 (a) Add two positive 8-bit binary integers (b) Understand the concept of overflow and why it occurs in binary addition	• An overflow error will occur if the value is greater than 255 in an 8-bit register • A computer or a device has a predefined limit that it can represent or store, for example 16-bit • An overflow error occurs when a value outside this limit should be returned
5 Perform a logical binary shift on a positive 8-bit binary integer and understand the effect this has on the positive binary integer	• Perform logical left shifts • Perform logical right shifts • Perform multiple shifts • Bits shifted from the end of the register are lost and zeros are shifted in at the opposite end of the register • The positive binary integer is multiplied or divided according to the shift performed • The most significant bit(s) or least significant bit(s) are lost
6 Use two's complement to represent positive and negative 8-bit binary integers	• Convert a positive binary or denary integer to a two's complement 8-bit integer and vice versa • Convert a negative binary or denary integer to a two's complement 8-bit integer and vice versa

1.1 Data Representation - Number Systems
QUESTIONS

2 A car park has a payment machine that allows a customer to pay for their parking.

The cost of parking is displayed as a denary number on a screen on the payment machine.

The cost of parking is stored in two 8-bit binary registers.

For the parking cost of $10.50:
- register 1 stores the denary value 10 as binary
- register 2 stores the denary value 50 as binary.

(a) Give the parking cost that would be displayed on the payment machine when the registers store:
- register 1: 00010001
- register 2: 01000110

Parking cost displayed $ ..... [2]

Working space

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(b) The parking cost of $14.98 is displayed on the payment machine.

Give the 8-bit binary numbers that are stored in the registers to display the parking cost.

Register 1 .....

Register 2 .....
[2]

Working space

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(c) The payment machine gives the customer a ticket when they have paid their parking cost. Each ticket has a 4-digit hexadecimal ticket number that is stored as binary.

The binary number 1010000000111101 is stored for a customer's ticket number.

Give the hexadecimal ticket number that would be displayed on this customer's ticket.

Hexadecimal ticket number ..... [4]

Working space

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(d) Explain why data input into the payment machine needs to be converted to binary.

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..... [2]

2 A register stores the binary number:

1	1	1	0	0	0	1	1

(a) Give the denary number for the binary number stored in the register.

..... [1]

Working space

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(b) Give the hexadecimal number for the binary number stored in the register.

..... [2]

Working space

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(c) A logical left shift of **two** places is performed on the binary number stored in the register.

Complete the binary register to show its contents after this logical left shift.

[1]

(d) The negative denary number −99 needs to be stored in the register.

Complete the register to show the binary number that would be stored, using two's complement. Show all your working.

Working space .....

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Register:

[2]

(e) The number 01001100 is added to 11100011

Add the two 8-bit binary numbers, using binary addition.

Give your answer in binary. Show all your working.

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..... [4]

2 Humans use a denary number system and computers use a binary number system.

(a) Explain what is meant by a binary number system.

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..... [2]

(b) Convert the denary numbers 14, 59 and 234 to binary.

14 .....

59 .....

234 .....

[3]

Working space

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(c) Convert the denary numbers 9, 26 and 65 to hexadecimal.

9 .....

26 .....

65 .....

[3]

Working space

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(d) Convert the positive denary number 123 to 8-bit binary using two's complement.

Show all your working.

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..... [2]

(e) Add the binary values 00110011 and 01111000 using binary addition.

Give your answer in binary. Show all your working.

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..... [3]

1.1 Data Representation - Number Systems
QUESTIONS

1 Binary is a number system used by computers.

(a) Tick (✓) **one** box to show which statement about the binary number system is correct.

A It is a base 1 system ☐

B It is a base 2 system ☐

C It is a base 10 system ☐

D It is a base 16 system ☐

[1]

(b) Denary numbers are converted to binary numbers to be processed by a computer.

Convert these **three** denary numbers to 8-bit binary numbers.

50 .....

102 .....

221 .....

[3]

Working space

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(c) Binary numbers are stored in registers.

Negative denary numbers can be represented as binary using two's complement.

Complete the binary register for the denary number –78

You must show all your working.

Working space .....

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Register:

[2]

(d) Two 8-bit binary numbers are given.

Add the **two** 8-bit binary numbers using binary addition.

Give your answer in binary. Show all your working.

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  0 0 1 1 0 0 1 1
+ 0 1 1 0 0 0 0 1
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[3]

(e) Two binary numbers are added by a computer and an overflow error occurs.

Explain why the overflow error occurred.

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..... [2]

2 Binary numbers can be converted to hexadecimal.

(a) Convert the **two** binary numbers to hexadecimal.

10010011 .....

00001101 .....

[4]

Working space

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(b) A value is stored as a binary number in a register.

0	1	1	1	1	0	1	0

A logical right shift of **three** places is performed on the binary number.

(i) Complete the binary register to show its contents after this logical right shift.

[1]

(ii) State **one** effect this logical shift has on the binary number.

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..... [1]

(c) Give **two** reasons why a programmer may use hexadecimal to represent binary numbers.

1 .....

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2 .....

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[2]

(d) Denary numbers can also be converted to hexadecimal.

Convert the denary number to hexadecimal.

301 ..... [2]

Working space

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1.1 Data Representation - Number Systems
QUESTIONS

1 Computers store data as binary. The binary number 10101110 is stored.

(a) Convert the binary number to denary.

..... [1]

Working space

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(b) Convert the binary number to hexadecimal.

..... [2]

Working space

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(c) A logical left shift of **three** places is performed on the binary number.

(i) Give the 8-bit binary number that would be stored after this logical left shift.

..... [1]

(ii) Tick (✓) **one** box to show which statement is true about the impact the logical left binary shift would have on the binary number.

A The least significant bits are lost. ☐

B The most significant bits are lost. ☐

C The number has been divided by six. ☐

D The number stays the same. ☐

[1]

(d) Add the **two** 8-bit binary numbers 11101110 and 00110001 using binary addition.

Give your answer in binary. Show all your working.

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..... [4]

(e) The denary number 301 needs to be stored.

Calculate the least number of bits that can be used to store the denary number 301.

..... [1]

Working space

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(f) The hexadecimal number A4D needs to be stored.

Calculate the least number of bits that can be used to store the hexadecimal number A4D.

..... [1]

Working space

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3 Error codes for a computer are often displayed as hexadecimal values. Each error code is stored in a 12-bit binary register.

(a) The error code 404 means 'file not found'.

Give the 12-bit binary value that would be stored for the hexadecimal error code 404

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Working space

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[2]

(b) The error code 12B means 'hardware fault'.

Give the 12-bit binary value that would be stored for the hexadecimal error code 12B

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Working space

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[2]

(c) Hexadecimal values can also be represented as denary values.

The hexadecimal error code 022 means 'file system error'. The hexadecimal error code 0AC means 'insufficient memory'.

Convert the hexadecimal error codes 022 and 0AC to denary values.

022 .....

0AC .....

Working space

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[2]

(d) The register stores the binary value 100111100000

Give the hexadecimal error code that would be displayed for the binary value 100111100000

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Working space

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[2]

(e) Give **two** reasons why error codes are represented in hexadecimal, instead of binary.

Reason 1 .....

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Reason 2 .....

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[2]

2 **(a)** Denary values are converted to binary values to be processed by a computer.

Draw **one** line from each denary value to the correctly converted 8-bit binary value.

Denary	8-bit binary
	11110101
72	01110010
	11100101
245	00010101
	00001111
15	01001000

Working space

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[3]

(b) Binary values can be converted to hexadecimal values.

Give the hexadecimal value for the 16-bit binary value 0000100110101110

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Working space

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[3]

4 All data needs to be converted to binary data so that it can be processed by a computer.

(a) Explain why a computer can only process binary data.

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..... [2]

(b) The denary values 64, 101 and 242 are converted to 8-bit binary values.

Give the 8-bit binary value for each denary value.

64 .....

101 .....

242 .....

[3]

Working space

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(c) The hexadecimal values 42 and CE are converted to binary.

Give the binary value for each hexadecimal value.

42 .....

CE .....

[4]

Working space

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2 Hexadecimal is used for Hypertext Markup Language (HTML) colour codes.

An HTML colour code is:

#2F15D6

Each pair of digits is stored as binary in an 8-bit register.

(a) Give the 8-bit binary value that would be stored for each pair of hexadecimal digits.

2F								
15								
D6								

[6]

Working space

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(b) HTML colour codes and Media Access Control (MAC) addresses are two examples of where hexadecimal is used in Computer Science.

Give **two** other examples of where hexadecimal can be used in Computer Science.

Example 1 .....

Example 2 .....

[2]

1.1 Data Representation - Number Systems
QUESTIONS

1 A computer stores data in binary form. Binary numbers can be represented as hexadecimal and denary numbers.

(a) Convert the 8-bit binary number 01010101 to denary.

..... [1]

Working space

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(b) Convert the binary number 11000000 to hexadecimal.

..... [1]

Working space

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(c) Convert the hexadecimal number 1A to denary.

..... [1]

Working space

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(d) Binary numbers can be stored as bytes.

State how many bits are in **two** bytes.

..... [1]

1.1 Data Representation - Number Systems
QUESTIONS

1 Binary is a number system that is used by computers.

(a) Tick (✓) **one** box to show whether binary is a base-2, base-10 or base-16 number system.

Tick (✓)

☐ Base-2

☐ Base-10

☐ Base-16

[1]

(b) Hexadecimal and denary are number systems that can be used by programmers.

Convert these **four** hexadecimal values into denary values.

09 .....

10 .....

28 .....

A1 .....

[4]

Working space

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2 A sports stadium has an electronic counter that counts each person that enters the stadium.

The count is stored as binary in a 16-bit register.

A denary value of the count is displayed on a screen at the entrance.

(a) The screen currently displays:

0	0	7	1

Give the binary value that is stored in the register to display the count shown.

Binary value: .....

Working space

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[2]

(b) More people enter the sports stadium and the screen now displays:

0	2	5	7

Give the binary value that is stored in the register to display the count shown.

Binary value: .....

Working space

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[2]

8)

(ii) The values in the MAC address are hexadecimal values.

Convert the **three** given hexadecimal values into 8-bit binary.

14 .....

A0 .....

C9 .....

[3]

Working space

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(iii) Convert the **two** given hexadecimal values into denary.

29 .....

C8 .....

[2]

Working space

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1.1 Data Representation - Number Systems
QUESTIONS

1 A hockey club records the number of people that watch each match. An 8-bit binary register is used to store this value.

(a) 46 people watch the first match and 171 people watch the second match.

Show how the registers would store these denary values as 8-bit binary.

Denary value	8-bit binary							
46								
171								

[2]

Working space

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(b) Give the largest denary value that can be stored in the 8-bit binary register.

..... [1]

(c) The hockey club wants to increase the number of people that can watch each match to 2000. The 8-bit binary register may no longer be able to store the value.

Give the smallest number of bits that can be used to store the denary value 2000.

..... [1]

Working space

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5 A computer uses an 8-bit register.

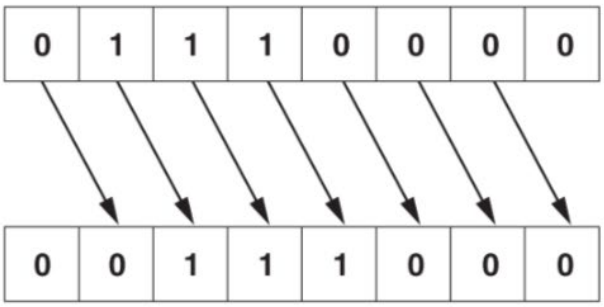
The 8-bit register contains binary integers.

(a) Write the denary (base 10) value represented by:

128	64	32	16	8	4	2	1
0	1	1	1	0	0	0	0

.....[1]

(b) All the bits in the register are shifted **one** place to the **right** as shown below.



Write the denary number that is represented after this shift.

.....[1]

(c) State the effect the shift to the right had on the original denary number from **part (a)**.

.....[1]

(d) The original number in **part (a)** is shifted **three** places to the **right**.

(i) Show the new binary number:

[1]

(ii) Write the equivalent denary number.

.....[1]