Learning Aims

- Represent positive integers in binary and hexadecimal
- Convert between binary, hexadecimal and denary

Binary number system – representing integers

Binary is a base 2 number system

- The bit at the leftmost position is known as the Most Significant Bit (MSB)
- The bit at the rightmost position is known as the Least Significant Bit (LSB)

Place Values	2^8	2^7	2^6	2^5	2^4	2^2	2^1	2^0
	128	64	32	16	8	4	2	1
	0	**0**	**0**	**1**	**0**	**1**	**0**	**1**

Adding these together gives **21**

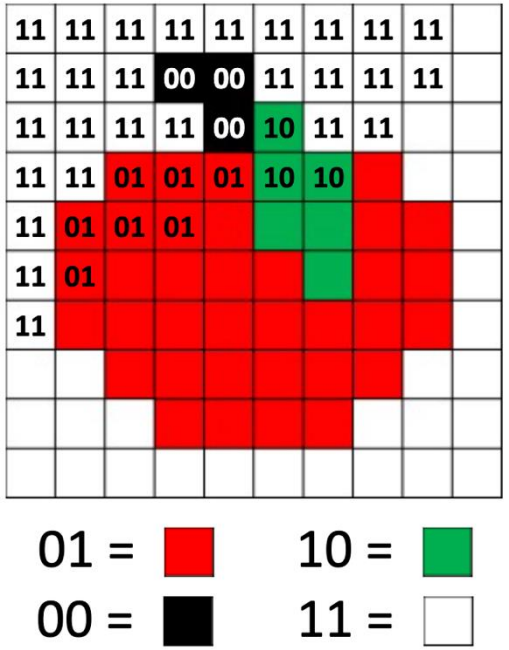
Using binary to represent data and program instructions

- Numbers, letters, images, sound and instructions have to encoded in binary
- For example, ASCII encoding system for representing text as binary numbers:

Letter	Binary
8	0011 1000
<space>	0010 0000
b	0110 0010
i	0110 1001
t	0111 0100
s	0111 0011

When we display a binary pattern as characters on the screen, it looks up the graphic representation for it in the font definition and sends it to the screen

To encode an image, each tiny picture element (pixel) is allocated its own binary pattern, for example 2 bits per pixel can generate 4 different possible colours.



Hexadecimal number system

The hexadecimal system, often referred to as simply ‘hex’

Base of 16.

Denary	Binary (4-bit)	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Converting from binary to hexadecimal and vice versa

To convert a binary number to hexadecimal, split the binary number into groups of 4 binary digits.

Binary	0011	1010	1111	1010
Hex	3	A	F	9

The hex representation of 0011 1010 1111 1010 is therefore 3AF9.

To convert from hex to binary, perform this operation in reverse by grouping the bits in groups of 4 and translating each group into binary. For example, to convert the number 23

HEX	2	3
Binary	0010	0011

= 00100011

Q1: Convert the hexadecimal number A7 into binary.

Q2: What is 1111 1111 in hexadecimal?

Converting from hexadecimal to denary and vice versa

To convert from hexadecimal to denary, remember that the left column now represents 16s and not tens.
For example, to convert 27_{16}

	16 s	1s
HEX	2	7

= 2 x 16 + 7 = 39

To convert a denary number to hex, the easiest way is to first convert the denary number to binary and then translate from binary to hex. For example, to convert 75 $_{10}$

	128	64	32	16	8	4	2	1
Binary	0	1	0	0	1	0	1	1
Split into 2 nibbles	8	4	2	1	8	4	2	1
Hex	4				B			

Therefore 75 = 4B

Another way

75/16 = 4 remainder 11, or 4B, since 11 is B in hexadecimal

A2C as a denary number is:

Column value	$256 = 16^2$	$16 = 16^1$	$1 = 16^0$
Hexadecimal number	A	2	C
Denary value	10*256	2*16	12

A2C is 2560+32+12 = 2604 in denary

Why the hexadecimal number system is used

- The hexadecimal system is used as a **shorthand for binary** since it is simple to represent a byte in just two digits

- Fewer mistakes are likely to be made in writing a hex number than a string of binary digits.

- It is easier for technicians and computer users to write or remember a hex number than a binary number.

Colour codes in images often use hexadecimal to represent the RGB values, as they are much easier to remember than a 24-bit binary string. In the example overleaf #364DB2 represents 3616

36 for Red,
4D for Green and B2 for Blue

Can be displayed or printed in the Colour Picker window more compactly than in binary.