0 1 . 1 Convert the **hexadecimal** numbers 27 and C9 into **binary**. Then, in **binary**, add them together to work out the total. Finally, convert the total back into **hexadecimal** to give the answer.

You **must** show your working.

[2 marks]

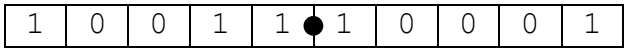
Answer in hexadecimal _____

0 1 . 2 In **decimal**, what is the most negative number that can be represented using a **12-bit two's complement binary integer**?

[1 mark]

0 2 . 1 The bit pattern below represents an **unsigned fixed-point binary** number with five bits before and five bits after the binary point.

Convert the binary number into decimal.



[2 marks]

0 2 . 2 Explain how the **two's complement binary integer** 00100111 can be subtracted from the **two's complement binary integer** 01001001 without converting the numbers into decimal.

[2 marks]

0 3 . 1 **Figure 2** shows two unsigned binary integers.

Figure 2

0	0	1	0	1	1	0	1

0	0	0	0	0	1	0	1

What is the result **in binary** of multiplying the two numbers shown in **Figure 2**?

You **must** show all your working in binary.

[2 marks]

Answer _____

0 3 . 2 Convert the decimal number 6.34375 into an **unsigned fixed point binary number** using 8 bits with 5 bits after the binary point.

You may use the space below for working.

[2 marks]

Answer

0 4 . 1 Convert the decimal number 177 to unsigned binary using 8 bits.

[1 mark]

0 5 . 1 State, **in decimal**, the lowest and highest values that could be represented in unsigned binary when using 16 bits.

[2 marks]

Lowest _____

Highest _____

0 5 . 2 **Figure 1** and **Figure 2** show the bit patterns of two **unsigned binary integers**.

Figure 1

0	0	0	1	0	1	0	1

Figure 2

0	0	0	0	0	1	1	1

Calculate the result of multiplying these two numbers together using **binary multiplication**.

You **must** show your working in binary.

[2 marks]

Answer _____

0 6 . 1 Shade in **one** lozenge to indicate which of the following prefixes represents 10^6

[1 mark]

A kibi ⬭

B mebi ⬭

C gibi ⬭

D kilo ⬭

E mega ⬭

F giga ⬭

0 6 . 2 **Table 1** shows two unsigned binary integers, **Number 1** and **Number 2**.

Complete the table to show the result in binary of adding the two numbers.

You **must** complete the carry row to show the carry from the previous column where there is one.

Table 1

Number 1	0	0	0	1	1	0	1	1
Number 2	0	0	0	0	0	1	1	1
Result								
Carry								

[1 mark]

0 6 . 3 What is the result of subtracting the two's complement binary number `00100100` from the two's complement binary number `00011011`?

You should give your answer in two's complement binary.

You **must** show all your working in binary.

[2 marks]

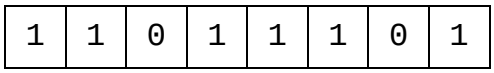
0 6 . 4 In **decimal**, what are the lowest and highest values that can be represented by an **8-bit two's complement** binary integer?

[1 mark]

Lowest: _____ Highest: _____

0 6 . 5 What is the **decimal** equivalent of the bit pattern shown in **Figure 1** if it represents an **unsigned fixed-point binary** value with two bits before the binary point and six bits after the binary point?

Figure 1



[2 marks]

0 7 . 1 Convert the bit pattern `10001010` to hexadecimal.

[1 mark]

0 7 . 2 Represent the decimal number 139 as an **8-bit unsigned binary integer**.

[1 mark]

0 7 . 3 Show how the **unsigned binary number** `00100011` can be added to the **unsigned binary number** `00101011` without converting the numbers into decimal.

You **must** show all your working in binary.

[2 marks]

```
  0 0 1 0 0 0 1 1
+ 0 0 1 0 1 0 1 1
```

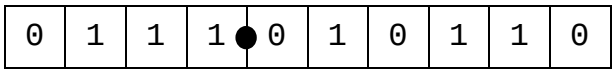
0 7 . 4 Show how the **8-bit two's complement binary integer** `00011100` can be subtracted from the **8-bit two's complement binary integer** `00111011` without converting the numbers to decimal.

You **must** show all your working in binary.

[2 marks]

0 7 . 5 The bit pattern in **Figure 1** represents a **10-bit unsigned fixed point binary number** with four bits before and six bits after the binary point.

Figure 1



Convert the bit pattern in **Figure 1** to decimal.

[2 marks]

0 8 A student has attempted to add together the binary numbers `00110011` and `10110110`, but has made a mistake.

The student's calculation is shown in **Figure 2** below.

Figure 2

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
	0	0	1	1	0	0	1	1
+	1	0	1	1	0	1	1	0
Carry	0	1	1	0	1	1	0	
Result	1	1	0	0	1	0	0	1

Explain what mistake the student has made.

The columns in the addition have been labelled **A** to **H** to help you make your explanation clear.

[1 mark]

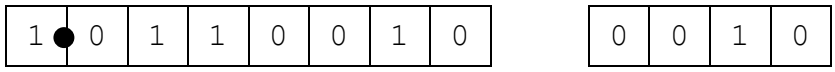
0 9 Questions **11.1**, **11.2**, **11.3** and **11.4** use a **normalised** floating point representation with an **8-bit** mantissa and a **4-bit** exponent, both stored using **two's complement**.

0 9 . 1 Write the **smallest positive** number that can be represented by the floating point system in the boxes below.

[2 marks]

Mantissa Exponent

0 9 . 2 The following is a floating point representation of a number:



Mantissa Exponent

Calculate the decimal equivalent of the number.

You **must** show your working.

[2 marks]

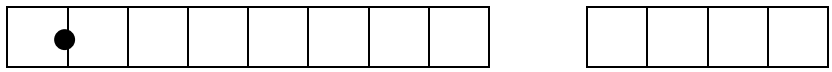
Answer _____

0 9 . 3 Write the normalised floating point representation of the decimal value 0.15625 (5/32 as a fraction) in the boxes below.

You **must** show your working.

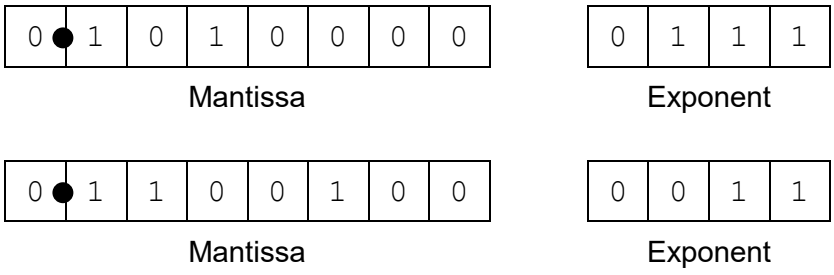
[3 marks]

Answer



Mantissa Exponent

0 9 . 4 The two floating point numbers below are multiplied together.



A problem occurs as a result of the multiplication operation.

Explain what problem has occurred and how the floating point representation could be redesigned to avoid it.

[3 marks]

1 0 Questions **02.2**, **02.3**, **02.4** and **02.5** use a normalised floating point representation with a 7-bit mantissa and a 5-bit exponent, both stored using **two's complement**.

1 0 . 1 Non-integer values such as -1.65 and 23/1068 can be represented by a computer using a fixed point or a floating point system.

State **one** advantage of using a floating point system over a fixed point system and **one** advantage of using a fixed point system over a floating point system.

You should assume that the two systems use the same number of bits to store a value.

[2 marks]

Advantage of floating point _____

_____

_____

_____

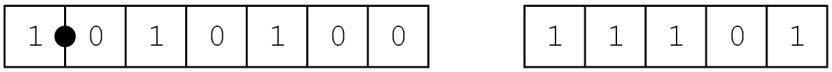
Advantage of fixed point _____

_____

_____

_____

1 0 . 2 The following is a floating point representation of a number:



Mantissa Exponent

Calculate the decimal equivalent of the number.

Express your answer to at least four decimal places or as a fraction. You should show your working.

[2 marks]

_____

_____

_____

_____

Answer

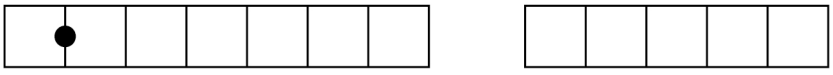
Questions **02.2**, **02.3**, **02.4** and **02.5** use a normalised floating point representation with a 7-bit mantissa and a 5-bit exponent, both stored using **two's complement**.

1 0 . 3 Write the normalised floating point representation of the decimal value 1632 in the boxes below.

You should show your working.

[3 marks]

Answer



Mantissa Exponent

Questions **02.2**, **02.3**, **02.4** and **02.5** use a normalised floating point representation with a 7-bit mantissa and a 5-bit exponent, both stored using **two's complement**.

1 0 . 4 State, in **decimal**, the highest (most positive) and lowest (most negative) values that could be represented by this floating point system.

You should show your working.

[3 marks]

Highest value _____ Lowest value _____

1 0 . 5 When the decimal value 28.25 is converted into binary using this floating point system, a rounding error occurs.

Explain:

- why a rounding error has occurred, **and**
- what the system might do when the value 28.25 is converted into binary.

[2 marks]

1 1 Use binary addition in 8-bit two's complement to perform the subtraction:

18 – 72

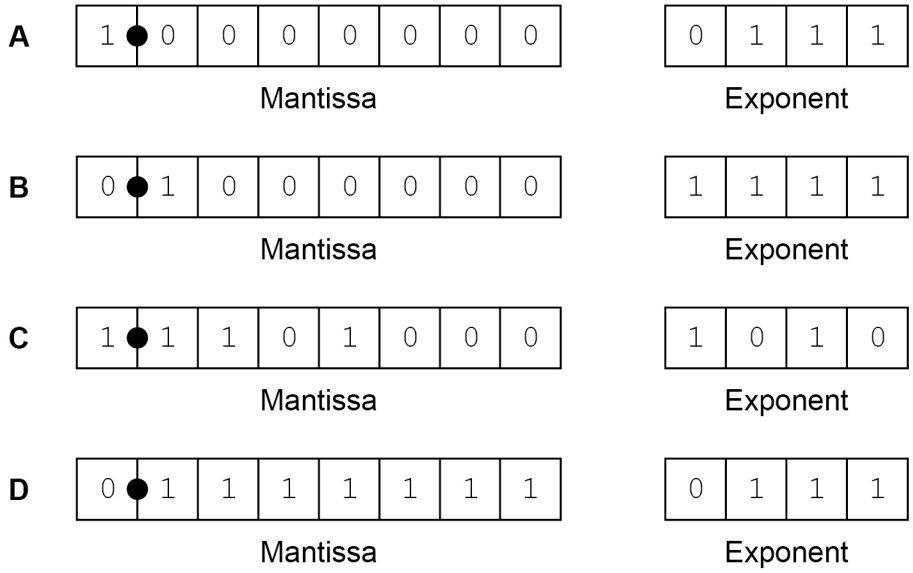
You **must** show both your working and your final answer in binary.

[2 marks]

1 2 A particular computer uses a **normalised** floating point representation with an 8-bit mantissa and a 4-bit exponent, both stored using **two's complement**.

1 2 . 1 Four-bit patterns that are stored in this computer's memory are listed in **Figure 5** and are labelled with the letters **A** to **D**. Three of the bit patterns are valid normalised floating point numbers and one is not.

Figure 5



Complete **Table 2** below. In the **Correct letter (A–D)** column write the appropriate letter from **A** to **D** to indicate which bit pattern in **Figure 5** is an example of the type of value described in the **Value description** column.

Do **not** use the same letter more than once.

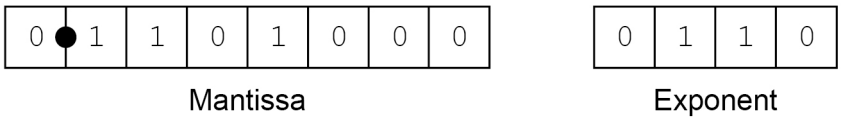
Table 2

Value description	Correct letter (A–D)
A negative value that is valid in the representation.	
The largest positive value that can be represented in the system.	
A value that is not valid in the representation because it is not normalised.	

[3 marks]

1 2 . 2 **Figure 6** shows a floating point representation of a number:

Figure 6



Calculate the decimal equivalent of the number.

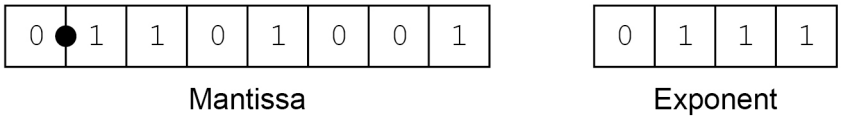
You should show your working.

[2 marks]

Answer _____

In this floating point system, the closest possible representation of the decimal number 104.7 is shown in **Figure 7**.

Figure 7



By converting this number back to decimal it can be seen that the actual value stored is 105

1 2 . 3 Calculate the **absolute error** that has occurred when representing 104.7 in **Figure 7**.

[1 mark]

Answer _____

1 2 . 4 Calculate the **relative error** that has occurred when representing 104.7 in **Figure 7**.

Express your answer as a percentage to two decimal places.

[1 mark]

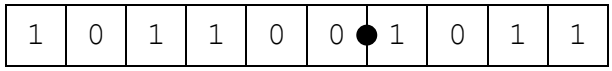
Answer _____

1 2 . 5 Explain why the relative error is usually considered to be a more important measure of error than the absolute error.

[1 mark]

1 3 . 1 **Figure 2** shows a number stored using a **fixed point** representation and **two's complement**, with six bits before and four bits after the binary point.

Figure 2



Convert the number in **Figure 2** to decimal.

You should show your working.

[2 marks]

Answer _____

1 3 . 2 State **two** reasons why values stored using a **floating point** representation are usually stored in normalised form.

[2 marks]

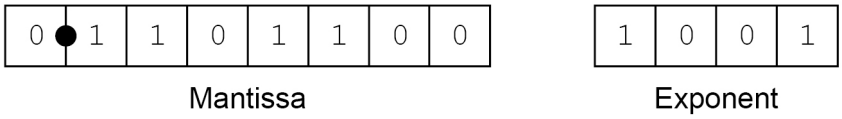
Reason 1 _____

Reason 2 _____

Questions **13.3**, **13.4** and **13.5** use a **normalised** floating point representation with an **8-bit** mantissa and a **4-bit** exponent, both stored using **two's complement**.

1 3 . 3 **Figure 3** shows a floating point representation of a number.

Figure 3



Calculate the decimal equivalent of the number.

Express your answer as a fraction or to 4 decimal places.

You should show your working.

[2 marks]

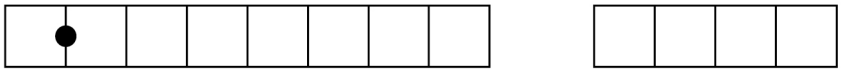
Answer _____

1 3 . 4 Write the normalised floating point representation of the decimal value –23.25 in the boxes below.

You should show your working.

[3 marks]

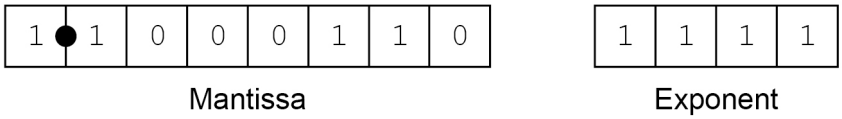
Answer



Mantissa Exponent

1 3 . 5 **Figure 4** shows the closest possible representation of the decimal number –0.22558594 in this floating point system.

Figure 4



By converting this number back to decimal it can be seen that the actual value stored is –0.2265625

Calculate the **relative error** that has occurred when representing –0.22558594

You should show your working.

Express your answer as a percentage to 2 decimal places.

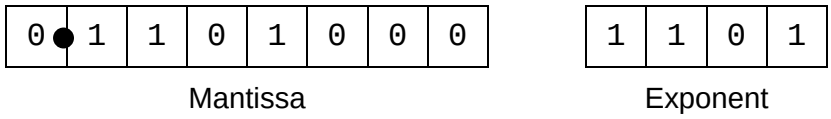
[2 marks]

Answer _____

Question parts **14.1** and **14.2** use a **normalised** floating point representation with an **8-bit mantissa** and a **4-bit exponent**, both stored using **two's complement**.

1 4 . 1 **Figure 7** shows a floating point representation of a number:

Figure 7



Calculate the decimal equivalent of the number in **Figure 7**.

You should show your working.

[2 marks]

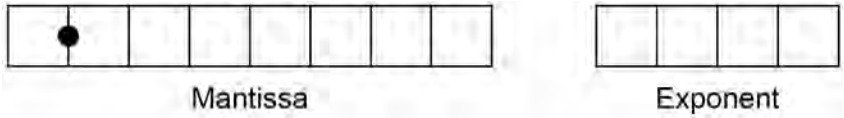
Answer _____

1 4 . 2 Write the normalised floating point representation of the decimal value –23.25 in the boxes below.

You should show your working.

[3 marks]

Answer



1 4 . 3 On each row of **Table 1**, state the name of the **Type of error** that has occurred in the **Situation** that is described.

[2 marks]

Table 1

Situation	Type of error
A calculation is performed and the result of the calculation is so close to zero that the number that is stored is zero.	
A calculation is performed and the result of the calculation is too large to fit in the available number of bits.	
A decimal value is converted to floating point but it cannot be represented exactly in the available number of bits.	

1 4 . 4 Explain how the floating point representation used in Question parts **06.1** and **06.2** could be modified to represent numbers more precisely, without changing the total number of bits used to represent a number.

[1 mark]

15.1 Shade the lozenges next to **all** of the **true** statements about representing numbers using fixed and floating point representations.

[2 marks]

A A processor can usually carry out calculations on fixed point numbers more quickly than calculations on floating point numbers. ⬭

B Fixed point numbers represent data using a mantissa and an exponent. ⬭

C In a given number of bits, a fixed point system can represent positive numbers that are closer to zero than a floating point system can. ⬭

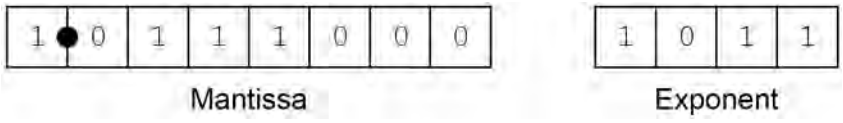
D In a given number of bits, a fixed point system can represent some numbers more precisely than a floating point system. ⬭

E In a given number of bits, a floating point system can represent a bigger range of numbers than a fixed point system. ⬭

Questions **15.2**, **15.3** and **15.4** use a **normalised** floating point representation with an **8-bit mantissa** and a **4-bit exponent**, both stored using **two's complement**.

15.2 **Figure 2** shows a floating point representation of a number:

Figure 2



Calculate the decimal equivalent of the number in **Figure 2**.

You should show your working.

[2 marks]

Answer _____

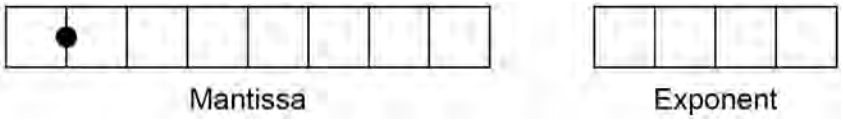
1 5 . 3 The decimal number 12.765625 (which can also be expressed as $12\frac{49}{64}$) cannot be represented exactly in this floating point system.

Write the closest possible normalised representation of this number in the boxes below.

You should show your working.

[3 marks]

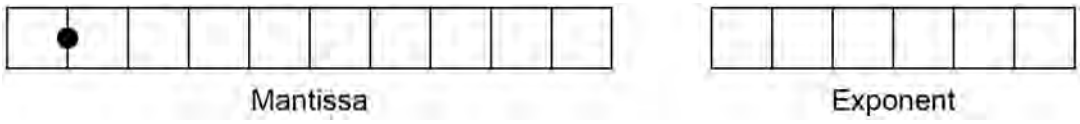
Answer



1 5 . 4 What is the smallest number of bits that would need to be **added to** the mantissa so that the decimal number 12.765625 could be represented exactly?

[1 mark]

1 5 . 5 A different system uses a **normalised** floating point representation with a **10-bit mantissa** and a **6-bit exponent**, both stored using **two's complement**.



In **decimal**, what is the most negative number that this system could represent?

You should show your working.

[2 marks]

Most negative number _____