Year 9
Computing
3. Data Representation

STUDENT	
TEACHER	
CLASS	

WORKING AT GRADE	
TERM TARGET	
YEAR TARGET	

The long answer questions in this booklet are designed to stretch and challenge you. It is important that you understand how they should be answered. You should structure your answer like this:

1st Paragraph – should explain the key term e.g. give a definition.

2nd Paragraph – should make a point (could be an advantage or disadvantage) and explain the point fully giving an example where necessary.

3rd Paragraph – should make another point (could be an advantage or disadvantage) and explain the point fully giving an example where necessary.

4th Paragraph – should make a point (could be an advantage or disadvantage) and explain the point fully giving an example where necessary.

You should have at least 1 advantage and 1 disadvantage.

Progress against termly target												
ABOVE												
ON												
BELOW												
TERM	**1**		**2**		**3**		**4**		**5**		**6**	

Learning Outcomes			
	Levels		
Lesson	**5**	**6**	**7**
1 Boolean logic	I can define data types: real numbers and Boolean.	I can perform simple operations using bit patterns e.g. binary addition.	I know the relationship between binary and electrical circuits, including Boolean logic.
2 Characters	I know that digital computers use binary to represent all data.	I know how numbers, images, sounds and character sets use the same bit patterns.	I know how and why values are data typed in many different languages when manipulated within programs.
3 Images	I know how bit patterns represent numbers and images.	I know the relationship between resolution and colour depth, including the effect on file size.	I know the relationship between data representation and data quality.
4 Sound	I know the relationship between binary and file size (uncompressed).	I know how numbers, images, sounds and character sets use the same bit patterns.	I know the relationship between data representation and data quality.
5 Instructions	I know that computers transfer data in binary.	I know the basic function and operation of location addressable memory.	I know that processors have instruction sets and that these relate to low-level instructions carried out by a computer.
6 Assessment	Achieves a level 5 in the end of term assessment	Achieves a level 6 in the end of term assessment	Achieves a level 7 in the end of term assessment

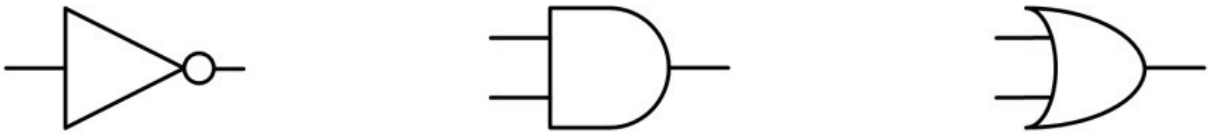
1. Boolean logic

Complete the missing symbols and units of data.

To make it harder they are in the wrong order!

Symbol	Unit of data	Equal to	Size in Bytes	Size difference
		1,024 bytes	$2^{10} = 1024$	2.40%
		1,024 gigabytes	$2^{40} = 1,099,511,627,776$	9.95%
		1,024 megabytes	$2^{30} = 1,073,741,824$	7.37%
		1,024 kilobytes	$2^{20} = 1,048,576$	4.86%

Below are the three main logic gates - label them



TRUTH TABLES

AND

1	1	
1	0	
0	1	
0	0	

OR

1	1	
1	0	
0	1	
0	0	

NOT

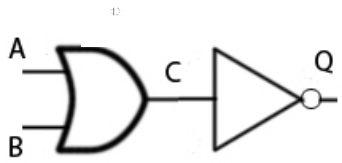
1	
0	

AND NOT

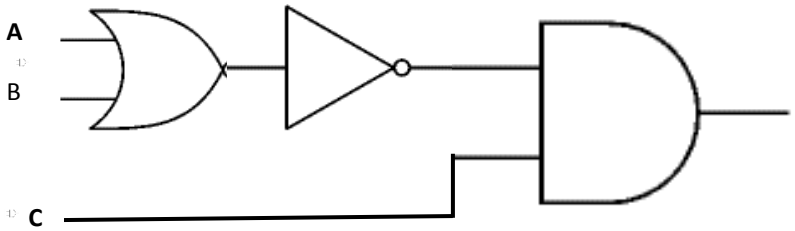
1	1		
1	0		
0	1		
0	0		

Logic gates are used to represent actual electrical circuits used inside computers.

Complete the truth table for this logic gate circuit



A	B	C	Q



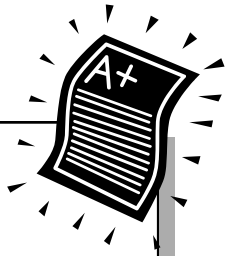
P=

What is the value of P for this logic circuit if A = 1, B = 0, C = 1?

Explain how binary applies to the electrical circuits used inside a computer system.

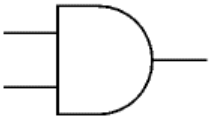
Why can a computer only work in binary?

Self Assessment: **R A G**	Exit Ticket: What kind of data is used in logic gates?

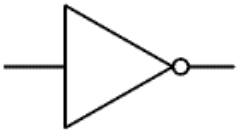


2. Characters

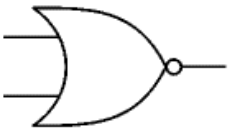
Identify the gates the symbols below represent



.....



.....



.....

80, 114, 111, 103, 114, 97, 109, 109, 101, 114, 115, 32, 97, 114, 101, 32, 116, 104, 101, 32, 110, 101, 119, 32, 114, 111, 99, 107, 115, 116, 97, 114, 115, 33

Can you use the ASCII table on the next page to find out what the secret message is?

ASCII Codes

American Standard Code for Information Interchange

ASCII control characters		
00	NULL	(Null character)
01	SOH	(Start of Header)
02	STX	(Start of Text)
03	ETX	(End of Text)
04	EOT	(End of Trans.)
05	ENQ	(Enquiry)
06	ACK	(Acknowledgement)
07	BEL	(Bell)
08	BS	(Backspace)
09	HT	(Horizontal Tab)
10	LF	(Line feed)
11	VT	(Vertical Tab)
12	FF	(Form feed)
13	CR	(Carriage return)
14	SO	(Shift Out)
15	SI	(Shift In)
16	DLE	(Data link escape)
17	DC1	(Device control 1)
18	DC2	(Device control 2)
19	DC3	(Device control 3)
20	DC4	(Device control 4)
21	NAK	(Negative acknowl.)
22	SYN	(Synchronous idle)
23	ETB	(End of trans. block)
24	CAN	(Cancel)
25	EM	(End of medium)
26	SUB	(Substitute)
27	ESC	(Escape)
28	FS	(File separator)
29	GS	(Group separator)
30	RS	(Record separator)
31	US	(Unit separator)
127	DEL	(Delete)

ASCII printable characters					
32	space	64	@	96	`
33	!	65	A	97	a
34	"	66	B	98	b
35	#	67	C	99	c
36	$	68	D	100	d
37	%	69	E	101	e
38	&	70	F	102	f
39	'	71	G	103	g
40	(	72	H	104	h
41	)	73	I	105	i
42	*	74	J	106	j
43	+	75	K	107	k
44	,	76	L	108	l
45	-	77	M	109	m
46	.	78	N	110	n
47	/	79	O	111	o
48	0	80	P	112	p
49	1	81	Q	113	q
50	2	82	R	114	r
51	3	83	S	115	s
52	4	84	T	116	t
53	5	85	U	117	u
54	6	86	V	118	v
55	7	87	W	119	w
56	8	88	X	120	x
57	9	89	Y	121	y
58	:	90	Z	122	z
59	;	91	[	123	{
60	<	92	\	124	|
61	=	93	]	125	}
62	>	94	^	126	~
63	?	95	_		

Extended ASCII characters							
128	Ç	160	á	192	└	224	Ó
129	ü	161	í	193	┴	225	ß
130	é	162	ó	194	┬	226	Ô
131	â	163	ú	195	├	227	Ò
132	ä	164	ñ	196	─	228	õ
133	à	165	Ñ	197	┼	229	Õ
134	å	166	ª	198	ã	230	µ
135	ç	167	º	199	Ã	231	þ
136	ê	168	¿	200	╚	232	Þ
137	ë	169	®	201	╔	233	Ú
138	è	170	¬	202	╩	234	Û
139	ï	171	½	203	╦	235	Ù
140	î	172	¼	204	╠	236	ý
141	ì	173	¡	205	═	237	Ý
142	Ä	174	«	206	╬	238	¯
143	Å	175	»	207	¤	239	´
144	É	176	░	208	ð	240	≡
145	æ	177	▒	209	Ð	241	±
146	Æ	178	▓	210	Ê	242	‗
147	ô	179	│	211	Ë	243	¾
148	ö	180	┤	212	È	244	¶
149	ò	181	Á	213	ı	245	§
150	û	182	Â	214	Í	246	÷
151	ù	183	À	215	Î	247	¸
152	ÿ	184	©	216	Ï	248	°
153	Ö	185	╣	217	┘	249	¨
154	Ü	186	║	218	┌	250	·
155	ø	187	╗	219	█	251	¹
156	£	188	╝	220	▄	252	³
157	Ø	189	¢	221	¦	253	²
158	×	190	¥	222	Ì	254	■
159	ƒ	191	┐	223	▀	255	nbsp

frequently-used (spanish language)	
ñ	alt + 164
Ñ	alt + 165
@	alt + 64
¿	alt + 168
?	alt + 63
¡	alt + 173
!	alt + 33
:	alt + 58
/	alt + 47
\	alt + 92

vowels acute accent (spanish language))	
á	alt + 160
é	alt + 130
í	alt + 161
ó	alt + 162
ú	alt + 163
Á	alt + 181
É	alt + 144
Í	alt + 214
Ó	alt + 224
Ú	alt + 233

vowels with diaresis	
ä	alt + 132
ë	alt + 137
ï	alt + 139
ö	alt + 148
ü	alt + 129
Ä	alt + 142
Ë	alt + 211
Ï	alt + 216
Ö	alt + 153
Ü	alt + 154

mathematical symbols	
½	alt + 171
¼	alt + 172
¾	alt + 243
¹	alt + 251
³	alt + 252
²	alt + 253
ƒ	alt + 159
±	alt + 241
×	alt + 158
÷	alt + 246

commercial / trade symbols	
$	alt + 36
£	alt + 156
¥	alt + 190
¢	alt + 189
¤	alt + 207
®	alt + 169
©	alt + 184
ª	alt + 166
º	alt + 167
°	alt + 248

quotes and parenthesis	
"	alt + 34
'	alt + 39
(	alt + 40
)	alt + 41
[	alt + 91
]	alt + 93
{	alt + 123
}	alt + 125
«	alt + 174
»	alt + 175

Brief History of ASCII code:

The American Standard Code for Information Interchange, or ASCII code, was created in 1963 by the "American Standards Associatio" Committee or "ASA", the agency changed its name in 1969 by "American National Standards Institute" or "ANSI" as it is known since.

This code arises from reorder and expand the set of symbols and characters already used in telegraphy at that time by the Bell company.

At first only included capital letters and numbers , but in 1967 was added the lowercase letters and some control characters, forming what is known as US-ASCII, ie the characters 0 through 127.
So with this set of only 128 characters was published in 1967 as standard, containing all you need to write in English language.

In 1981, IBM developed an extension of 8-bit ASCII code, called "code page 437", in this version were replaced some obsolete control characters for graphic characters. Also 128 characters were added , with new symbols, signs, graphics and latin letters, all punctuation signs and characters needed to write texts in other languages, such as Spanish.
In this way was added the ASCII characters ranging from 128 to 255.

How to use the ASCII code:

Without knowing it you use it all the time, every time you use a computer system, but if all you need is to get some of the characters not included in your keyboard should do the following, for example:

How to type a Spanish "enye", uppercase N with tilde, ÑÑE,?

On computers with Windows operating system like Win 7, Vista, Windows XP, etc., to get the letter, character, sign or symbol "Ñ":

- Press the "Alt" key on your keyboard, and do not let go.
- While keep press "Alt", on your numeric keypad

How is the binary data that is stored for characters different to the binary stored for images?

Write your own message using ASCII and write it out as the computer would store it in binary.

Can you work out the ASCII value of each of these characters?

Character	Binary	Decimal
A		
z		
!		

Can you work out what character each of these ASCII values represent?

Character	Binary	Decimal
		68
		64
		48

What would your name be in ASCII?

Can you see any problems with the ASCII character set?

Why has it become necessary to develop Unicode?

Self Assessment: R A G	**Exit Ticket:** Is the binary stored different for characters?

3. Images

If the cell has a 1 in it colour it in black.

Cells with 0 in should stay white

0	0	0	0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	1	0	0	0
0	1	0	0	0	0	0	1	1	1	0
0	1	0	0	0	0	0	1	0	1	0
0	0	1	0	0	0	1	1	1	1	0
0	0	0	1	1	1	0	0	0	0	0
0	1	1	1	1	1	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0

Computers use binary to represent each pixels colour. What we have done so far is a simplified version, in reality each pixel is represented by between 8 and 32 bits depending on the colour system being used by the computer system.

Use the spreadsheet your teacher has given to you create a simple design on the black and white tab.

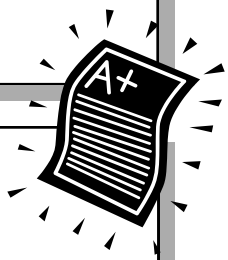
Explain why this image has a colour depth of 1:

Now look at the greyscale tab. This shows an image that has a colour depth of 8—explain why this has a colour depth of 8:

What will happen to the file size of the image as you increase the colour depth?

You have created an image using two resolutions— 1 ppi and 2 ppi. Explain how increasing the resolution of an image effects file size:

Explain the advantages and disadvantages of increasing colour depth and resolution:



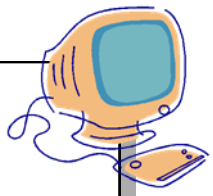
Self Assessment: **R A G**	**Exit Ticket:** What would happen to the image file size if you increase either the colour depth or resolution?

4. Sound

Match up the correct keyword to its definition

ASCII	At least 16-bit code. Defines what characters it encodes and then uses a suitable number of octets to store them as a number.
Pixel	The number of dots per unit length. It affects the clarity of the image.
Resolution	'Picture cell' – a dot that makes up a part of an image. Resolution The number of dots per unit length. It affects the clarity
Unicode	American Standard Code for Information Interchange – a7-bit character code.

Today we are learning about how computers represent sounds and why the data for this must be accurate. Copy the binary below into the Python program as one continuous string when prompted.



010001110001	010001110001	010001010001
010001010001	010001110001	010001010001
010000110001	010001110010	010001110001
010001010001	010001110001	010001010001
010001110001	010001010001	010000110100
010001110001	010000110001	
010001110010	010001010001	
010001010001	010001110001	
010001010001	010001110001	
010001010010	010001110010	

What song does the binary data create? _____

_____

Copy the data into the spreadsheet given to you by your teacher, what do you notice? Why can this happen?

_____

_____

_____.

When computers convert analogue sound into digital, regular recordings of the height of the sound wave are taken and converted into binary. This is called sampling. Using the worksheet given to you experiment with changing the sample rate and explain your findings below:

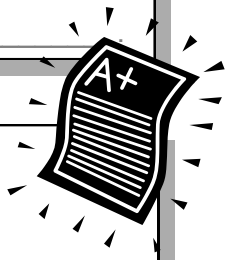
_____

_____

_____.

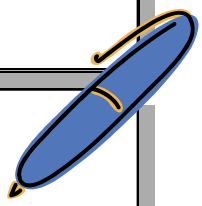
_____.

_____



Self Assessment:	Exit Ticket: Are bit patterns for sound different to images?
R A G	

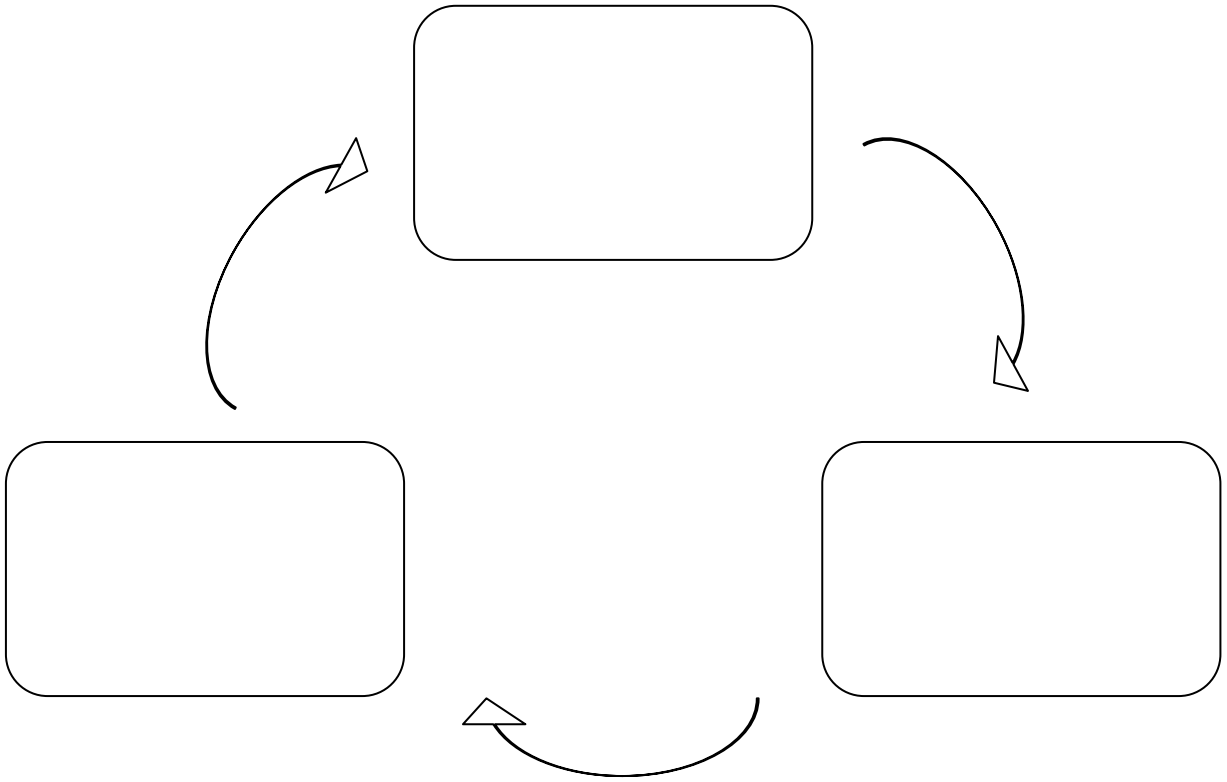
STRENGTH	TARGET	ACTION	EFFORT



Green Pen Activity:

5. Instructions

Complete the diagram for the fetch / execute cycle , explaining each step:



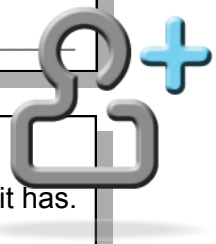
What is an instruction?

What are the two parts of an instruction called?

What are instructions stored and executed by a computer written in?

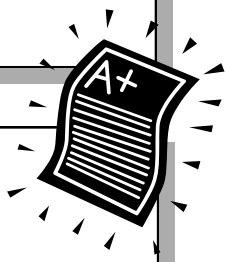
Write a set of instructions using the LMC instruction set to:

1. Ask the user for two numbers
2. Store them as num1 and num2
3. Output them in reverse order



Try to extend the program you have written in the LMC and multiply the two numbers together.

It is said that the instructions you can write for your CPU to do are limited by the instruction set it has. Explain what is meant by this sentence and give an example.



Self Assessment:	Exit Ticket: What does the operand relate to?
R A G	

6. Assessment lesson

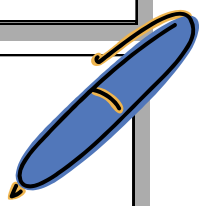
Data Representation

X N G N I L P M A S G V J E I N M A Z G
E E G G X B R L T M R A S R Z Q D J U B
L D M Z T I H W K V L Y T D N C I G O L
U U L A N D L N O I T U L O S E R V B T
F I L E C U W A Q C C X I I Q D R S K A
C Z K C X N K U T N A S H B W K X B N X
N Q X G A I U C H I S B P C D W M C H J
N H W C T C P E S E G C W O L F R E V O
A J E D T O N O R H E I J Y C X T I B O
Z T N U I D L P M Z C P D Q A U P P R P
I V M S G E M Z V T T Z E P J G T O E G
I S B E N O I T C U R T S N I A P S T K
C Q W S C S L H E X U V N W W E C Z C V
S M Z A T A D A T E M G R O R I W M A N
A R A S M Y Q I N U P A U A H E S X R S
I O E R L C M K L A O N N P S E F A A A
S T I L B E M B S O O D A M T C Q F H D
Q C Z D T J L A G R D R I P F Q D O C R
B E G A R X E K P B G J X G N J Q L O O
L V G H W A R O T A R E P O H S Y U R O

LOGIC
AND
ASCII
UNICODE
METADATA
VECTOR
COMPRESSION
INSTRUCTION
OPERATOR
NOT
GATE
CHARACTER
BIT
PIXEL
GRAPHICS
DIGITAL
SET
OR
OVERFLOW
SET
MAP
RESOLUTION
ANALOGUE
SAMPLING
OPERAND

STRENGTH	TARGET	ACTION	EFFORT

Green Pen Activity:



Keywords

Logic gate	A special circuit that allows a specific output depending on the inputs. A processor is made up of millions of these circuits.
NOT gate	A logic gate that has one input. If the input is ‘0’, its output is ‘1’. If the input is ‘1’, its output is ‘0’.
OR gate	A logic gate that has two inputs. If either or both of the two inputs is ‘1’, its output is ‘1’.
AND gate	A logic gate that has two inputs. If both inputs are ‘1’ it will output ‘1’, otherwise it will output ‘0’.
Overflow	An error caused by attempting to store a number that is too large for the number of bits available.
ASCII	American Standard Code for Information Interchange – a7-bit character code.
Character set	The complete collection of characters that can been coded in a particular coding system.
Unicode	At least 16-bit code. Defines what characters it encodes and then uses a suitable number of octets to store them as a number.
Bit map	An image file format where the picture is represented asset of dots or pixels.
Metadata	Data about data.
Pixel	’Picture cell’ – a dot that makes up a part of an image. Resolution The number of dots per unit length. It affects the clarity
Resolution	The number of dots per unit length. It affects the clarity of the image.
Vector graphics	Graphics stored as formulae.
Analogue	A form of signal that can take any value between the lowest and the highest. Sound is like this.
Compression	The process of reducing a file’s size by removing data.
Digital	A form of signal that is either on or off. Computer music files must be digital.
MP3 MPEG-1 or MPEG-2	P3 MPEG-1 or MPEG-2 Audio Layer III – a digital audio encoding format which uses lossy data compression. A common standard for digital music.
Sampling	The process of capturing data about the sound at intervals.
Instruction set	The total collection of instructions that a processor can carry out.
Operand	The part of an instruction that identifies the data to be handled by the operator.
Operator	The part of an instruction that tells the processor what to do.