Topical Past Papers
Paper 3 - Questions



13.3 Floating-Point Numbers, Representation and Manipulation

May/June 2015.P31/P32

A gardener grows vegetables in a greenhouse. For the vegetables to grow well, the temperature needs to always be within a particular range.

The gardener is not sure about the actual temperatures in the greenhouse during the growing season. The gardener installs some equipment. This records the temperature every hour during the growing season.

(c) The equipment records temperatures in the greenhouse. It does this for seven locations.

Each recording is stored as two successive bytes. The format is shown below:

		G	reenh	ouse	location	on				Tem	peratu	re rea	ding	
7	6	5	4	3	2	1	0							
			Byt	te 1				-			Byt	e 2		

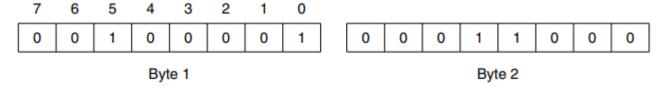
The location is indicated by the setting of one of the seven bits in byte 1. For example, location 4 is indicated by setting bit 4.

Bit 0 of byte 1 acts as a flag:

- the initial value is zero
- when the reading has been processed it is set to 1

Byte 2 contains the temperature reading (two's complement integer).

(i) Interpret the data in byte 1 shown below:



[2]











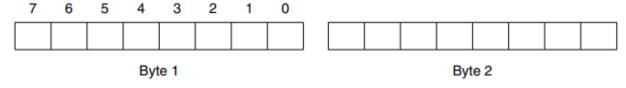
Topical Past Papers Paper 3 - Questions



13.3 Floating-Point Numbers, Representation and Manipulation

(ii) The system receives a temperature reading of -5 degrees from sensor 6.

Complete the boxes below to show the two bytes for this recording. The reading has not yet been processed.



[2]

Oct/Nov 2015.P31/P33

- In a particular computer system, real numbers are stored using floating-point representation with:
 - 8 bits for the mantissa, followed by
 - 8 bits for the exponent

Two's complement form is used for both mantissa and exponent.

(a)(i) A real number is stored as the following two bytes:

			Man	tissa							Expo	nent			
0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1

Calculate the denary value of this number. Show your working.

[3]

(ii) Explain why the floating-point number in part (a)(i) is not normalised.

[2]















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13.3 Floating-Point Numbers, Representation and Manipulation

1	an)	Normalise t	he flaating	-noint num	her in	nart (a)(i)	
- 1		Normanac t	ine moating	ponit nan		part	u / (i / .	,

	Man	tissa				Expo	nent		

[2]

(b)(i) Write the largest positive number that can be written as a normalised floating-point number in this format.

		Man	tissa				Expo	nent		

Zak Zafar ali khan







Zak [2]

(ii) Write the smallest positive number that can be written as a normalised floating-point number in this format.

		Man	tissa				Expo	nent		
]					
١					J					

[2]

(iii) If a positive number is added to the number in part (b)(i) explain what will happen.

[2]

(c) A student writes a program to output numbers using the following code:

$$X = 0.0$$

FOR $i = 0$ TO 1000
 $X = X + 0.1$



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13.3 Floating-Point Numbers, Representation and Manipulation

OUTPUT X ENDFOR

The student is surprised to see that the program outputs the following sequence:

0.0 0.1 0.2 0.2999999 0.3999999

Explain why this output has occurred.

[3]





















Topical Past Papers Paper 3 - Questions



13.3 Floating-Point Numbers, Representation and Manipulation

Oct/Nov 2015.P32

- In a particular computer system, real numbers are stored using floating-point representation with:
 - 8 bits for the mantissa, followed by
 - 4 bits for the exponent

Two's complement form is used for both mantissa and exponent.

(a)(i) A real number is stored as the following 12-bit binary pattern:

0	1	1	0	1	0	0	0		0	0	1	1	
---	---	---	---	---	---	---	---	--	---	---	---	---	--

Calculate the denary value of this number. Show your working.

[3]

(ii) Give the normalised binary pattern for +3.5. Show your working.

[3]

(iii) Give the normalised binary pattern for -3.5. Show your working.

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Za [3]

The number of bits available to represent a real number is increased to 16.

(b)(i) If the system were to use the extra 4 bits for the mantissa, state what the effect would be on the numbers that can be represented. [1]

(ii) If the system were to use the extra 4 bits for the exponent instead, state what the effect would be on the numbers that can be represented. [1]

(c) A student enters the following expression into an interpreter:

OUTPUT
$$(0.1 + 0.2)$$

The student is surprised to see the following output:

0.3000000000000001

Explain why this output has occurred.



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[3]

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13.3 Floating-Point Numbers, Representation and Manipulation

Oct/Nov 2016.P31/P33

- 1 In a particular computer system, real numbers are stored using floating-point representation with:
 - 12 bits for the mantissa
 - 4 bits for the exponent
 - two's complement form for both mantissa and exponent
 - (a) Calculate the floating-point representation of + 2.5 in this system. Show your working.

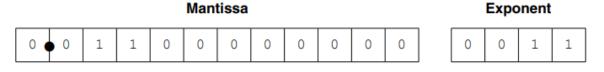


(b) Calculate the floating-point representation of – 2.5 in this system. Show your working.



[3]

(c) Find the denary value for the following binary floating-point number. Show your working.



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[3]

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13.3 Floating-Point Numbers, Representation and Manipulation

	(d)(i) State whether the floating-point number given	n in part (c) is normalised or not normalised.	[1]
	(ii) Justify your answer given in part (d)(i).		[1]
	(e) The system changes so that it now allocates 8 bit	s to both the mantissa and the exponent.	
	State two effects this has on the numbers that can be	pe represented.	[2]
Oct/No	v 2016.P32		
1	In a particular computer system, real numbers are st	tored using floating-point representation wi	th:
	 8 bits for the mantissa 8 bits for the exponent two's complement form for both mantissa and exp (a) Calculate the floating point representation of + 3 		Zak
	Mantissa Mantissa	Exponent	IKHAN
	•		[2]
			[3]
	(b) Calculate the floating-point representation of –3.	.5 in this system. Show your working.	
	Mantissa	Exponent	
			[3]
	(c) Find the denary value for the following binary flo	ating-point number. Show your working.	
	Mantissa	Exponent	
	0 • 1 1 1 0 0 0 0	0 0 0 0 0 1 0	Page 7 of 2
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Paper 3 - Questions

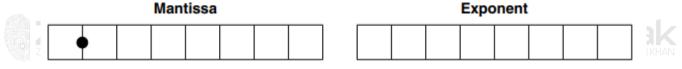


13.3 Floating-Point Numbers, Representation and Manipulation

[3]

- (d)(i) State whether the floating-point number given in part (c) is normalised or not normalised. [1]
- (ii) Justify your answer given in part (d)(i). [1]

(e) Give the binary two's complement pattern for the negative number with the largest magnitude.



[2]

May/June 2018.P31/P33

- 1 In a computer system, real numbers are stored using normalised floating-point representation with:
 - 12 bits for the mantissa
 - 4 bits for the exponent
 - Two's complement form for both mantissa and exponent.
 - (a) Find the denary value for the following binary floating-point number.



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13.3 Floating-Point Numbers, Representation and Manipulation

	Show	your \	workii	ng.																	[3]
	(b) Ca	lculat	e the	norm	alised	float	ing-po	oint re	prese	ntatio	n of !	5.25 ir	n this	syste	em. S	Show	v yoı	ur w	orkin	g.	
					M	lanti	ssa									E	хро	nen	t		
																					[3]
	(c) Th	e size	of the	man	tissa i	s dec	reased	d and t	the si	ze of t	he ex	pone	nt is	increa	ased						
	State	how t	his aff	ects t	he ra	nge a	nd pre	ecision	of th	ne nun	nbers	that	the c	ompı	uters	syste	em c	an r	epres	sent.	[2]
	Z	ak								Zal	K									al	<
May/Ju	ine 201	8.P32																			
3	In a c	omput	er sys	stem,	real n	umb	ers are	e store	d usi	ng nor	malis	sed-flo	oatin	g poir	nt re	pres	enta	ation	with	1:	
		ts for t																			
		ts for t 's com		-		r bot	h man	ntissa a	and e	xpone	nt.										
	(a) Ca	lculate	e the	norm	alised	float	ing-po	oint re	prese	ntatio	n of +	+ 21.7	5 in t	his sy	ysten	n. Sh	now	you	r wor	king.	
						Manti	ssa						ı	Expo	nent	t					
																					[3]











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Paper 3 - Questions



13.3 Floating-Point Numbers, Representation and Manipulation

(b) Find the denary value for the following binary floating-point number.

			Mant	tissa	ı			ı	Expo	nen	t
1	0	1	1	0	0	0	0	1	1	1	0

Show your working. [3]

Oct/Nov 2018.P31/P33

- **2 (a)** A computer system stores real numbers using floating-point representation. The floating-point numbers have:
 - eight bits for the mantissa
 - four bits for the exponent.

The mantissa and exponent are both in two's complement form.

(i) Calculate the denary value of the following floating-point number.

Zak Zafar ali khan



 Mantissa
 Exponent

 0
 0
 1
 1
 1
 0
 0
 0
 1
 1
 1

Show your working. [3]

(ii) State how you know the floating-point number in part (a)(i) is not normalised.

(iii) Normalise the floating-point number in part (a)(i).



[2]

[1]











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13.3 Floating-Point Numbers, Representation and Manipulation

Ī		
	(b)(i) Write the largest positive number that this system canumber in this format.	in represent as a normalised floating-point
	Mantissa	Exponent
		[2]
	(ii) Write the smallest positive number that can be stored a format.	as a normalised floating-point number in this
	Mantissa	Exponent
		[2]
	(c) The number of bits available to represent a real number State the effect this has on the numbers that can be represent a real number of bits available to represent a real number of bits available t	sented, if the additional four bits are used in the:
	(d) A student enters the following code into an interpreter	•
	<pre>X = 0.1 Y = 0.2 Z = 0.3 OUTPUT (X + Y + Z)</pre>	
	The student is surprised to see the output:	
	0.6000000000000000000000000000000000000	
	Explain why this is output.	[3]
0	v 2018.P32	

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13.3 Floating-Point Numbers, Representation and Manipulation

- (a) A computer system uses floating-point representation to store real numbers. The floating-point numbers have:
 - 8 bits for the mantissa
 - 8 bits for the exponent

The mantissa and exponent are both in two's complement form.

(i) Calcula	te th	e der	nary	value	of tl	he fo	llow	ing fl	oat	ing-pc	int n	umb	er. It	is no	ot in	norm	alise	d form.
				Man	tissa	1							Expo	onen	t			
	0	0	1	0	1	0	1	0		0	0	0	0	0	1	0	1	
Show you				umh	er +7	7 5 ir	nto a	norn	nali	sed flo	nating	g-noi	nt nı	ımhe	ar.			[3]
Show you				ZAFAR /						AR ALI KI-		5 PO.			RALIK			Zafar ali khan
				Man	tissa	a							Ехр	oner	nt			
																		[3]

(iii) Convert the denary number -7.5 into a normalised floating-point number.

Show your working.



[3]











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Paper 3 - Questions



13.3 Floating-Point Numbers, Representation and Manipulation

(b) A normalised floating-point number is shown.

			Man	tissa	ı					-	Expo	nen	t		
0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1

(i) State the significance of this binary number.

[1]

(ii) State what will happen if a positive number is added to this number.

[1]

May/June 2019.P31/P33

- 1 In a computer system, real numbers are stored using normalised floating-point representation with:
 - twelve bits for the mantissa
 - four bits for the exponent.

The mantissa and exponent are both in two's complement form.

(a) Calculate the denary value for the following binary floating-point number.

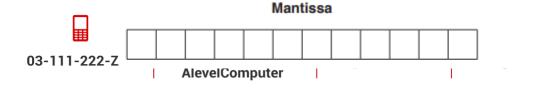
Show your working.

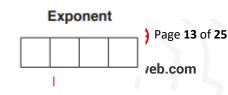


[3]

(b) Calculate the normalised floating-point representation of +1.5625 in this system.

Show your working.





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13.3 Floating-Point Numbers, Representation and Manipulation

	[3]
(c)(i) Write the largest positive number that can be stored as a new	ormalised floating-point number using this
format. Mantissa	Exponent
	[2]
(ii) Write the smallest non-zero positive number that can be stor	
using this format. Mantissa	Exponent
ANN ZATAT	
	[2]
	[2]
(d) The developer of a new programming language decides that a bit normalised floating-point representation. She must decide he	
how many bits for the exponent.	ow many bits to use for the mantissa and
Explain the trade-off between using either a large number of bits	s for the mantissa, or a large number of bits
for the exponent.	-
	[3]
/June 2019.P32	
(a) A computer stores real numbers using floating-point represer	ntation. The floating-point numbers have:
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13.3 Floating-Point Numbers, Representation and Manipulation

•	eight	bits	for	the	mantissa
---	-------	------	-----	-----	----------

• four bits for the exponent.

The mantissa and exponent are both stored in two's complement format.

(i) Calculate the denary value of the following floating-point number.

Show your working.	
Mantissa	Exponent
0 0 1 1 0 1 1 1	0 1 0 1
	[3]
(ii) State why the floating-point number in part (a)(i) is not	normalised. [1]
(iii) Give the floating-point number in part (a)(i) in normalis	7 John Zak
ZAFAR ALIKHAN Mantissa	Exponent ZAFAR ALI KHAN
	[2]
(b)(i) Convert the denary number +11.625 into a normalise	d floating-point number.
Show your working.	
Mantissa	Exponent
	[3]

(ii) Convert the denary number -11.625 into a normalised floating-point number.



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13.3 Floating-Point Numbers, Representation and Manipulation

Show your w	vorkii	ng.								
			Man	tissa	ı		- 1	Expo	nen	t

[3]

(c) A student enters the following into an interpreter:

OUTPUT(0.2 * 0.4)

The student is surprised to see that the interpreter outputs the following:

0.080000000000000002

Explain why the interpreter outputs this value.

[3]











1 Real numbers are stored using floating-point representation in a computer system.

This representation uses:

- 8 bits for the mantissa, followed by
- 4 bits for the exponent.

Two's complement form is used for both the mantissa and the exponent.

(a)(i) A real number is stored as a 12-bit normalised binary number as follows:

			Man	tissa	l		
0	1	0	1	0	0	1	0

Calculate the denary value for this binary number. Show your working.

[3]











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13.3 Floating-Point Numbers, Representation and Manipulation

(ii) Calculate the normalised binary number for -3.75. Show your working. Mantissa Exponent [3] (b) The number of bits available to represent a real number is increased to 16. State the effect of increasing the size of the exponent by 4 bits. [1] [1] (c) State why some binary representations can lead to rounding errors. (d) Complete the following descriptions by inserting the two missing terms. become too large to be represented using the number of bits available. A calculation results in a number so small that it cannot be represented by the number of bits available. This is called [2] Oct/Nov 2019.P32 (a) The following 16-bit binary pattern represents a floating-point number stored in two's complement form. The twelve most significant bits are used for the mantissa and the four least significant bits are used for the exponent. Most Least significant bit significant bit 1 0 1 1 Page 17 of 25

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(i) Identify the binary value of the exponent.	[1]
(ii) Identify the binary value of the mantissa.	[1]
(iii) State whether the number stored is positive or negative. Justify your choice.	[2]
(iv) Convert the binary floating-point number in part (a) into denary. Show your working.	[3]
(b) The number of bits used for the exponent is increased to eight, and the number of bits used for the mantissa is decreased to eight.	
State the effects of this change.	[2]
 In a particular computer system, real numbers are stored using floating-point representation with: 10 bits for the mantissa 6 bits for the exponent paralisms	K
(a) Calculate the normalised floating-point representation of +192.5 in this system. Show your working	
Mantissa Exponent	
	[3]
(b) Calculate the normalised floating-point representation of –192.5 in this system. Show your working	; .
Mantissa Exponent	
	[3]

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13.3 Floating-Point Numbers, Representation and Manipulation

		_	•	repr	eser	ntati	on h	as ch	nan	ged	l. Th	ere	are r	now 1	.2 b	its fo	or the	e mar	ntissa	a and 4	4 bits fo	or the	!
expo	onent	as snc	own.			N	Mant	issa	l								Ехр	oner	nt				
	[Ι													
Expl	lain wh	ny +19	2.5 c	anno	t be	accı	urate	ely re	epro	ese	ntec	l in t	his f	orma	t.							[:	3]
<u> Oct/Nov 202</u>	0.P31/	<u>′P33</u>																					
1 In a	partic	ular co	ompu	iter s	yste	m, r	eal n	umb	ers	are	e sto	red	usin	g floa	itin	g-po	int re	pres	enta	tion w	vith:		
• 4 k	bits for bit	the e	expor	ent		both	n ma	ntiss	аа	nd	expo	oner	nt.										
(a) T	Γhe fol	lowing	g floa					er sto	rec					ed.							Z		
Calc	culate 1	the de	nary			the		ting-	poi		afar / num			w you	ır v	vorki	ng.						
						Mai	ntis	sa								E	Ехро	nent	t				
	0	0	0	0	1	1	0) ()	0	0	(0	0		0	1	0	1			ſ	3]
(b)(i	i) Norr	nalise	the f	loati	ng-n	oint	num	nher	giv	en i	n n a	art (:	a).									٠	- 1
	te you								Б. ч		p.		-,.										
						ı	Man	tissa	a								Exp	one	nt				
																						[2]]
				f						¥											#	Pa	ge 19 of 25
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13.3 Floating-Point Numbers, Representation and Manipulation

(ii) Describe one problem that can occur when floating-point numbers are not normalised.

[2]

Oct/Nov 2020.P32

- In a particular computer system, real numbers are stored using floating-point representation, with: 1
 - 12 bits for the mantissa
 - 4 bits for the exponent
 - two's complement form for both mantissa and exponent.
 - (a) Calculate the denary value for the following floating-point number. Show your working.

		Mant	issa							Expo	nen	t
0 1 0	1 0	0	0	0	0	0	0	0	0	1	1	0

[3]

Zak Zak

- (b) A new operating system has been installed that has changed the way the floating-point numbers are used. The order of the exponent and the mantissa are reversed.
- (i) Calculate the new denary value for the following floating-point number that has the same bit pattern as the number in part (a). Show your working.



[3]

(ii) Identify two problems that can occur due to the change in the representation of the floating-point number.

[2]











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Paper 3 - Questions



13.3 Floating-Point Numbers, Representation and Manipulation

May/June 2021.P31/P33

- In a particular computer system, two real numbers, **A** and **B**, are stored using floating-point representation with:
 - 12 bits for the mantissa
 - 4 bits for the exponent
 - two's complement form for both mantissa and exponent.

Number A	Mantissa	Exponent
	1 1 0 0 0 0 0 0 0 0 0 0	0 0 1 0
Number B	Mantissa	Exponent EALKHAN
	0 1 1 1 0 0 0 0 0 0 0 0	1 1 1 1
(a)(i) Identify whet	ther each number is positive or negative. Justify your answ	ver. [2]
(ii) Convert the bir values.	nary values of the mantissa and the exponent for each nu	mber to their separate denary [4]







(iii) Calculate the denary value of each floating-point number using your values from part (a)(ii).

(b) State which number, A or B, is stored in normalised floating-point form. Justify your answer.





[2]

[3]

Topical Past Papers Paper 3 - Questions



13.3 Floating-Point Numbers, Representation and Manipulation

May/June 2021.P32

1	In a computer sy	vstem, two rea	I numbers,	A and B,	, are stored usi	ng floating-	point rep	resentation v	with:

- 12 bits for the mantissa
- 4 bits for the exponent
- two's complement form for both mantissa and exponent.

Number B	0	1	1	0	0	0	0	0	0	0						_	
Number B											U	0		1	1	1	1
					N	/lanti	ssa								Expo	onen	t
	1	1	1	0	0	0	0	0	0	0	0	0		0	1	0	0
(a)(i) Convert the	hinary	, valı	ies o	fthe	mar	nticca	and	the e	vno	nent	for e	ach i	num	her to	n the	ir ser	ar
values. HAN			ALIKH		illai	1033		RALIKH		iieiit	-		RALIK		Jule	11 36	ZAF
(ii) Calculate the o	denary	valu	ie of	each	floa	ا-ting	ooint	num	ber	using	you	r valu	ies fi	om r	oart (a)(i).	

May/June 2021.P31/P32/P33 (9618)

- 1 Real numbers are stored in a computer system using floating-point representation with:
 - 10 bits for the mantissa
 - 6 bits for the exponent
 - Two's complement form for both the mantissa and the exponent.
 - (a) Calculate the normalised floating-point representation of –7.25 in this system. Show your working.

	Mantissa											=xpc	Page 22 of 2 !			
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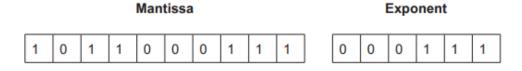
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13.3 Floating-Point Numbers, Representation and Manipulation

[3]

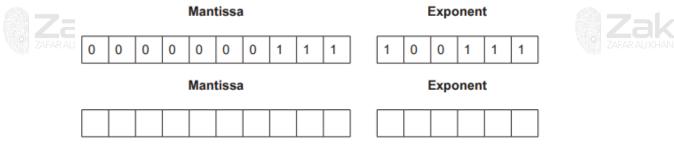
(b) Calculate the denary value of the given binary floating-point number. Show your working.



[3]

(c) The given binary floating-point number is not normalised.

Normalise the floating-point number. Show your working.



[3]

- (d) The denary number 513 cannot be stored accurately as a normalised floating-point number in this computer system.
- (i) Explain the reason for this. [3]
- (ii) Describe an alteration to the way floating-point numbers are stored to enable this number to be stored accurately using the same total number of bits. [2]



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Topical Past Papers Paper 3 - Questions



13.3 Floating-Point Numbers, Representation and Manipulation

Oct/Nov 2021.P31/P32/P33 (9618)

- 1 (a) Numbers are stored in a computer using floating-point representation with:
 - 12 bits for the mantissa
 - 4 bits for the exponent
 - two's complement form for both the mantissa and exponent.

(i) Write the nor	malised floating-point i	representation of the fo	llowing unsigned binary	number using this
system.		Zak		

system. ZAFAR ALI KHAN				ZAFAR ALI KHAN 1011100.01100																	
																				[2]	
Mantissa												Exponent									
																				[2]	
(ii) State system.						ring t	he bi	nary	num	iber i	in pa	rt (a)(i) a	is a	floati	ing-p	oint nu	ımbı	er in t	this [2]	
(b) Explain the reason why binary numbers are stored in normalised form.										[3]											











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