Chapter 1-Information representation

1.1 Data Representation
1.2 Multimedia – Graphics, Sound
1.3 Compression

Learning objectives

1.1 Data Representation

Show understanding of binary magnitudes and the difference between binary prefixes and decimal prefixes	Understand the difference between and use: • kibi and kilo • mebi and mega • gibi and giga • tebi and tera
Show understanding of the basis of different number systems	Use the binary, denary, hexadecimal number bases and Binary Coded Decimal (BCD) and one's and two's complement representation for binary numbers Convert an integer value from one number base / representation to another
Perform binary addition and subtraction	Using positive and negative binary integers Show understanding of how overflow can occur
Describe practical applications where Binary Coded Decimal (BCD) and Hexadecimal are used	
Show understanding of and be able to represent character data in its internal binary form, depending on the character set used	Familiar with ASCII (American Standard Code for Information Interchange), extended ASCII and Unicode. Students will not be expected to memorise any particular character codes

Learning objectives

1.2 Multimedia:

Graphics

Show understanding of how data for a bitmapped image are encoded	Use and understand the terms: *pixel*, *file header*, *image resolution*, *screen resolution*, *colour depth/bit depth*
Perform calculations to estimate the file size for a bitmap image	
Show understanding of the effects of changing elements of a bitmap image on the image quality and file size	Use the terms: *image resolution*, *colour depth/bit depth*
Show understanding of how data for a vector graphic are encoded	Use the terms: *drawing object*, *property*, *drawing list*
Justify the use of a bitmap image or a vector graphic for a given task	

Sound

Show understanding of how sound is represented and encoded	Use the terms: *sampling*, *sampling rate*, *sampling resolution*, *analogue and digital data*
Show understanding of the impact of changing the sampling rate and resolution	Impact on file size and accuracy

Learning objectives

1.3 Compression

Show understanding of the need for and examples of the use of compression	
Show understanding of lossy and lossless compression and justify the use of a method in a given situation	
Show understanding of how a text file, bitmap image, vector graphic and sound file can be compressed	Including the use of run-length encoding (RLE)

Chapter 1-Information representation

1.1 Data Representation

Learning objectives

1.1 Data Representation

Show understanding of binary magnitudes and the difference between binary prefixes and decimal prefixes	Understand the difference between and use: • kibi and kilo • mebi and mega • gibi and giga • tebi and tera
Show understanding of the basis of different number systems	Use the binary, denary, hexadecimal number bases and Binary Coded Decimal (BCD) and one's and two's complement representation for binary numbers Convert an integer value from one number base / representation to another
Perform binary addition and subtraction	Using positive and negative binary integers Show understanding of how overflow can occur
Describe practical applications where Binary Coded Decimal (BCD) and Hexadecimal are used	
Show understanding of and be able to represent character data in its internal binary form, depending on the character set used	Familiar with ASCII (American Standard Code for Information Interchange), extended ASCII and Unicode. Students will not be expected to memorise any particular character codes

1.1 Data Representation

Introduction:

What is binary?

Binary is a base 2 number system, meaning that all numbers and other data can only represented using ones and zeros. All modern computer systems store data and programs in binary

```
01010101  01001100  01000001  01001110
01000001  01001110  01010100  01001111
01010111  01001111  00100000  01001001
```

This stream of ones and zeros could represent any form of data – text, graphics, video, sound

1.1 Data Representation

Introduction:

What is binary?

Key Advantages:

•Binary data can be transmitted easily and reliably.
•Binary data can be stored and read very easily and reliably.
•Computers use circuits that can only be on one of 2 states – on or off, these work very well with binary calculations.
•The input voltage in to computers is not very stable, so only a system that use voltage/no voltage would be reliable.

Take a look at the following video in the next slide for more detailed information.

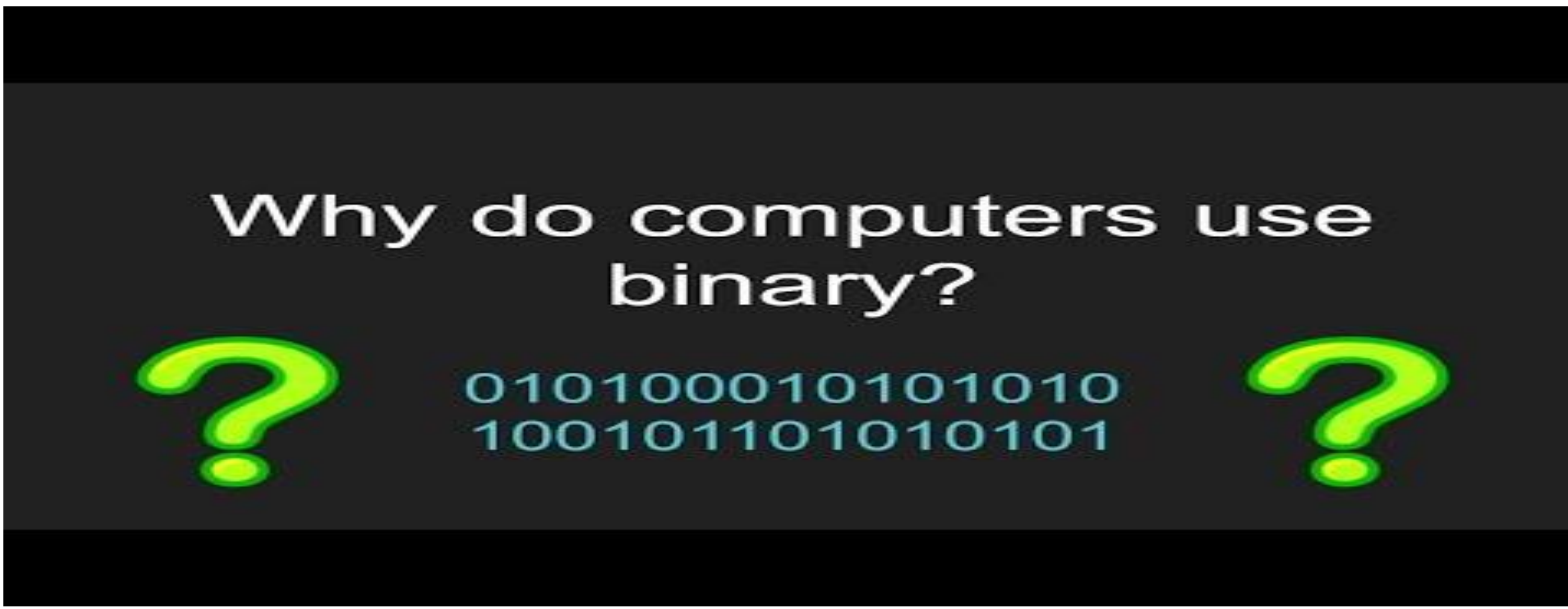
1.1 Data Representation

Introduction:

What is binary?

Click the link below to watch the video at home 17 minutes

https://youtu.be/k-5jpns0uTA



1.1 Data Representation

Bits, Bytes & Nibbles

Bit – e.g. 0
Each individual 1 or 0 is known as a **bit**.
Here are three bits – 110
Byte – e.g. 11001100
Each group of 8 bits is known as a **Byte**
Here is a stream of Bytes:
01010011 01101011 01111001 01110010 01101001 01101101 00100000 01101001 01110011 00100000 01100001 01110111 01100101 01110011 01101111 01101101 01100101 00100001

Nibble – e.g. 1111

A nibble is 4 bits, or half a Byte.

Here is a nibble – 1101

1.1 Data Representation

Measurement of the size of computer memories

The Difference Between Kilobytes and Kibibytes

A kibibyte is the formal name for 1024 Bytes. It is "supposed" to be used instead of kilobyte for this quantity, which according to SI naming conventions is supposed to be used for 1000 bytes. Kibibyte, Kilobyte.

In my experience, the "kibi" terms seem to be rarely used, as just about every computer person other than some people on the net uses kilobyte to mean 1024 bytes and megabyte (or "meg") to be 1024^2 bytes (versus "mebibyte", which I've seen even more rarely).

In practice, powers of 1024 bytes tend to end up being used for RAM, while powers of 1000 end up being used for selling hard disks and other persistent storage. Confusingly, file sizes in bytes are also typically reported in terms of 1024 byte powers by most Unix/Linux file size tools, such as "ls -lh". (ls -lh. This command will show you the file sizes in human readable format)

Whenever I hear the word "kibibyte", I think of this…

1.1 Data Representation

Measurement of the size of computer memories

Name of memory size	Equivalent denary value (bytes)
1 kilobyte (1 KB)	1 000
1 megabyte (1 MB)	1 000 000
1 gigabyte (1 GB)	1 000 000 000
1 terabyte (1 TB)	1 000 000 000 000
1 petabyte (1 PB)	1 000 000 000 000 000

Name of memory size	Number of bytes	Equivalent denary value (bytes)
1 kibibyte (1 KiB)	2^{10}	1 024
1 mebibyte (1 MiB)	2^{20}	1 048 576
1 gibibyte (1 GiB)	2^{30}	1 073 741 824
1 tebibyte (1 TiB)	2^{40}	1 099 511 627 776
1 pebibyte (1 PiB)	2^{50}	1 125 899 906 842 624

1.1 Data Representation

The Difference Between Kilobytes and Kibibytes

Multiples of bytes								V·T·E
Decimal			Binary					
Value	Metric		Value	IEC		JEDEC		
1000	kB	kilobyte	1024	KiB	kibibyte	KB	kilobyte	
1000^2	MB	megabyte	1024^2	MiB	mebibyte	MB	megabyte	
1000^3	GB	gigabyte	1024^3	GiB	gibibyte	GB	gigabyte	
1000^4	TB	terabyte	1024^4	TiB	tebibyte	—		
1000^5	PB	petabyte	1024^5	PiB	pebibyte	—		
1000^6	EB	exabyte	1024^6	EiB	exbibyte	—		
1000^7	ZB	zettabyte	1024^7	ZiB	zebibyte	—		
1000^8	YB	yottabyte	1024^8	YiB	yobibyte	—		

This system is more accurate. Internal memories (such as RAM) should be measured using the IEC system. A 64 GiB RAM could, therefore, store 64×2^{30} bytes of data (68 719 476 736 bytes).

1.1 Data Representation

Number systems:

Designers of computer systems adopted the binary (base 2) number system since this allows only two values, 0 and 1.

- 2^0 = 1
- 2 ^ 1 = 2
- 2 ^ 2 = 4
- 2 ^ 3 = 8
- 2 ^ 4 = 16
- 2 ^ 5 = 32
- 2 ^ 6 = 64
- 2 ^ 7 = 128
- 2 ^ 8 = 256
- 2 ^ 9 = 512
- 2 ^ 10 = 1024

Learning objectives

1.1 Data Representation

Number systems: Converting from binary to denary

We use a number system that uses 10 different numbers. (Base 10 number system):

0 , 1, 2, 3, 4, 5, 6, 7, 8, 9

This is called the **Denary System:** **example: 00000011 is binary for 3.**

- The position of numbers in binary is also important.
- Calculating denary number 6:

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

(1 * 4) = 4 + (1 * 2) = 2

Binary = 00000110

1.1 Data Representation

Number systems: Converting from binary to denary

Let's suppose we are trying to find the decimal for the **binary number 01101011.**

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

64 + 32 + 8 + 2 + 1 = 107

1.1 Data Representation

Number systems: Converting from binary to denary

ACTIVITY 1A

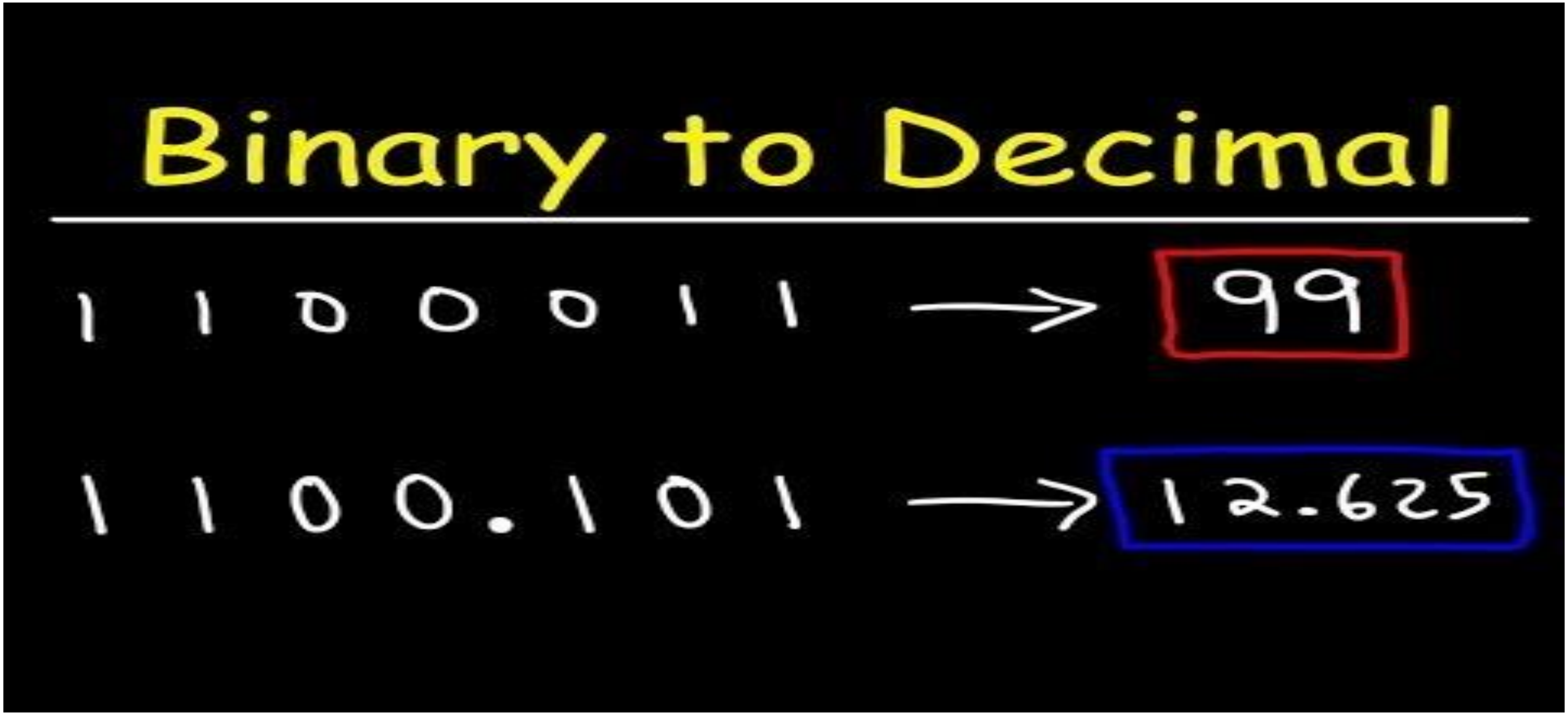
Convert these binary numbers into denary.

a) 0 0 1 1 0 0 1 1
b) 0 1 1 1 1 1 1 1
c) 1 0 0 1 1 0 0 1
d) 0 1 1 1 0 1 0 0
e) 1 1 1 1 1 1 1 1
f) 0 0 0 0 1 1 1 1
g) 1 0 0 0 1 1 1 1
h) 0 0 1 1 0 0 1 1
i) 0 1 1 1 0 0 0 0
j) 1 1 1 0 1 1 1 0

Number systems

Watch the video for the Binary-Decimal or Denary conversions

https://www.youtube.com/watch?v=VLflTjd3lWA



1.1 Data Representation

Number systems: Converting from denary to binary

Let's suppose we are trying to find the binary for the **decimal number 75**

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

Binary number : 01001011

1.1 Data Representation

Number systems: Converting from denary to binary

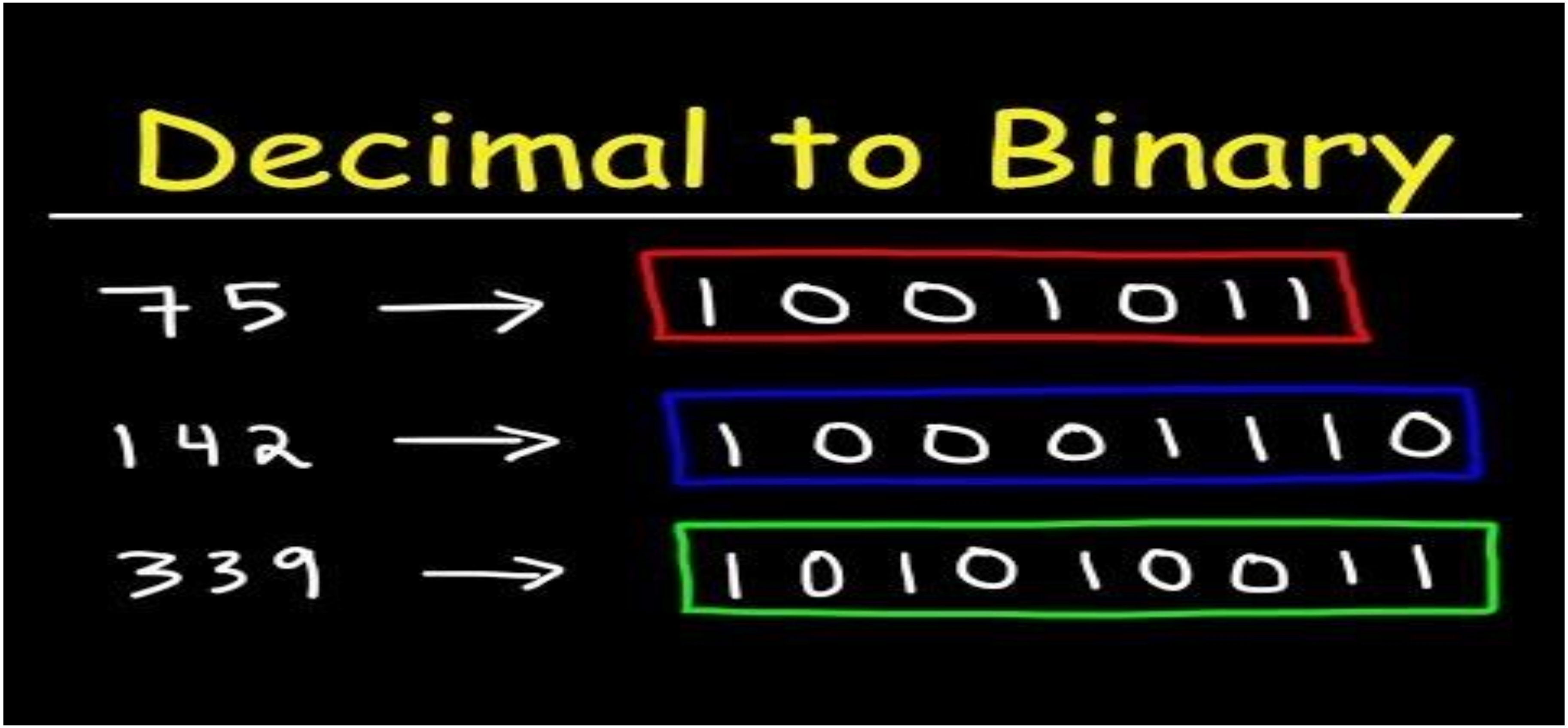
Convert these denary numbers into binary

a) 41
b) 67
c) 86
d) 100
e) 111
f) 127
g) 144
h) 189
i) 200
j) 255

Number systems

Watch the video for Decimal or Denary to Binary conversions

https://www.youtube.com/watch?v=rsxT4FfRBaM



1.1 Data Representation

Hexadecimal

Hexadecimal (or hex) is a base 16 system used to simplify how binary is represented. A hex digit can be any of the following 16 digits: **0 1 2 3 4 5 6 7 8 9 A B C D E F**.

Each hex digit reflects a 4-bit binary sequence.

This table below shows each hex digit with the equivalent values in binary and denary.

Denary	Binary	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

1.1 Data Representation

Hexadecimal

This means an **8-bit** binary number can be written using only two different hex digits - one hex digit for each nibble (or group of **4-bits**). It is much easier to write numbers as hex than to write them as binary numbers.

For example:

11010100 in binary would be **D4** in hex

FFFF3 in hex would be **11111111111111110011** in binary

Hex codes are used in many areas of computing to simplify binary codes. It is important to note that computers do not use hexadecimal - it is used by humans to shorten binary to a more easily understandable form. Hexadecimal is translated into binary for computer use.

Some examples of where hex is used include:

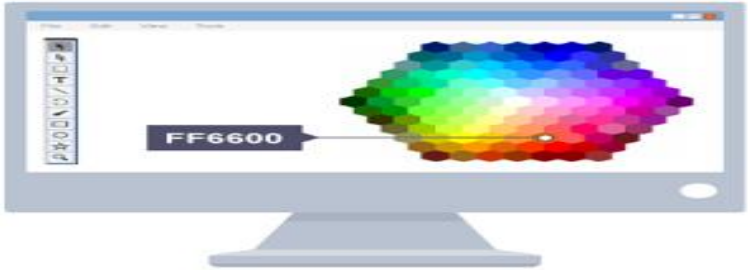
colour references
assembly language programs
error messages

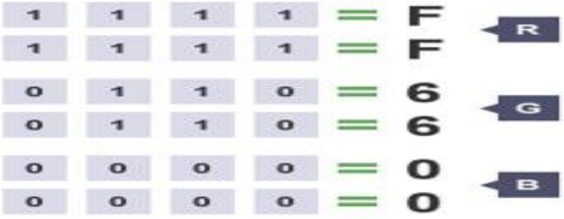
1.1 Data Representation

Hexadecimal

Hex can be used to represent colours on web pages and image-editing programs using the format **#RRGGBB** (**RR = reds**, **GG = greens**, **BB = blues**). The **#** symbol indicates that the number has been written in hex format.

This system uses two hex digits for each colour, eg **#FF6600**.





As one hex digit represents 4 **bits**, two hex digits together make 8 bits (1 **byte**). The values for each colour run between 00 and FF. In binary, 00 is 0000 0000 and FF is 1111 1111. That provides 256 possible values for each of the three colours.

That gives a total **spectrum** of 256 reds x 256 greens x 256 blues - which is over 16 million colours in total.

#FF0000 will be the purest red - red only, no green or blue.

Black is **#000000** - no red, no green and no blue.

White is **#FFFFFF.**

spectrum mean is a band of colours

1.1 Data Representation

a).Converting from Hexadecimal to Decimal or (Denary)

Using the same method as denary and binary, this gives the headings of 16^0, 16^1, 16^2, 16^3 and so on. The typical headings for a hexadecimal number with five digits would be

65 536	4 096	256	16	1
(16^4)	(16^3)	(16^2)	(16^1)	(16^0)

- Hexadecimal Number FF to denary

F = 15

Decimal	4096	256	16	1
Hexadecimal			F	F

((16 * 15) = 240) + ((1 * 15) = 15))

(240 + 15 = 255)

Denary = 255

1.1 Data Representation

a.)Converting from Hexadecimal to Decimal or (Denary)

Hexadecimal Number 8D to denary

D = 13

Decimal	4096	256	16	1
Hexadecimal			8	D

((16 * 8) = 128) + ((1 * 13) = 13)

((128 + 13 = 141)

Denary = 141

1.1 Data Representation

a).Converting from Hexadecimal to Decimal or (Denary)

Convert 55AC to denary

A = 10
C = 12

Decimal	4096	256	16	1
Hexadecimal	5	5	A	C

(4096 * 5) + (256+5)+ (16 *10)+(1*12)

Denary = 21932

1.1 Data Representation

a).Converting from Hexadecimal to Decimal or (Denary)

Convert the following hexadecimal numbers into denary

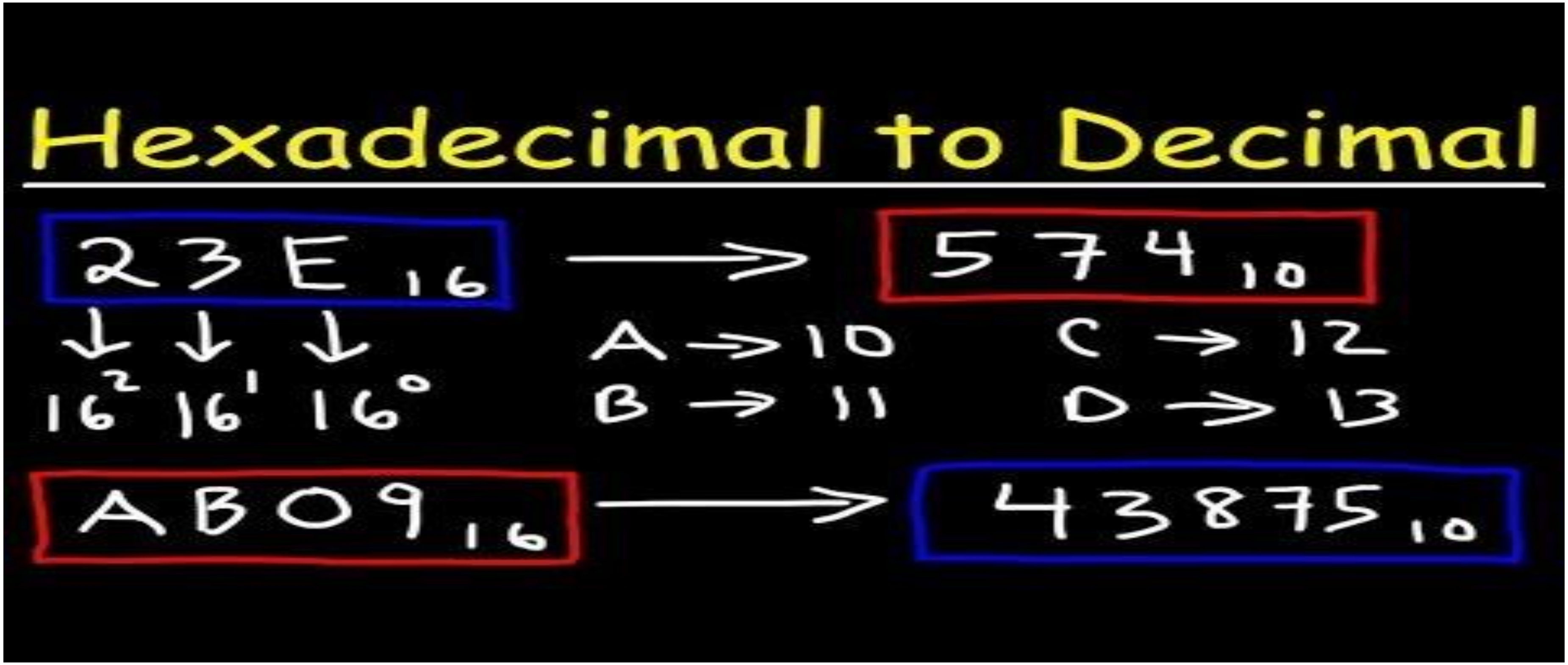
a 6 B
b 9 C
c 4 A
d F F
e 1 F F
f A 0 1
g B B 4
h C A 8
i 1 2 A E
j A D 8 9

1.1 Data Representation

a).Converting from Hexadecimal to Decimal or (Denary)

Click the link below to watch the video to How to convert Hexadecimal to Decimal or (Denary)

https://www.youtube.com/watch?v=pg-HEGBpCQk



1.1 Data Representation

b).Converting from Decimal to Hexadecimal

Method 1: Convert the denary to binary first and then convert the binary to hex as below:

Consider the conversion of the denary number, 2004, into hexadecimal.

Denary	1024	512	256	128	64	32	16	8	4	2	1
Binary	1	1	1	1	1	0	1	0	1	0	0

7 | D | 4

Now look at Hexadecimal is a base 16 number table system above: you need to start from the left to the right by dividing

01111 = 7 and 1101 = D and 0100 = 4

denary number = 2004, into hexadecimal = 7D4

1.1 Data Representation

b).Converting from Decimal to Hexadecimal

- **To verify our finding then we use the method 2 below :**

Consider the conversion of the denary number, 2004, into hexadecimal. This method

involves placing hexadecimal digits in the appropriate position so that the total

256	16	1	
7	D	4	(Note: D = 13)

A quick check shows that: $(7 \times 256) + (13 \times 16) + (4 \times 1)$ gives 2004.

1.1 Data Representation

b).Converting from Decimal to Hexadecimal

Convert the following denary numbers into hexadecimal (using both methods):

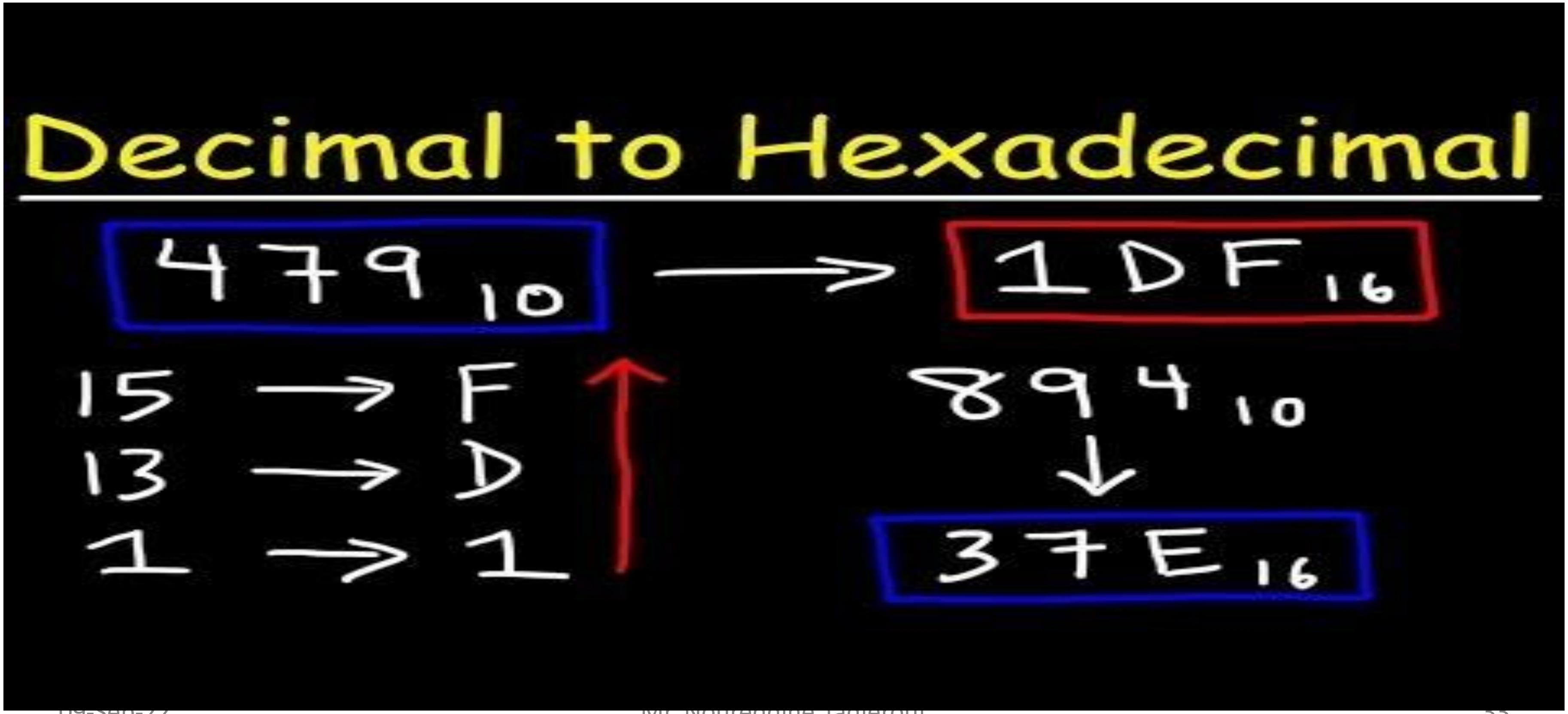
a 9 8
b 2 2 7
c 4 9 0
d 5 1 1
e 8 2 6
f 1 0 0 0
g 2 6 3 4
h 3 7 4 3
i 4 0 0 7
j 5 0 0 0

1.1 Data Representation

b).Converting from Decimal to Hexadecimal

Click the link below to watch the video to How to convert Decimal to Hexadecimal

https://www.youtube.com/watch?v=QJW6qnfhC70



1.1 Data Representation

C). Converting from Binary to Hexadecimal

The first hex digit represents groups of 16, the second hex digit represents the units left over.

$$92 \text{ denary} = \underbrace{0101}_{\substack{5\\ \text{(groups of 16)}}}\ \underbrace{1100}_{\substack{12\\ \text{units}\\ \text{(replaced by C)}}} = 5C \text{ in hex}$$

Convert the following binary numbers into hexadecimal:

a 1 1 0 0 0 0 1 1

b 1 1 1 1 0 1 1 1

c 1 0 0 1 1 1 1 1 1 1

d 1 0 0 1 1 1 0 1 1 1 0

e 0 0 0 1 1 1 1 0 0 0 0 1

f 1 0 0 0 1 0 0 1 1 1 1 0

g 0 0 1 0 0 1 1 1 1 1 1 1 0

h 0 1 1 1 0 1 0 0 1 1 1 0 0

i 1 1 1 1 1 1 1 1 0 1 1 1 1 1 0 1

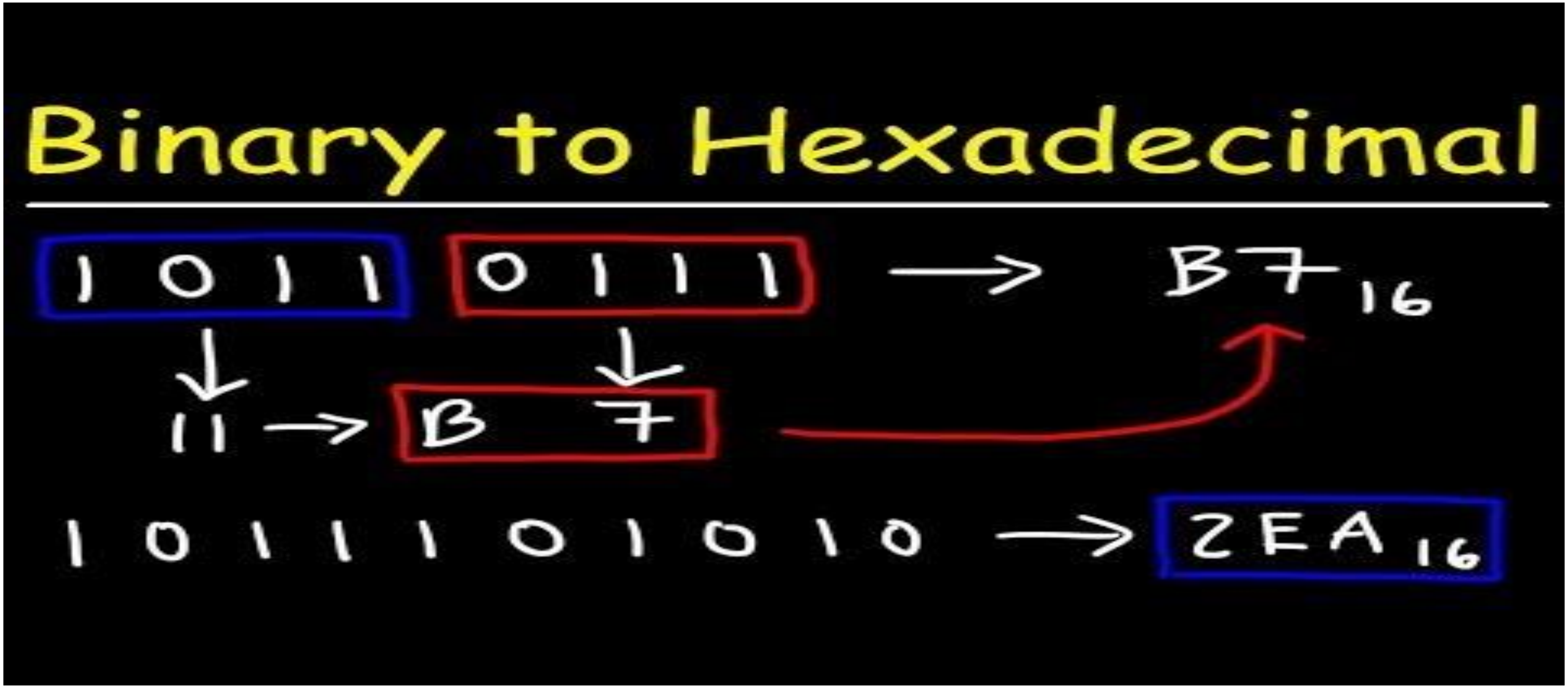
j 0 0 1 1 0 0 1 1 1 1 0 1 0 1 1 1 0

1.1 Data Representation

C). Converting from Binary to Hexadecimal

Click the link below to watch the video to How to convert Binary to Hexadecimal

https://www.youtube.com/watch?v=tSLKOKGQq0Y

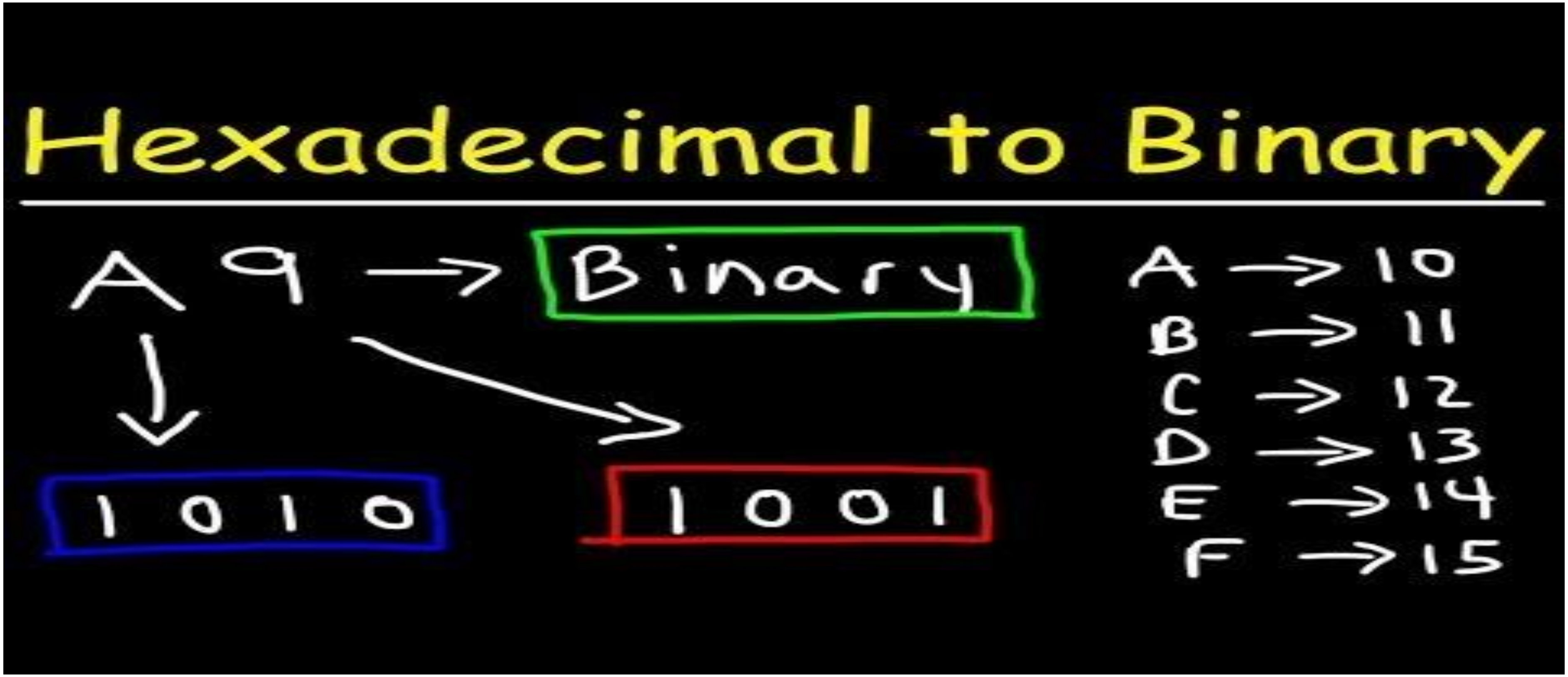


1.1 Data Representation

d). Converting from Hexadecimal to Binary

Click the link below to watch the video to How to convert Hexadecimal to Binary

https://www.youtube.com/watch?v=D_YC6DSPpQE



1.1 Data Representation

d). Converting from Hexadecimal to Binary

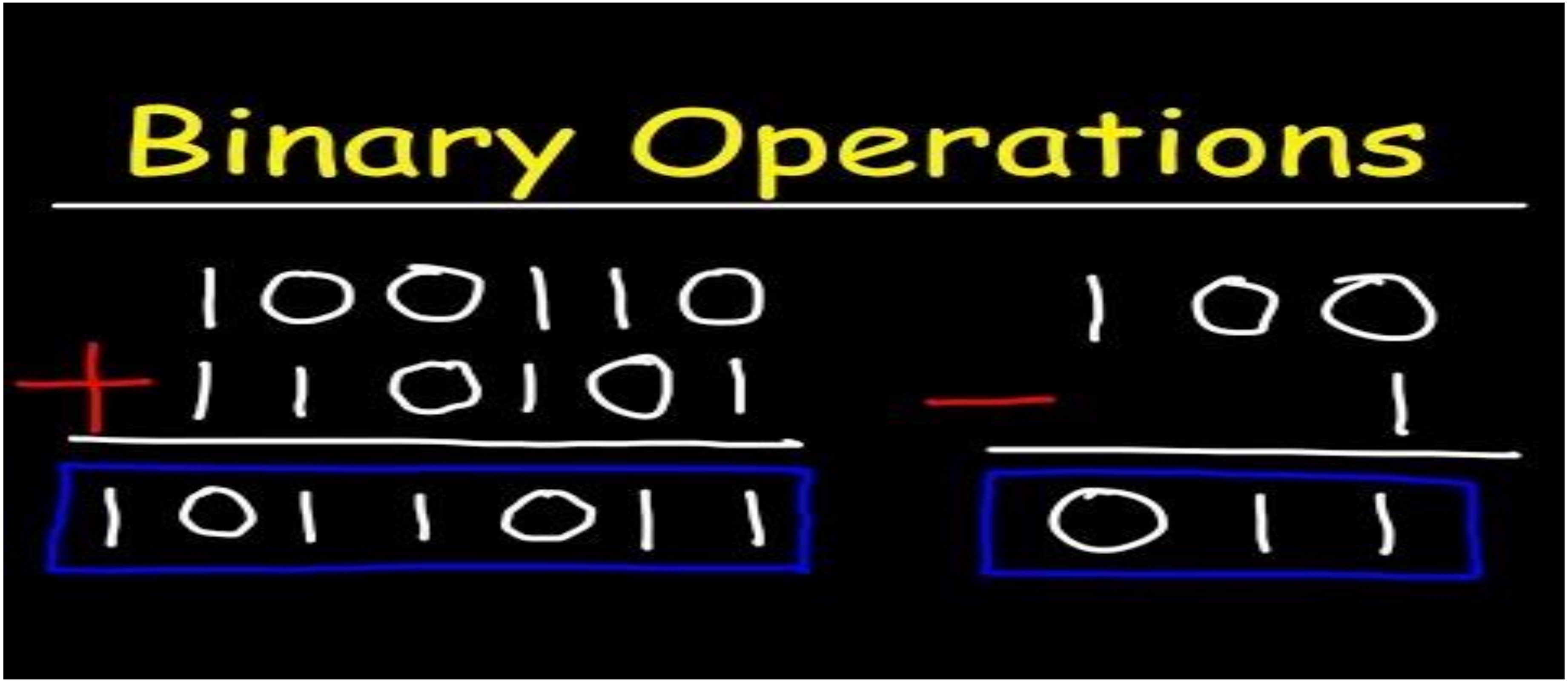
Convert the following hexadecimal numbers into binary:

a 6 C
b 5 9
c A A
d A 0 0
e 4 0 E
f B A 6
g 9 C C
h 4 0 A A
i D A 4 7
j 1 A B 0

1.1 Data Representation

Number systems: Binary addition and subtraction

Click the link below to watch the video to How To Add and Subtract Binary Numbers:
https://www.youtube.com/watch?v=C5EkxfNEMjE



1.1 Data Representation

Number systems: Binary Addition:

Example 1.1

Add 0 0 1 0 0 1 0 1 (37 in denary) and 0 0 1 1 1 0 1 0 (58 in denary).

Solution

−128	64	32	16	8	4	2	1
0	0	1	0	0	1	0	1
			+				
0	0	1	1	1	0	1	0
			=				
0	1	0	1	1	1	1	1

This gives us 0 1 0 1 1 1 1 1, which is 95 in denary; the correct answer.

1.1 Data Representation

Number systems: Binary Addition:

Example 1.2

Add 0 1 0 1 0 0 1 0 (82 in denary) and 0 1 0 0 0 1 0 1 (69 in denary).

Solution

−128	64	32	16	8	4	2	1
0	1	0	1	0	0	1	0
				+			
0	1	0	0	0	1	0	1
				=			
1	0	0	1	0	1	1	1

1.1 Data Representation

Number systems: Binary Addition:

Question:

Add the following binary numbers:

```
  10010          1011101          10011
+ 1100       + 1000000      + 1111101

  10011001       11000011        1001100
+   100111   +     101111   + 1100101
```

1.1 Data Representation

Number systems: Binary Addition

Answer:

```
  10010             1011101          10011
+ 1100          + 1000000        + 1111101
------          ---------        ---------
 11110           10011101         10010000

  10011001         11000011        1001100
+   100111     +     101111      + 1100101
----------     ----------        ---------
  11000000         11110010       10110001
```

1.1 Data Representation

Number systems: Binary Subtraction: for this example we will look at 2 complement in details in slides 58

Carry out the subtraction 95 – 68 in binary.

Solution

1 Convert the two numbers into binary:

95 = 0 1 0 1 1 1 1 1

68 = 0 1 0 0 0 1 0 0

2 Find the two's complement of 68:

invert the digits:	1	0	1	1	1	0	1	1	
add 1:								1	
which gives:	1	0	1	1	1	1	0	0	= −68

3 Add 95 and −68:

	−128	64	32	16	8	4	2	1
	0	1	0	1	1	1	1	1
					+			
	1	0	1	1	1	1	0	0
					=			
1	0	0	0	1	1	0	1	1

The additional ninth bit is simply ignored leaving the binary number 0 0 0 1 1 0 1 1 (denary equivalent of 27, which is the correct result of the subtraction).

1.1 Data Representation

Number systems: Binary addition and subtraction

Carry out these binary subtraction. Convert your answers to denary.

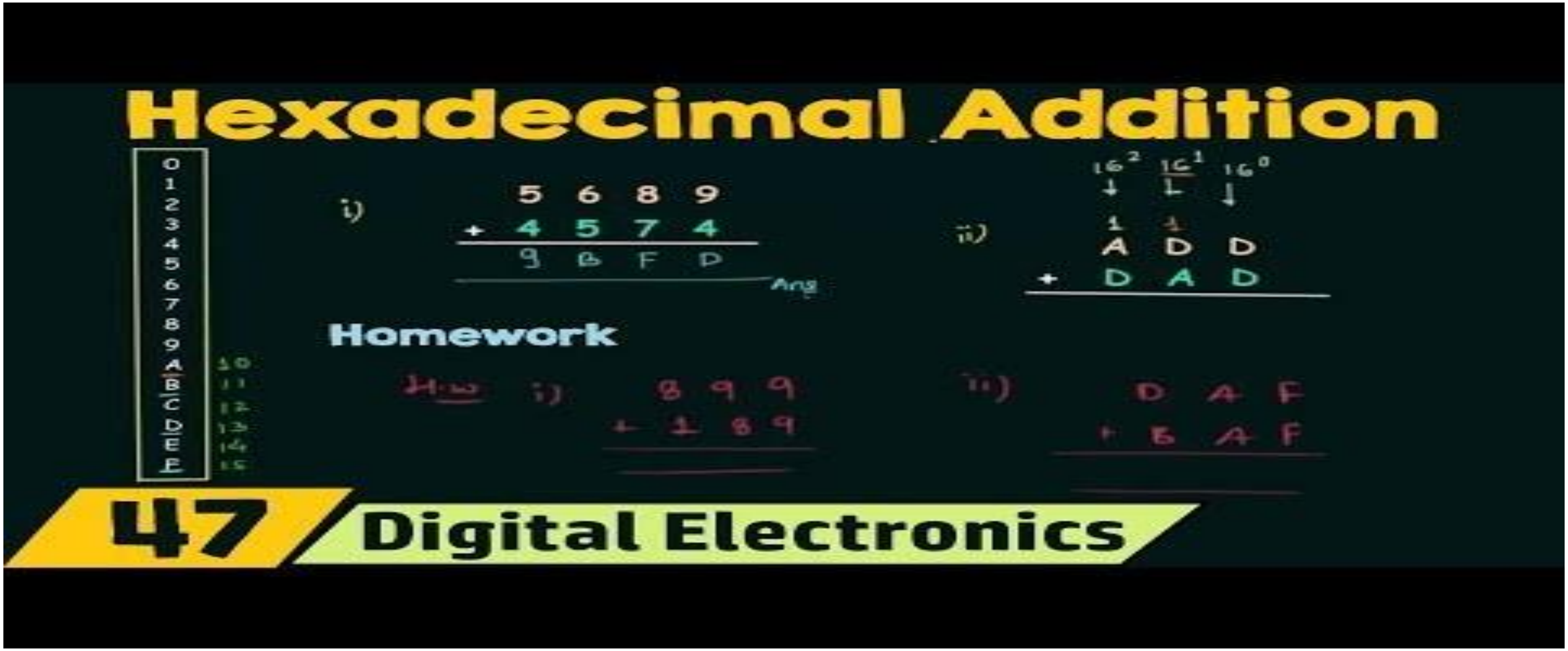
a) 0 0 1 1 0 1 0 1 - 0 1 0 0 1 0 0 0
b) 0 1 0 0 1 1 0 1 - 0 1 1 0 1 1 1 0
c) 0 1 0 1 1 1 1 1 - 0 0 0 1 1 1 1 0
d) 0 1 0 0 0 1 1 1 - 0 1 1 0 1 1 1 1
e) 1 0 0 0 0 0 0 1 - 0 1 1 1 0 1 1 1
f) 1 0 1 0 1 0 1 0 - 1 0 1 0 1 0 1 0

1.1 Data Representation

Number systems: Hexadecimal addition and subtraction

Click the link below to watch the video on

https://www.youtube.com/watch?v=y0B6tuC6niE



1.1 Data Representation

Number systems: Hexadecimal addition

Example 2: **Hex value:** 8B + AA = 1 3 5

Hex value: 8B = 1000 1011 and Decimal value: 139

Denary	1024	512	256	128	64	32	16	8	4	2	1
Binary	0	0	0	1	0	0	0	1	0	1	1

Hex value: AA = 1010 1010 and Decimal value: 170

Denary	1024	512	256	128	64	32	16	8	4	2	1
Binary	0	0	0	1	0	1	0	1	0	1	0

Hex value: 8B + AA = 1 3 5 and Decimal value: 139 + 170 = 309

Denary	1024	512	256	128	64	32	16	8	4	2	1
Binary	0	0	1	0	0	1	1	0	1	0	1

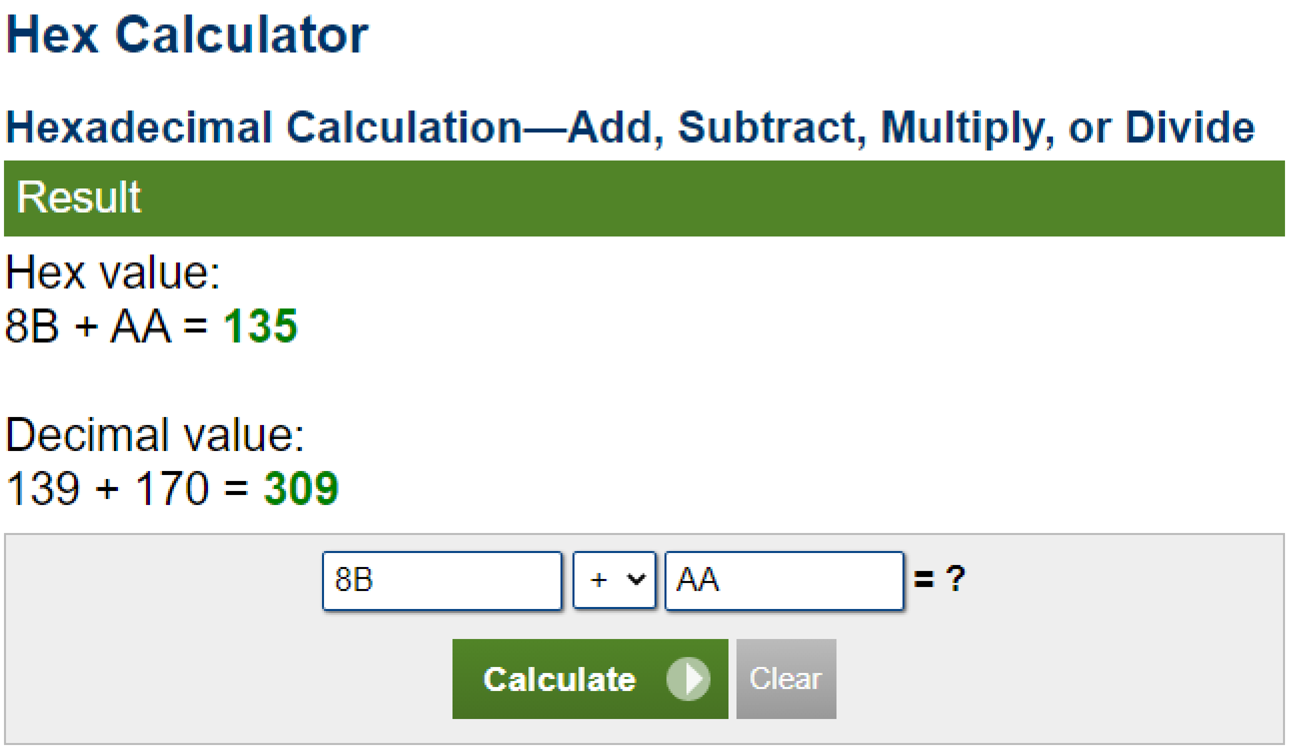
1 | 3 | 5

1.1 Data Representation

Number systems: Hexadecimal addition

To double check your answer click in the link below:

https://www.calculator.net/hex-calculator.html



1.1 Data Representation

Number systems: Hexadecimal addition

Activity 1: Hexadecimal Calculation addition:

Hex value:

A + E = ?

D + A = ?

E7 + AB = ?

9F + CB = ?

A5 + EF = ?

99 + EE = ?

8B + AA =?

B2 + C7 = ?

A9 + E7 = ?

AC + EF = ?

2C + D4 = ?

1.1 Data Representation

Number systems: Hexadecimal subtraction

Example 1: **Hex value:** 8B - 7A = 0 1 1

Hex value: 8B = 1000 1011 and Decimal value: 139

Denary	1024	512	256	128	64	32	16	8	4	2	1
Binary	0	0	0	1	0	0	0	1	0	1	1

Hex value: 7A = 0111 1010 and Decimal value: 122

Denary	1024	512	256	128	64	32	16	8	4	2	1
Binary	0	0	0	0	1	1	1	1	0	1	0

Hex value: 8B – 7A = 11 and Decimal value: 139 - 122 = 17

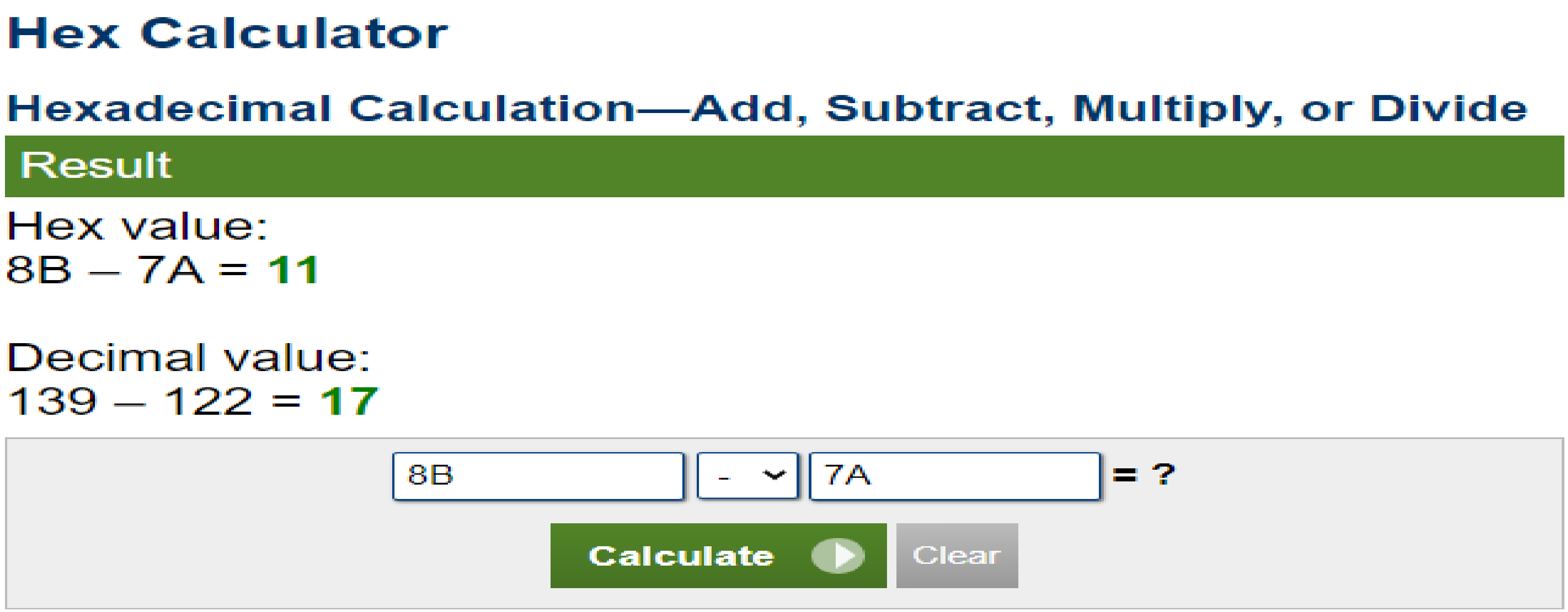
Denary	1024	512	256	128	64	32	16	8	4	2	1
Binary	0	0	0	0	0	0	1	0	0	0	1

0 | 1 | 1

1.1 Data Representation

Number systems: Hexadecimal subtraction

To double check your answer click in the link below:
https://www.calculator.net/hex-calculator.html



1.1 Data Representation

Binary coded decimal (BCD)

Binary-coded decimal is a system of writing numerals that assigns a four-digit binary code to each digit 0 through 9 in a decimal (base 10) number. Simply put, binary-coded decimal is a way to convert decimal numbers into their binary equivalents. However, binary-coded decimal is not the same as simple binary representation. Compared to the binary system, it is easy to code and decode binary-coded decimal numbers.

The binary-coded decimal (BCD) system uses a 4-bit code to represent each denary digit:

The most obvious use of BCD is in the representation of digits on a calculator or clock display.

Example 1

Decimal number = 1764

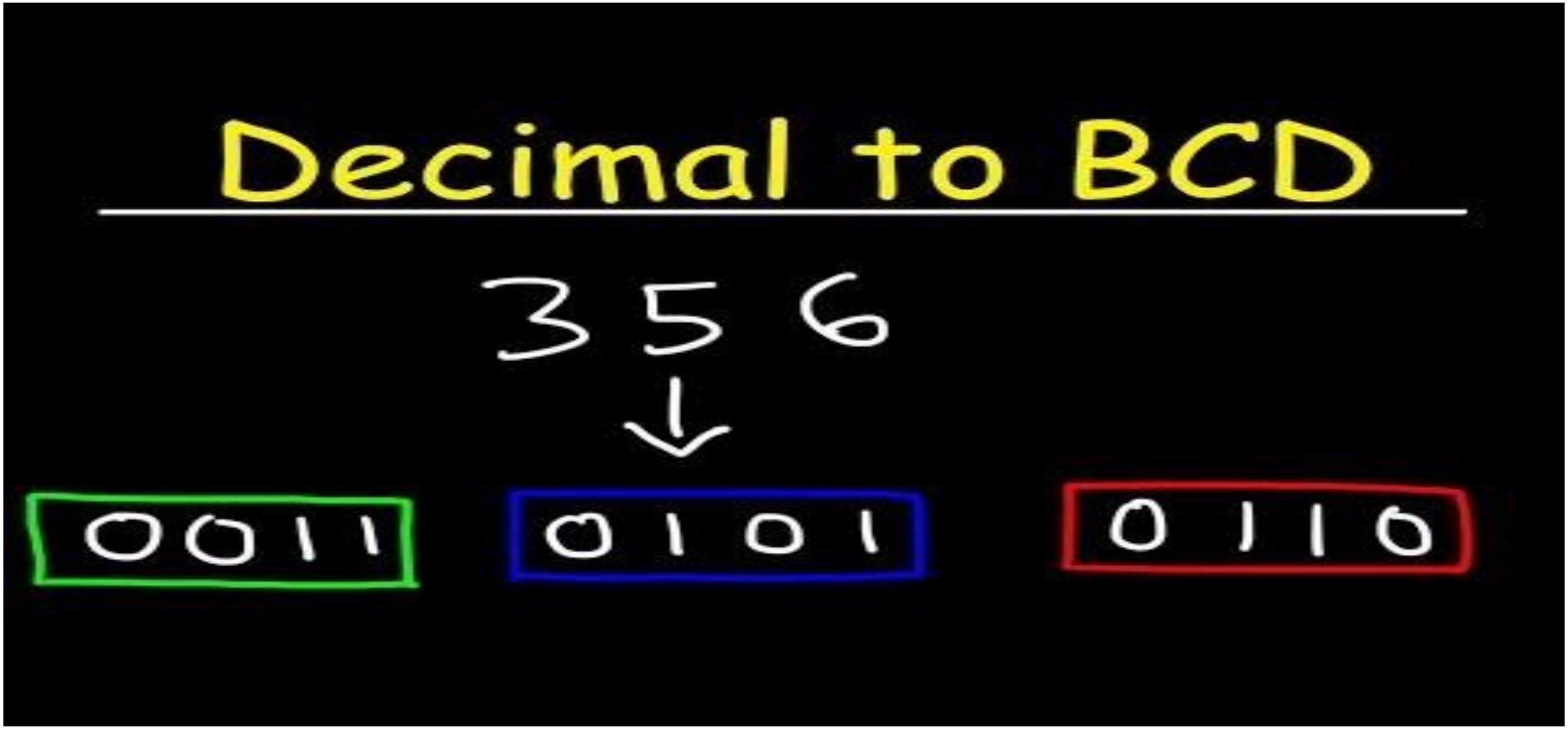
The binary-coded decimal rendition is represented as the following:

1	7	6	4
0001	0111	0110	0100

1.1 Data Representation

Watch the video for the Binary coded decimal (BCD)

https://www.youtube.com/watch?v=AM0tr8Kyvzg



1.1 Data Representation

Activity :Binary coded decimal (BCD)

1 Convert these denary numbers into BCD format.

a) 2 7 1

b) 5 0 0 6

c) 7 9 9 0

2 Convert these BCD numbers into denary numbers.

a) 1 0 0 1 0 0 1 1 0 1 1 1

b) 0 1 1 1 0 1 1 1 0 1 1 0 0 0 1 0

1.1 Data Representation

Number systems: One's and Two's Compliment

Up until now we have assumed all binary numbers have positive values. There are a number of methods to represent both positive and negative numbers. We will consider:

- Signed Magnitude method
- one's complement
- two's complement.

It is not possible to add minus or plus symbol in front of a binary number because a binary number can have only two symbol either 0 or 1 for each position or bit. That's why we use this extra bit called sign bit or sign flag. The value of sign bit is 1 for negative binary numbers and 0 for positive numbers.
When an integer binary number is positive, the sign is represented by 0 and the magnitude by a positive binary number. When the number is negative, the sign is represented by 1 but the rest of the number may be represented in one of three possible ways: Sign-Magnitude method, 1's Complement method, and 2's complement method. These are explained as following below.

1.1 Data Representation

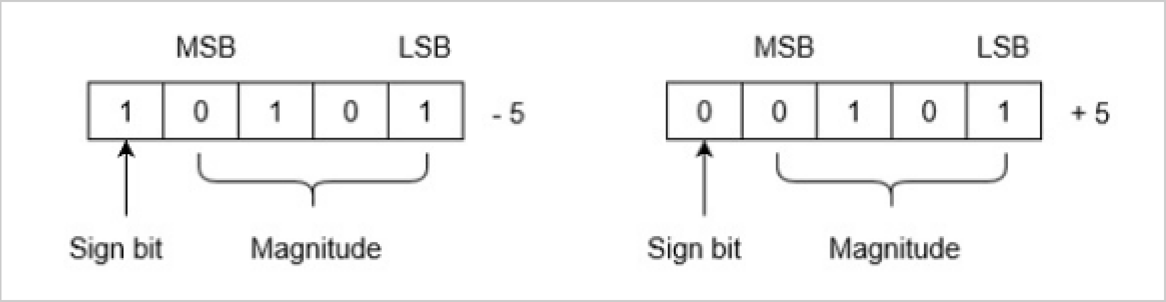
Number systems: One's and Two's Compliment

a). Signed Magnitude method

In this method, number is divided into two parts: Sign bit and Magnitude. If the number is positive then sign bit will be 0 and if number is negative then sign bit will be 1. Magnitude is represented with the binary form of the number to be represented.

Example 1: Let we are using **5 bits register**. The representation of -5 to +5 will be as follows:

Most significant bit (MSB) and Least significant bit (LSB)

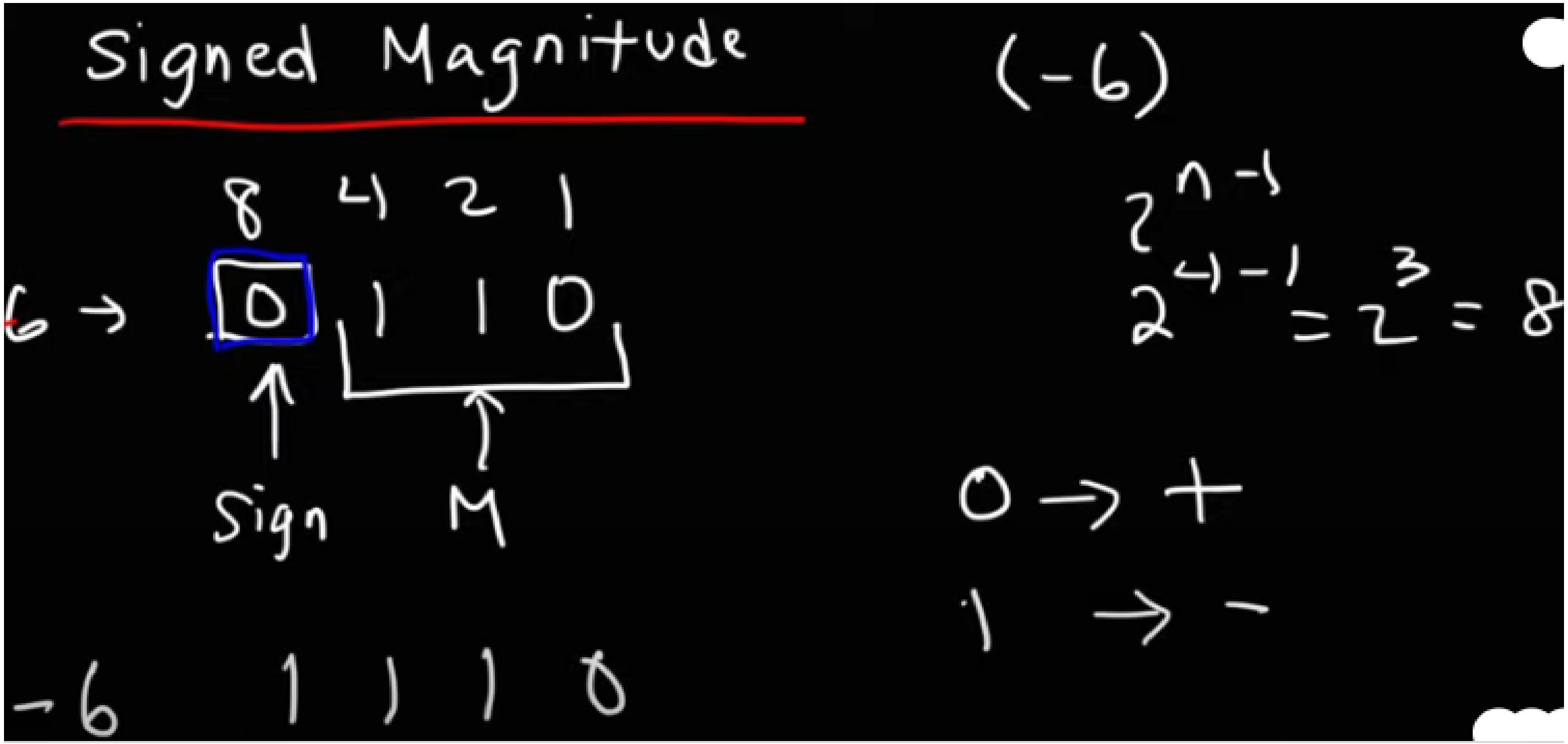


1.1 Data Representation

Number systems: One's and Two's Compliment

a). Signed Magnitude method

Example 1: Let we are using **4 binary bits register**. The representation of -7 to +7 will be as follows:



1.1 Data Representation

Number systems: One’s and Two’s Compliment

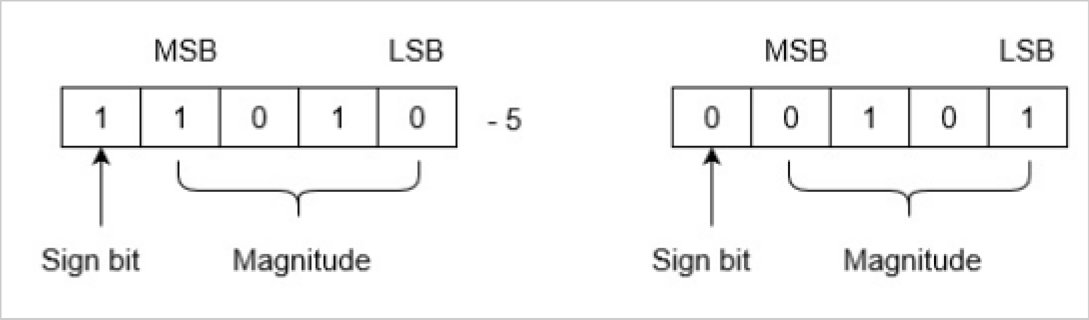
b). One’s Complement Method:

Positive numbers are represented in the same way as they are represented in sign magnitude method. If the number is negative then it is represented using 1’s complement. First represent the number with positive sign and then take 1’s complement of that number.

In **one’s complement**, each digit in the binary number is inverted (in other words, 0 becomes 1 and 1 becomes 0).

For example 1: 01000110 (denary value 70) becomes 10111001 (denary value −70).

For example 2: Let we are using 5 bits register. The representation of -5 and +5 will be as follows

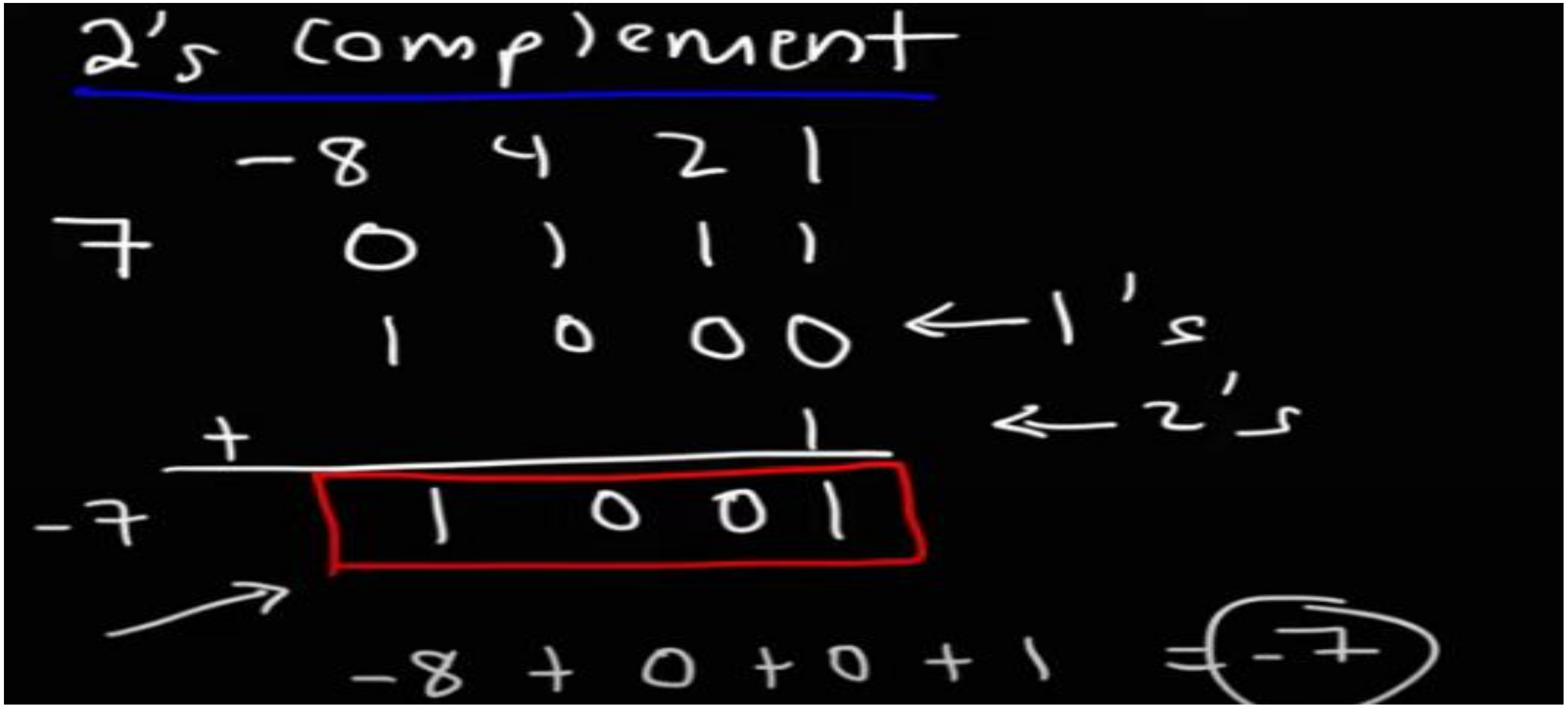


1.1 Data Representation

Number systems: One's and Two's Compliment

c). Two's Complement Method:

Positive numbers are represented in the same way as they are represented in sign magnitude method. If the number is negative then it is represented using 2's complement. First represent the number with positive sign and then take 2's complement of that number.

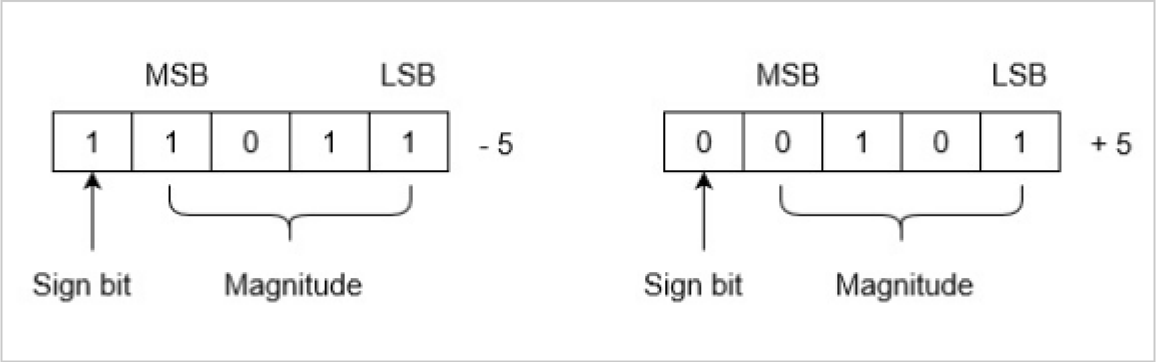


1.1 Data Representation

Number systems: One’s and Two’s Compliment

c). Two’s Complement Method:

Example 2: Let we are using 5 bits registers. The representation of -5 and +5 will be as follows:



+5 is represented as it is represented in sign magnitude method. -5 is represented using the following steps:

(i) +5 = 0 0101

(ii) Take 2’s complement of 0 0101 and that is 1 1011. MSB is 1 which indicates that number is negative.

MSB is always 1 in case of negative numbers

1.1 Data Representation

Number systems: One's and Two's Compliment

c). Two's Complement Method:

Example 2: Let we are using 8 bits registers. The representation of -104 and +104 will be as follows:

+104		128	64	32	16	8	4	2	1
Binary		0	1	1	0	1	0	0	0
1 comp Opposite		1	0	0	1	0	1	1	1
Add 1		0	0	0	0	0	0	0	1
- 104		1	0	0	1	0	0	0	0

Recap Two's Complement

$\boxed{-6}$

(128 − 6 = 122)

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

−128 + 64 + 32 + 16 + 8 + 2 = −6.

$\boxed{-49}$

(128 − 49 = 79.)

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

−128 + 64 + 8 + 4 + 2 + 1 = −49.

$\boxed{-109}$

(128 − 109 = 19).

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

−128 + 16 + 2 + 1 = −109.

$\boxed{-77}$

(128 − 77 = 51)

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

−128 + 32 + 16 + 2 + 1 = −77

$\boxed{-17}$

(128 − 17 = 111).

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

= −128 + 64 + 32 + 8 + 4 + 2 + 1 = −17

$\boxed{-122}$

(128 − 122 = 6).

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

−128 + 4 + 2 = −122

1.1 Data Representation

c). Two's Complement Method:

Number systems: Binary Subtraction

Carry out the subtraction 95 – 68 in binary.

Solution

1 Convert the two numbers into binary:

95 = 0 1 0 1 1 1 1 1

68 = 0 1 0 0 0 1 0 0

2 Find the two's complement of 68:

invert the digits:	1	0	1	1	1	0	1	1	
add 1:								1	
which gives:	1	0	1	1	1	1	0	0	= −68

3 Add 95 and −68:

	−128	64	32	16	8	4	2	1
	0	1	0	1	1	1	1	1
					+			
	1	0	1	1	1	1	0	0
					=			
1	0	0	0	1	1	0	1	1

The additional ninth bit is simply ignored leaving the binary number 0 0 0 1 1 0 1 1 (denary equivalent of 27, which is the correct result of the subtraction).

1.1 Data Representation

c). Two's Complement Method

Number systems: Binary Subtraction

Carry out the subtraction 49 – 80 in binary.

Solution

1 Convert the two numbers into binary:

49 = 0 0 1 1 0 0 0 1

80 = 0 1 0 1 0 0 0 0

2 Find the two's complement of 80:

invert the digits:	1	0	1	0	1	1	1	1	
add 1:								1	
which gives:	1	0	1	1	0	0	0	0	= −80

3 Add 49 and −80:

−128	64	32	16	8	4	2	1
0	0	1	1	0	0	0	1
			+				
1	0	1	1	0	0	0	0
			=				
1	1	1	0	0	0	0	1

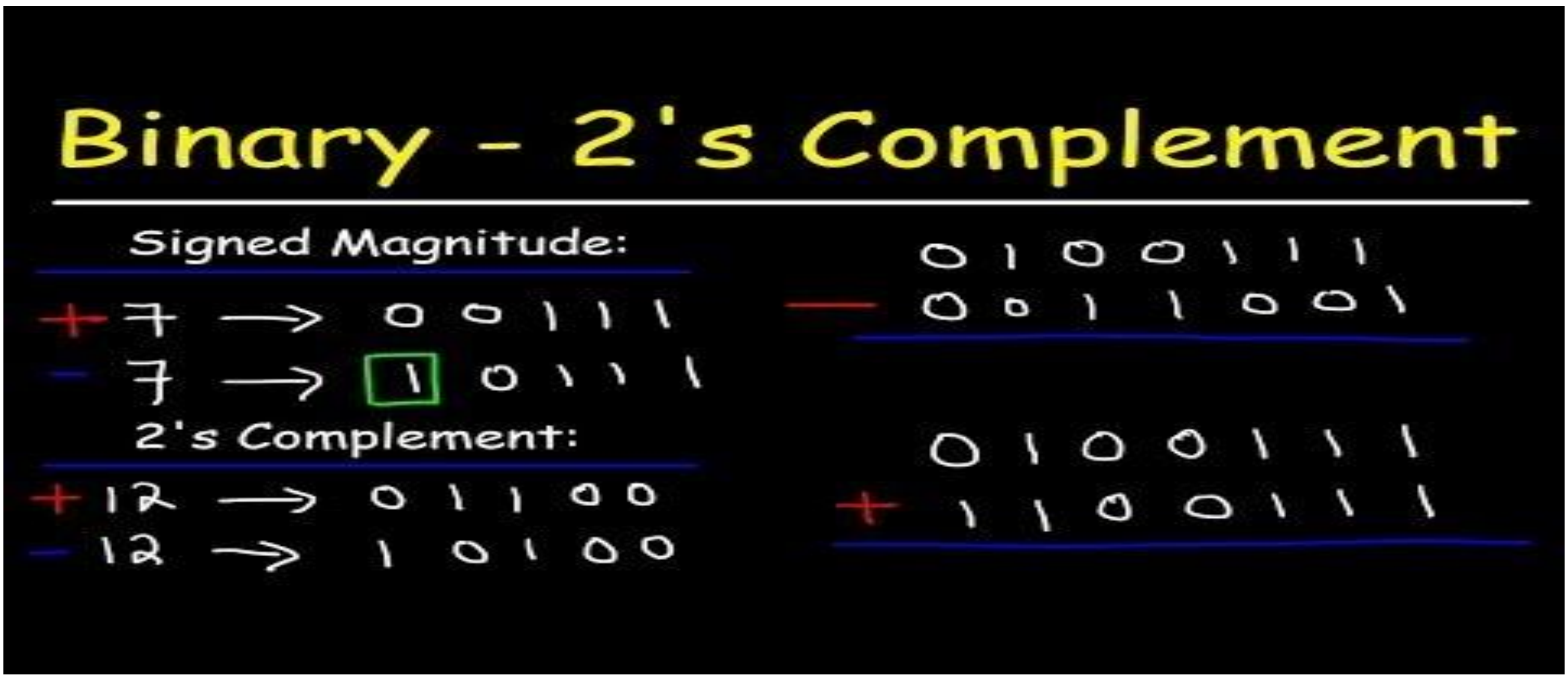
This gives us 1 1 1 0 0 0 0 1, which is −31 in denary; the correct answer.

1.1 Data Representation

Number systems: One’s and Two’s Compliment:

Watch the video for the Signed Binary (Sign and Magnitude & Two's Complement)

https://www.youtube.com/watch?v=sJXTo3EZoxM



1.1 Data Representation

Watch the video for theTwo's complement representation of a signed integer

https://www.youtube.com/watch?v=mRvcGijXI9w

Convert -6 into 8 bit binary

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

$-128 + 64 + 32 + 16 + 8 + 2 = -6$

$-6_{10} = 11111010_{2}$

1.1 Data Representation

Number systems: One's and Two's Compliment:

Convert the following negative Decimal number to binary

(- 49) = ?
(- 109) = ?
(- 107) = ?
(- 77) = ?
(- 17) = ?
(- 122) = ?
(- 38) = ?
(- 200) = ?
(-26) = ?
(-2) = ?
(-11) = ?
(- 52) = ?

1.1 Data Representation

Number systems: One's and Two's Compliment:

ACTIVITY 1D

Carry out these binary additions and subtractions using these 8-bit column weightings:

–128	64	32	16	8	4	2	1

a) 0 0 1 1 1 0 0 1 + 0 0 1 0 1 0 0 1
b) 0 1 0 0 1 0 1 1 + 0 0 1 0 0 0 1 1
c) 0 1 0 1 1 0 0 0 + 0 0 1 0 1 0 0 0
d) 0 1 1 1 0 0 1 1 + 0 0 1 1 1 1 1 0
e) 0 0 0 0 1 1 1 1 + 0 0 0 1 1 1 0 0
f) 0 1 1 0 0 0 1 1 − 0 0 1 1 0 0 0 0
g) 0 1 1 1 1 1 1 1 − 0 1 0 1 1 0 1 0
h) 0 0 1 1 0 1 0 0 − 0 1 0 0 0 1 0 0
i) 0 0 0 0 0 0 1 1 − 0 1 1 0 0 1 0 0
j) 1 1 0 1 1 1 1 1 − 1 1 0 0 0 0 1 1

AS level Paper 1 Exam: Question 1

1 (i) Convert the following binary number into hexadecimal.

1 0 1 1 1 0 0 0

....[1]

(ii) Convert the following denary number into BCD format.

9 7

....[1]

(iii) Using two's complement, show how the following denary numbers could be stored in an 8-bit register:

114								
- 93								

[2]

AS level Paper 1 Exam: Answer 1

1 (i) B 8 [1]

(ii) 1 0 0 1 0 1 1 1 [1]

(iii)

114	**0**	**1**	**1**	**1**	**0**	**0**	**1**	**0**
– 93	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**1**

[2]

AS level Paper 1 Exam: Question 2

(a) (i) Using two's complement, show how the following denary numbers could be stored in an 8-bit register:

124

–77

[2]

(ii) Convert the two numbers in **part (a) (i)** into hexadecimal.

124 ....

–77 .... [2]

(b) Binary Coded Decimal (BCD) is another way of representing numbers.

(i) Write the number 359 in BCD form.

.... [1]

(ii) Describe a use of BCD number representation.

....

.... [2]

AS level Paper 1 Exam: Answer 2

(a) (i)

124	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
–77	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**1**

[2]

(ii) 124: 7 C

–77: B 3 [2]

(b) (i) 0 0 1 1 0 1 0 1 1 0 0 1 [1]

(ii)
- when denary numbers need to be electronically coded
- e.g. to operate displays on a calculator where each digit is represented
- decimal fractions can be accurately represented [2]

AS level Paper 1 Exam: Question 3

(a) Convert the following denary integer into 8-bit binary.

55

[1]

(b) Convert the following Binary Coded Decimal (BCD) number into denary.

10000011

....[1]

(c) Convert the following denary integer into 8-bit two's complement.

−102

[2]

(d) Convert the following hexadecimal number into denary.

4E

....[1]

AS level Paper 1 Exam: Answer 3

(a) 00110111 **[1]**

(b) 83 **[1]**

(c) 10011010 **[2]**

Marks allocated as follows:

1 mark for the most significant bit
1 mark for the remaining 7 bits

(d) 78 **[1]**

AS level Paper 1 Exam: Question 4

(a) Convert the following 8-bit binary integer into denary.

01001101

....[1]

(b) Convert the following denary number into Binary Coded Decimal (BCD).

82

....[1]

(c) Convert the following two's complement integer number into denary.

11001011

....

....

....[2]

(d) Convert the following denary number into hexadecimal. Show your working.

198

....[2]

AS level Paper 1 Exam: Answer 4

(a) 77 **[1]**

(b) 1000 0010 **[1]**

(c) −53 **[2]**

One mark for '**53**' and **one** mark for '**−**'

(d) C6 **[2]**

One mark for the answer, one mark for the method

- Working e.g. 198 / 16 = 12, 198 − (12*16) = 6

AS level Paper 1 Exam: Question 5

(a) (i) Convert the denary number 46 to an 8-bit binary integer.

....

....[1]

(ii) Convert the denary integer −46 to an 8-bit two's complement form.

....

....[1]

(iii) Convert the denary number 46 into hexadecimal.

....

....[1]

(b) Binary Coded Decimal (BCD) is another way of representing numbers.

(i) Describe how denary integers larger than 9 can be converted into BCD.
Give an example in your answer.

....

....

....

....[2]

(ii) Describe how an 8-bit BCD representation can be converted into a denary integer.
Give an example in your answer.

....

....

....

[2]

AS level Paper 1 Exam: Answer 5

(a) (i) 0 0 1 0 1 1 1 0 [1]

(ii) 1 1 0 1 0 0 1 0 [1]

(iii) 2 E [1]

(b) (i) **One mark** for the explanation and **one mark** for the example

- Each denary digit is written as a 4-bit binary number
- Example: 46 = 0100 0110 [2]

(ii) **One mark** for the explanation and **one mark** for the example

- Binary number is split up into groups of 4 bits (starting from the right) // Each group of 4 bits is converted to a denary digit
- Example: 0011 0111 = 37

[2]

AS-level Paper 1 Exam: Question 6

Hexadecimal, Binary Coded Decimal (BCD) and binary values are shown below.

Draw a line to link each value to its correct denary value.

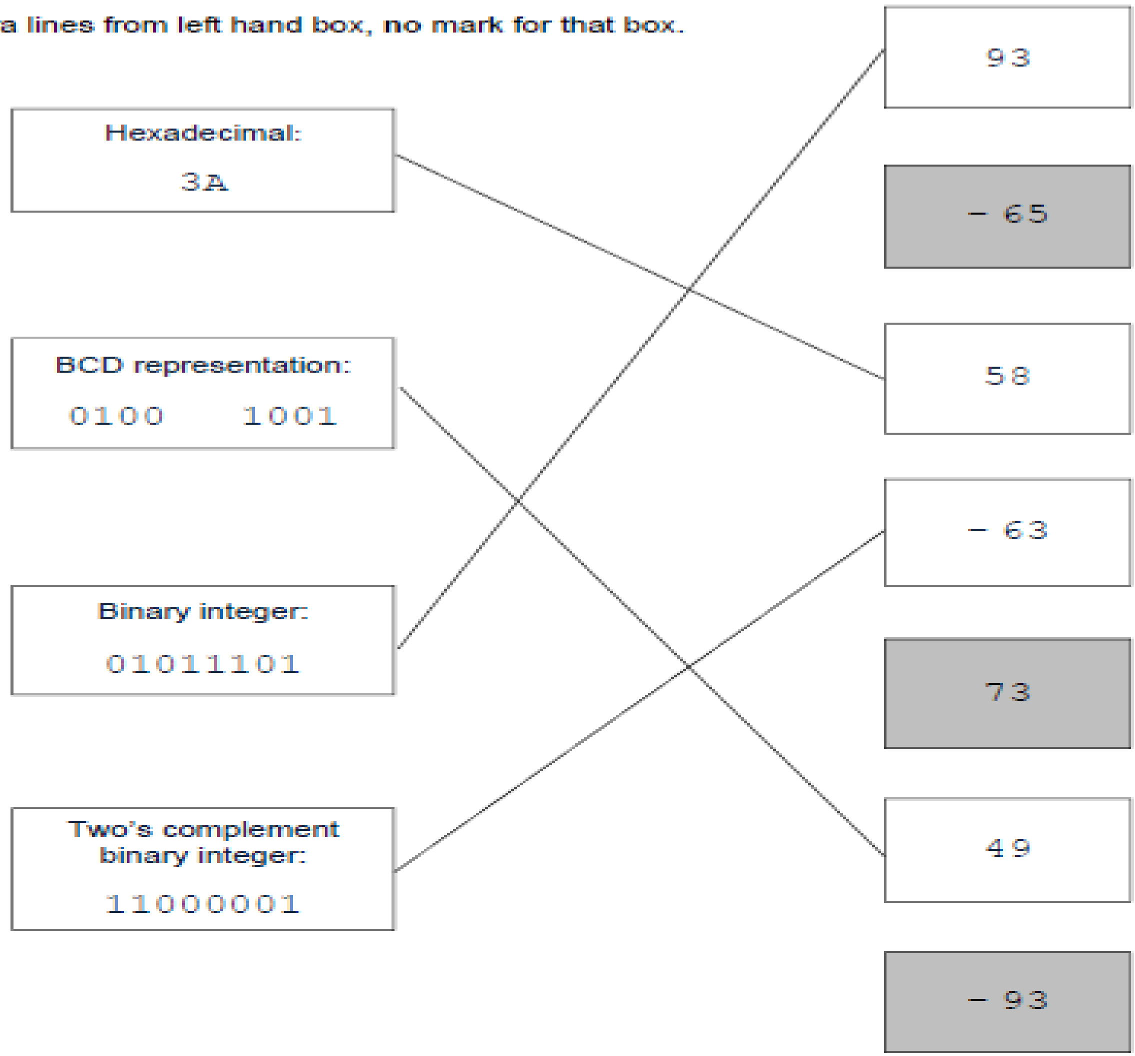
Hexadecimal, BCD, binary	Denary
	93
Hexadecimal: 3A	−65
BCD representation: 0100 1001	58
	−63
Binary integer: 01011101	73
Two's complement binary integer: 11000001	49
	−93

[4]

AS-level Paper 1 Exam: Answer 6

4 ONE mark for each correct line.

Extra lines from left hand box, no mark for that box.



AS-level Paper 1 Exam: Question 7

(a) Each of the following bytes represents an integer in two's complement form.

State the denary value.

(i) `0111 0111` Denary .... [1]

(ii) `1000 1000` Denary .... [1]

(iii) Express the following integer in two's complement form.

`-17`

[1]

(iv) State in denary, the range of integer values that it is possible to represent in two's complement integers using a single byte.

Lowest value ....

Highest value .... [1]

AS-level Paper 1 Exam: Question 7

(b) **(i)** Convert the following denary integer into Binary Coded Decimal (BCD).

653

....[1]

(ii) A 3-digit BCD representation has been incorrectly copied. It is shown as:

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

State how you can recognise that this is not a valid BCD representation.

....

....[1]

(iii) Describe a practical application where BCD is used.

....

....[1]

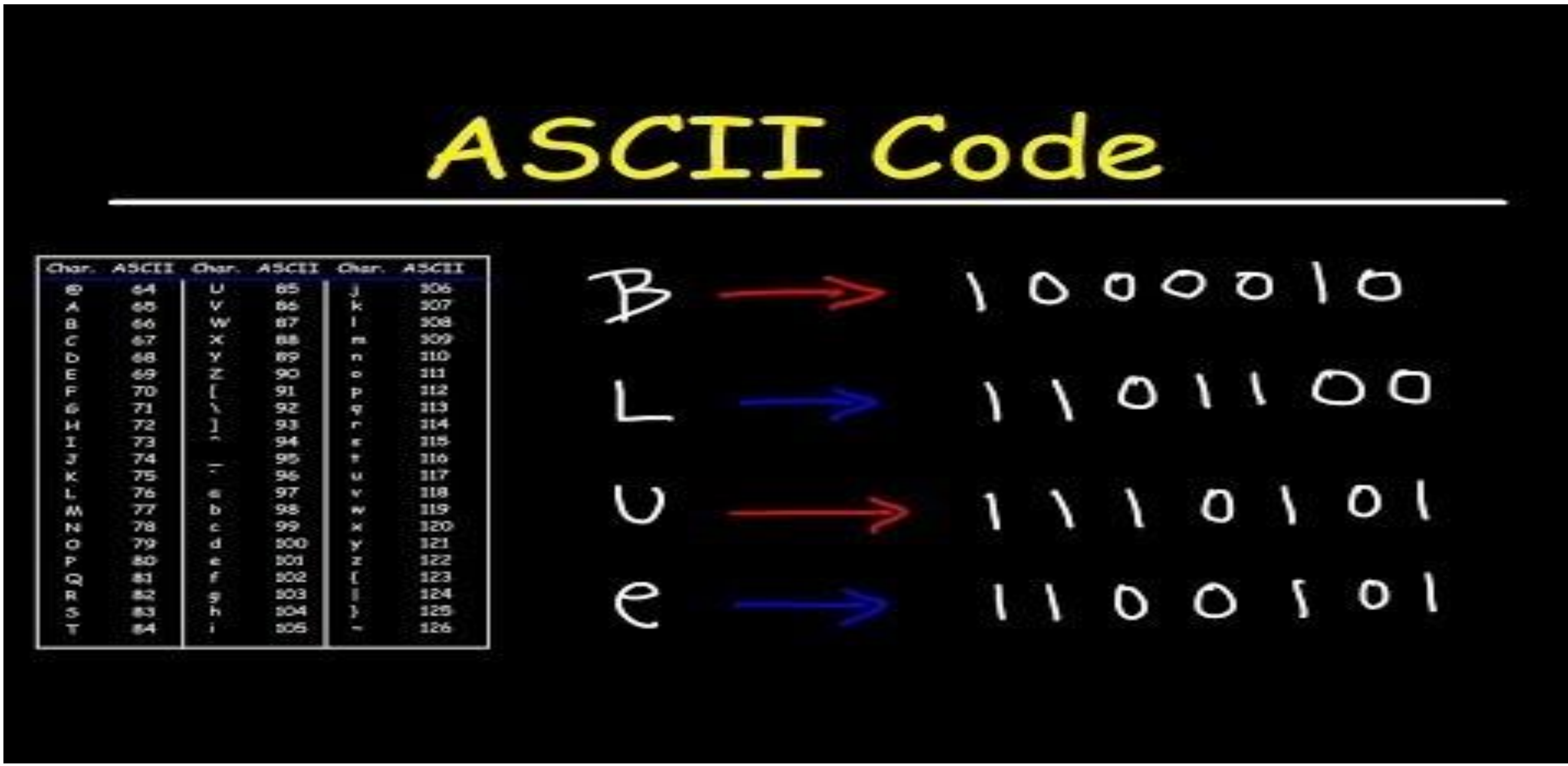
AS-level Paper 1 Exam: Answer 7

Question	Answer	Marks
1(a)(i)	119	1
1(a)(ii)	–120	1
1(a)(iii)	1 | 1 | 1 | 0 | 1 | 1 | 1 | 1	1
1(a)(iv)	Lowest value: −128 Highest value: +127	1
1(b)(i)	0110 0101 0011	1
1(b)(ii)	The second block of four binary digits represents a digit larger than 9 // 14	1
1(b)(iii)	A string of digits on any electronic device displaying numeric values	1

1.1 Data Representation

Watch the video for the ASCII Code

https://www.youtube.com/watch?v=H4l42nbYmrU



1.1 Data Representation

ASCII Code Table:

Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
32	20	<SPACE>	64	40	@	96	60	`
33	21	!	65	41	A	97	61	a
34	22	"	66	42	B	98	62	b
35	23	#	67	43	C	99	63	c
36	24	$	68	44	D	100	64	d
37	25	%	69	45	E	101	65	e
38	26	&	70	46	F	102	66	f
39	27	'	71	47	G	103	67	g
40	28	(	72	48	H	104	68	h
41	29	)	73	49	I	105	69	i
42	2A	*	74	4A	J	106	6A	j
43	2B	+	75	4B	K	107	6B	k
44	2C	,	76	4C	L	108	6C	l
45	2D	-	77	4D	M	109	6D	m
46	2E	.	78	4E	N	110	6E	n
47	2F	/	79	4F	O	111	6F	o
48	30	0	80	50	P	112	70	p
49	31	1	81	51	Q	113	71	q
50	32	2	82	52	R	114	72	r
51	33	3	83	53	S	115	73	s
52	34	4	84	54	T	116	74	t
53	35	5	85	55	U	117	75	u
54	36	6	86	56	V	118	76	v
55	37	7	87	57	W	119	77	w
56	38	8	88	58	X	120	78	x
57	39	9	89	59	Y	121	79	y
58	3A	:	90	5A	Z	122	7A	z
59	3B	;	91	5B	[	123	7B	{
60	3C	<	92	5C	\	124	7C	|
61	3D	=	93	5D	]	125	7D	}
62	3E	>	94	5E	^	126	7E	~
63	3F	?	95	5F	_	127	7F	<DELETE>

1.1 Data Representation

Watch the video for the ASCII and Unicode Character Sets

https://www.youtube.com/watch?v=5aJKKgSEUnY

ASCII and Unicode Character Sets

ASCII

The ASCII character set is a **7-bit set** of codes that allows **128 different characters**. That is enough for every upper-case letter, lower-case letter, digit and punctuation mark on most keyboards. ASCII is only used for the English language.

This table shows some examples of letters represented using the ASCII character set:

Character	Denary value	Binary value	Hex
N	78	1001110	4E
O	79	1001111	4F
P	80	1010000	50
Q	81	1010001	51
R	82	1010010	52

Extended ASCII

Extended ASCII code is an 8-bit character set that represents **256 different characters**, making it possible to use characters such as **é** or **©**. Extended ASCII is useful for European languages

ASCII and Unicode Character Sets

Advantage and Disadvantage ASCII

Advantages: ASCII code takes less space as it has only 256 characters. it stores all alphanumeric characters. The demand for memory in ASCII is less than the Unicode.

Disadvantages of ASCII : maximum 128 characters that is not enough for some key boards having special characters. 7bit may not enough to represent larger values.

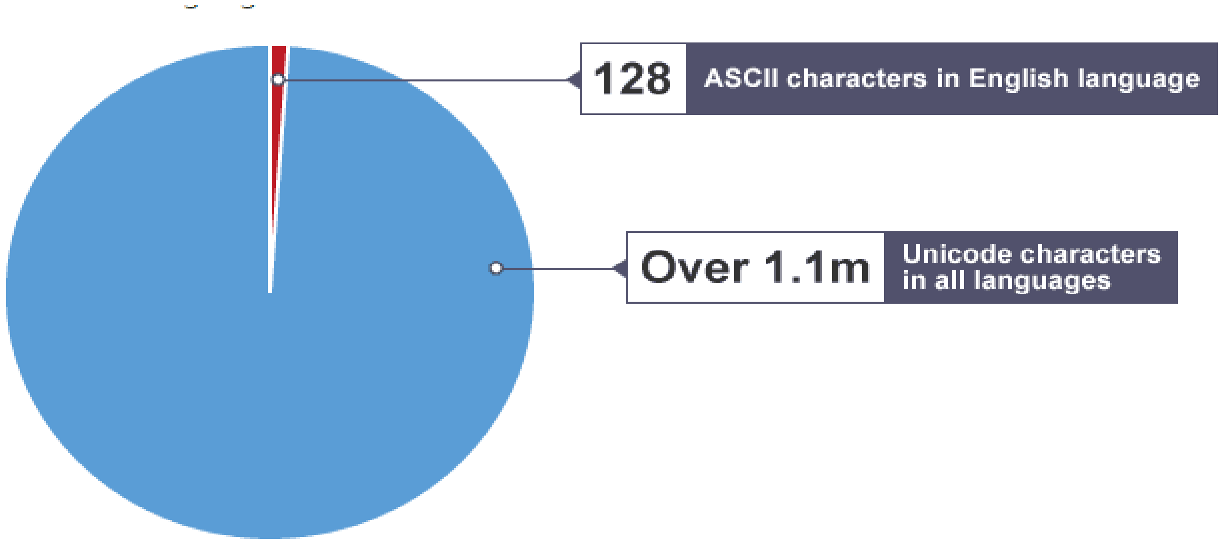
- Only 128 / 256 characters can be represented
- Uses values 0 to 127 (or 255 if extended form) / one byte
- Many characters used in other languages cannot be represented
- In extended ASCII the characters from 128 to 255 may be coded differently in different systems

ASCII and Unicode Character Sets

Unicode

Unicode uses between **8** and **32 bits per character**, so it can represent characters from languages from all around the world. It is commonly used across the internet. As it is larger than ASCII, it might take up more **storage** space when saving documents.

Global companies, like Facebook and Google, would not use the ASCII character set because their users communicate in many different languages.



ASCII and Unicode Character Sets

Advantage and disadvantage Unicode.

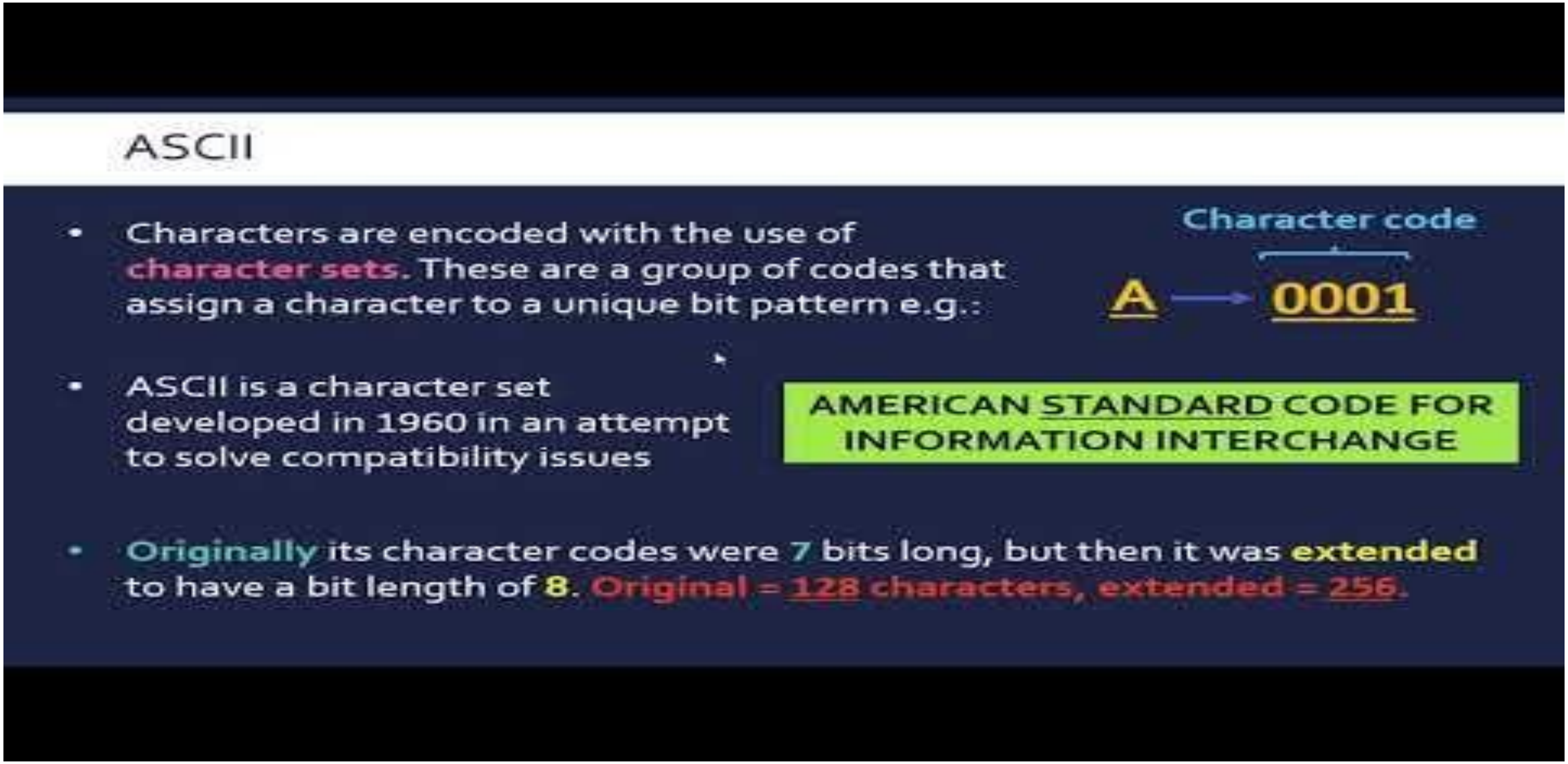
Advantage: Unicode is a 16-bit system which can support many more characters than ASCII.

Disadvantage: One disadvantage Unicode has over ASCII, though, is that it takes at least twice as much memory to store a Roman alphabet character because Unicode uses more bytes to enumerate its vastly larger range of alphabetic symbols.

1.1 Data Representation

Watch the video for the Representing Text in Binary (ASCII & Unicode)

https://www.youtube.com/watch?v=tdmeXcDX-Uc



1.1 Data Representation

Key terms

Binary – base two number system based on the values 0 and 1 only.

Bit – abbreviation for binary digit.

One's complement – each binary digit in a number is reversed to allow both negative and positive numbers to be represented.

Two's complement – each binary digit is reversed and 1 is added in right-most position to produce another method of representing positive and negative numbers.

Sign and magnitude – binary number system where left-most bit is used to represent the sign (0 = + and 1 = –); the remaining bits represent the binary value.

Hexadecimal – a number system based on the value 16 (uses the denary digits 0 to 9 and the letters A to F).

Memory dump – contents of a computer memory output to screen or printer.

Binary-coded decimal (BCD) – number system that uses 4 bits to represent each denary digit.

ASCII code – coding system for all the characters on a keyboard and control codes.

Character set – a list of characters that have been defined by computer hardware and software. It is necessary to have a method of coding, so that the computer can understand human characters.

Unicode – coding system which represents all the languages of the world (first 128 characters are the same as ASCII code).

Learning objectives

1.2 Multimedia:

Graphics

Show understanding of how data for a bitmapped image are encoded	Use and understand the terms: *pixel, file header, image resolution, screen resolution, colour depth/bit depth*
Perform calculations to estimate the file size for a bitmap image	
Show understanding of the effects of changing elements of a bitmap image on the image quality and file size	Use the terms: *image resolution, colour depth/bit depth*
Show understanding of how data for a vector graphic are encoded	Use the terms: *drawing object, property, drawing list*
Justify the use of a bitmap image or a vector graphic for a given task	

Sound

Show understanding of how sound is represented and encoded	Use the terms: *sampling, sampling rate, sampling resolution, analogue and digital data*
Show understanding of the impact of changing the sampling rate and resolution	Impact on file size and accuracy

1.2 Multimedia:

Key terms

Bit-map image – system that uses pixels to make up an image.

Pixel – smallest picture element that makes up an image.

Colour depth – number of bits used to represent the colours in a pixel, e.g. 8 bit colour depth can represent $2^8 = 256$ colours.

Bit depth – number of bits used to represent the smallest unit in, for example, a sound or image file – the larger the bit depth, the better the quality of the sound or colour image.

Image resolution – number of pixels that make up an image, for example, an image could contain 4096 × 3192 pixels (12 738 656 pixels in total).

Screen resolution – number of horizontal and vertical pixels that make up a screen display. If the screen resolution is smaller than the image resolution, the whole image cannot be shown on the screen, or the original image will become lower quality.

Resolution – number of pixels per column and per row on a monitor or television screen.

Pixel density – number of pixels per square centimetre.

Vector graphics – images that use 2D points to describe lines and curves and their properties that are grouped to form geometric shapes.

Sampling resolution – number of bits used to represent sound amplitude (also known as bit depth).

Sampling rate – number of sound samples taken per second.

Frame rate – number of video frames that make up a video per second.

Bitmaps

- General purpose
- Contain pixels as the smallest component
- Pixel has a defined colour and position
- A bitmap image has a defined resolution
- Can be scaled but quality is affected
- A bitmap file has a header containing meta data, which defines the colour depth and the resolution

Let's explore more about sampling by clicking the link below:

https://www.bbc.co.uk/bitesize/guides/zqyrq6f/revision/1

1.2 Multimedia:

A)- Graphics :

Bit-map images are made up of pixels (picture elements); the image is stored in a two dimensional matrix of pixels.

When storing images as pixels, we have to consider

- at least 8 bits (1 byte) per pixel are needed to code a coloured image (this gives 256 possible colours by varying the intensity of the blue, green and red elements)
- true colour requires 3 bytes per pixel (24 bits), which gives more than one million colours
- the number of bits used to represent a pixel is called the **colour depth**.

We will now consider the actual image itself and how it can be displayed on a screen. There are two important definitions here:

- **Image resolution** refers to the number of pixels that make up an image; for example, an image could contain 4096 × 3192 pixels (12 738 656 pixels in total).
- **Screen resolution** refers to the number of horizontal pixels and the number of vertical pixels that make up a screen display (for example, if the screen resolution is smaller than the image resolution then the whole image cannot be shown on the screen or the original image will now be a lower quality).

Bitmaps

Watch the video for the Bitmap Images (6 minutes)

https://www.youtube.com/watch?v=0KmimFoalTI

Bitmaps

Calculating bit-map image file sizes

It is possible to estimate the file size needed to store a bit-map image. The file size will need to take into account the image resolution and bit depth.

Example: a full screen with a resolution of 1920 × 1080 pixels and a bit depth of 24 requires 1920 × 1080 × 24 bits = 49 766 400 bits for the full screen image

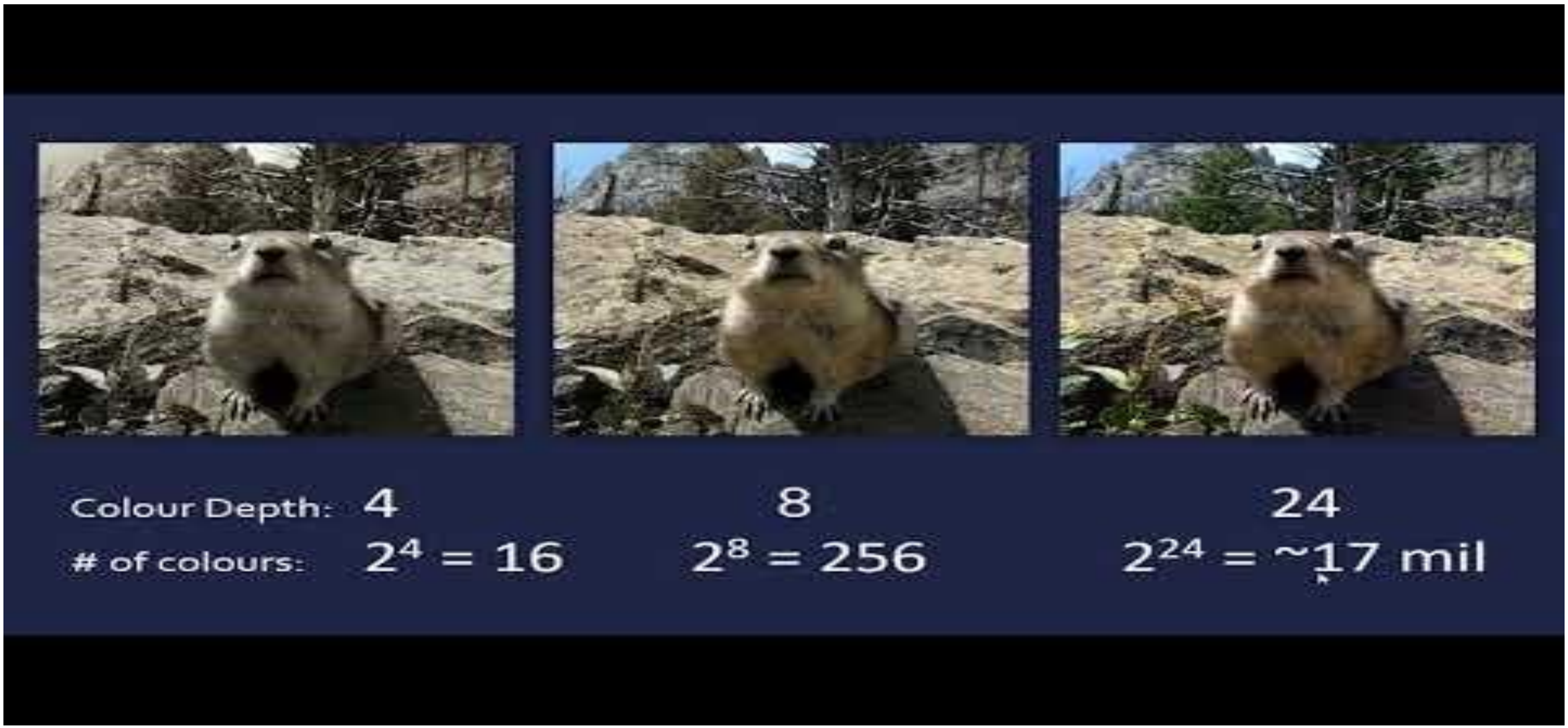
Dividing by 8 gives us 6 220 800 bytes (equivalent to 6.222 MB using the SI units or 5.933 MiB using IEE units). An image which does not occupy the full screen will obviously result in a smaller file size.

Note: when saving a bit-map image, it is important to include a file header; this will contain items such as file type (.bmp or .jpeg), file size, image resolution, bit depth (usually 1, 8, 16, 24 or 32), any type of data compression employed and so on.

Bitmaps

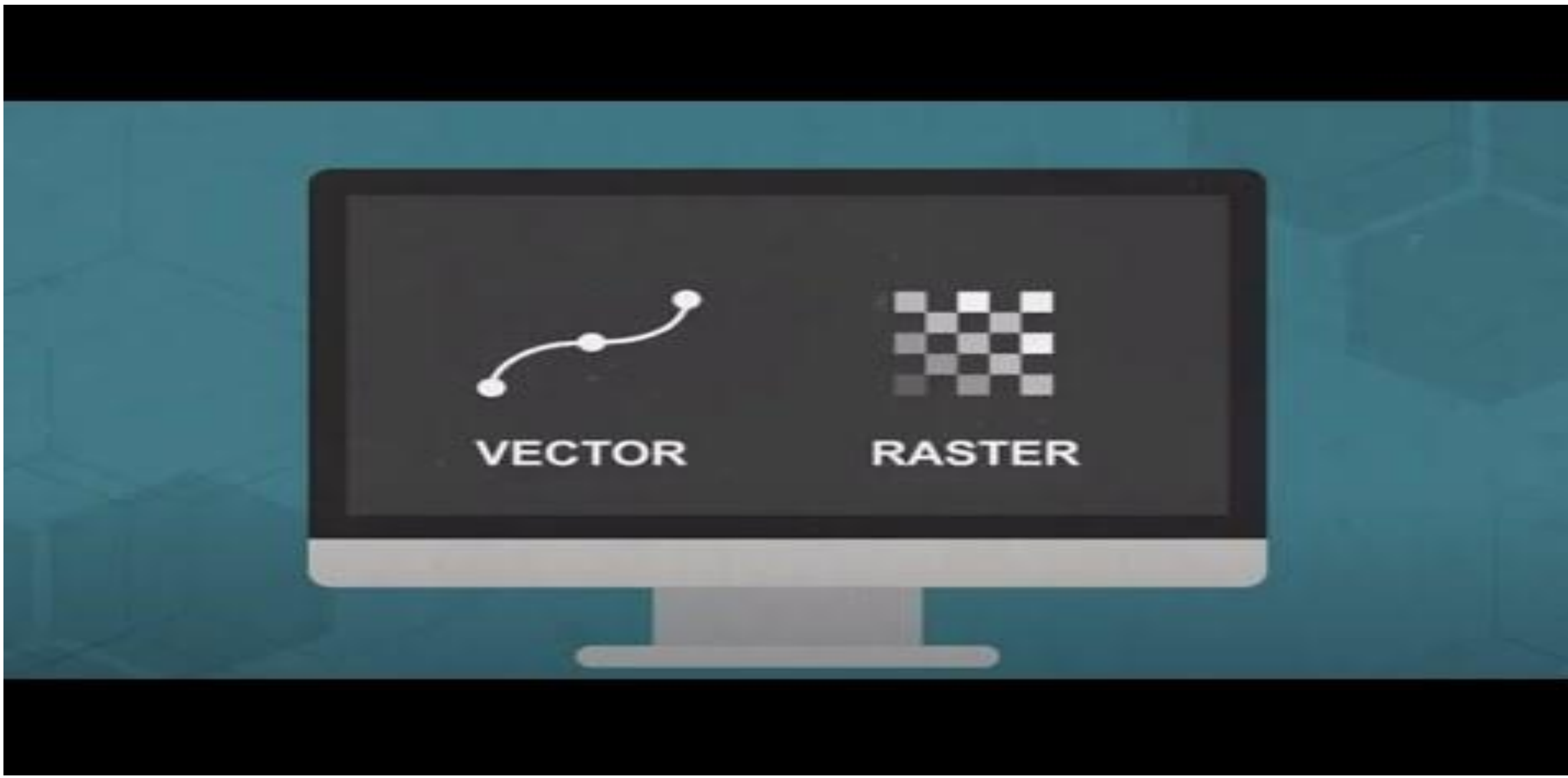
Watch the video for the Representing Images in Binary (5mintes)

https://www.youtube.com/watch?v=a3Y_ZvOr0K0



1.2 Multimedia:

A)- Graphics : Vector graphics (2 minutes)
https://youtu.be/ywIpBSblBdA



1.2 Multimedia:

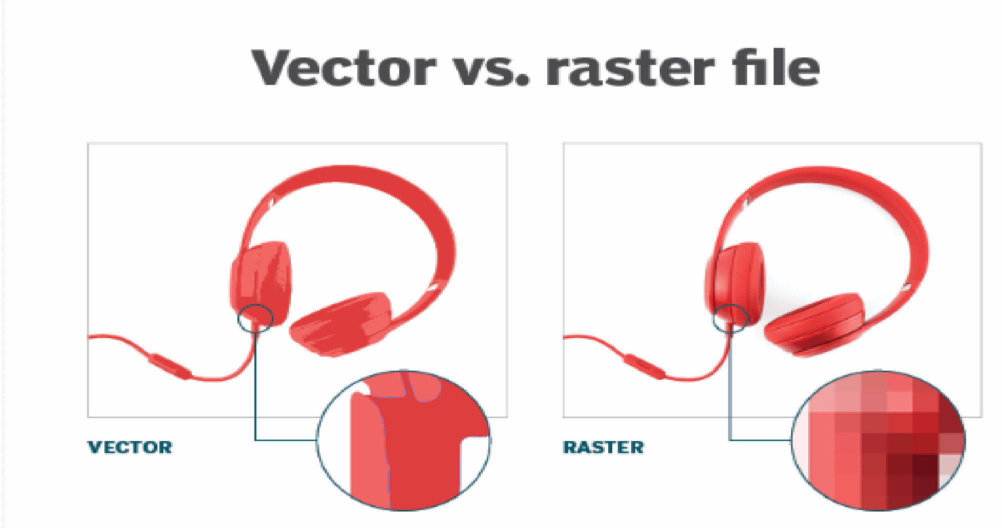
A)-Graphics : Vector graphics

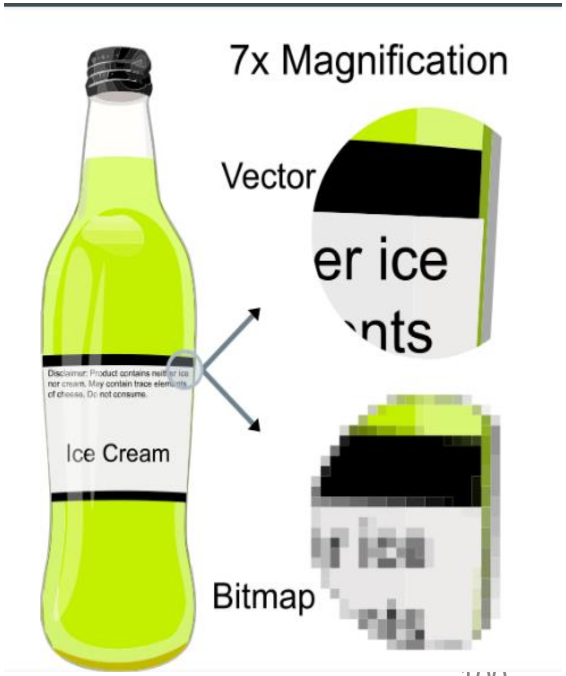
Vector graphics are computer images created using a sequence of commands or mathematical statements that place lines and shapes in a two-dimensional or three-dimensional space. In vector graphics, a graphic artist's work, or file, is created and saved as a sequence of vector statements.

A vector graphic file describes a series of points to be connected.

These files are sometimes called geometric files. Images created with tools such as Adobe Illustrator and Corel's Corel DRAW are usually vector image files.

Simplified, vector graphics are like connect-the-dots drawings.





1.2 Multimedia:

A)-Graphics : Vector graphics

Comparison between vector graphics and bit-map images

Vector graphic images	Bit-map images
made up of geometric shapes which require definition/attributes	made up of tiny pixels of different colours
to alter/edit the design, it is necessary to change each of the geometric shapes	possible to alter/edit each of the pixels to change the design of the image
they do not require large file size since it is made up of simple geometric shapes	because of the use of pixels (which give very accurate designs), the file size is very large
because the number of geometric shapes is limited, vector graphics are not usually very realistic	since images are built up pixel by pixel, the final image is usually very realistic
file formats are usually .svg, .cgm, .odg	file formats are usually .jpeg, .bmp, .png

AS-level Paper 1 Exam: Question 1

Draw a line to link each term to its correct description.

Term	Description
	Measured in dots per inch (dpi); this value determines the amount of detail an image has
Bitmap graphic	Picture element
Image file header	Image made up of rows and columns of picture elements
Image resolution	Image made up of drawing objects. The properties of each object determine its shape and appearance.
Pixel	Specifies the image size, number of colours, and other data needed to display the image data
Screen resolution	Number of samples taken per second to represent some event in a digital format
Vector graphic	Value quoted for a monitor specification, such as 1024 × 768. The larger the numbers, the more picture elements will be displayed.

AS-level Paper 1 Exam: Question 1

(b) **(i)** A black and white image is 512 pixels by 256 pixels.

Calculate the file size of this image in kilobytes (KB) (1 KB = 1024 bytes).
Show your working.

....

....

....

....

....[2]

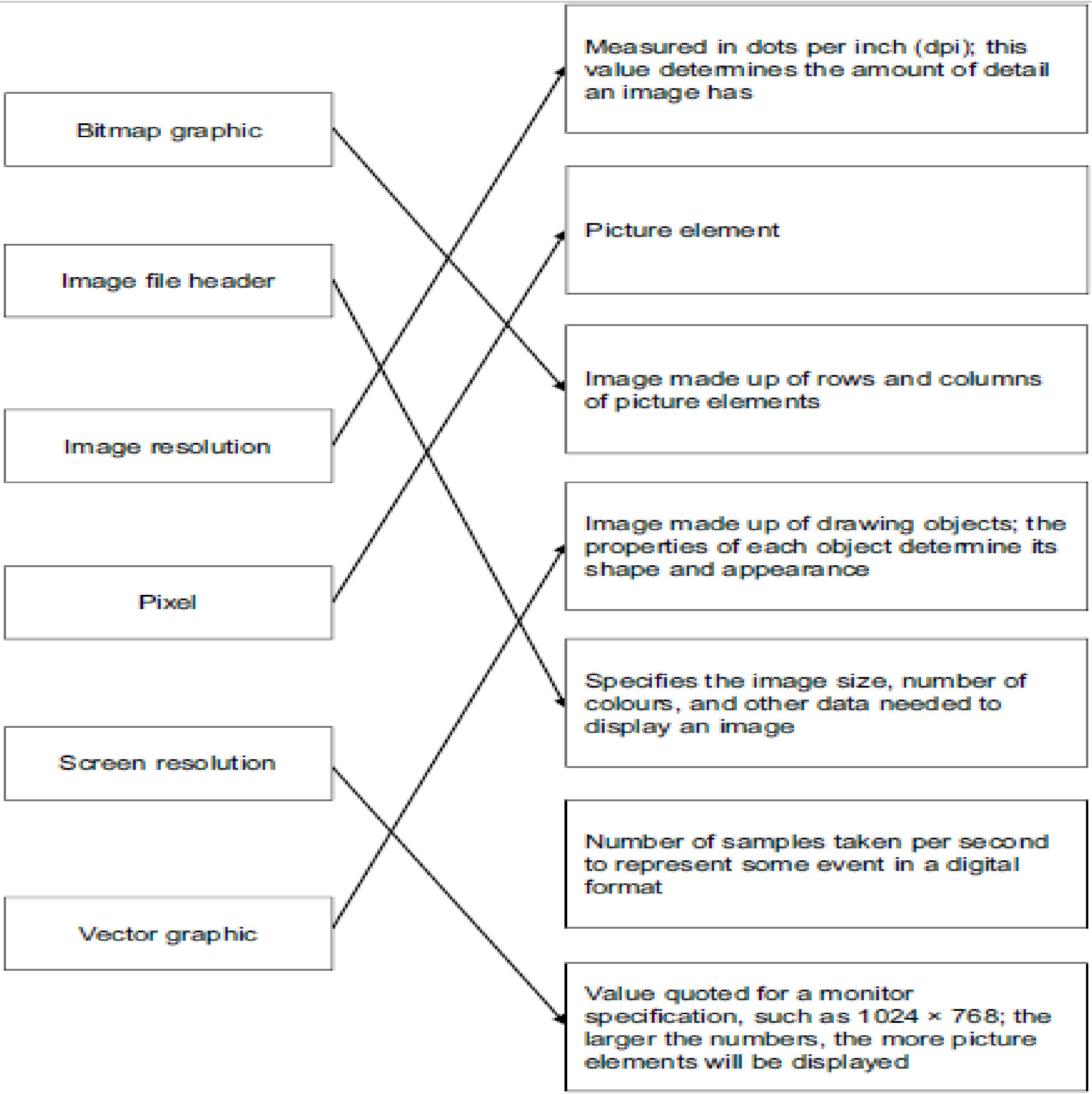
(ii) Give a reason why it is important to estimate the file size of an image.

....

....

....[1]

AS-level Paper 1 Exam: Answer 1



AS-level Paper 1 Exam: Answer 1

(b) (i) $\dfrac{512 \times 256}{8 \times 1024}$ = 16 KB

1 mark for numerator + 1 mark for denominator [2]

(ii) so it is possible to estimate how many images can be stored / to decide if it can be sent as an email attachment [1]

AS-level Paper 1 Exam: Question 2

A small company produces scientific magazines. The owner buys some new desktop computers. The computers are used to store thousands of colour images (diagrams and photographs). All the computers have Internet access.

(a) Name **three** utility programs the company would use on all their computers. Describe what each program does.

1 ....

Description ....

....

2 ....

Description ....

....

3 ....

Description ....

....[6]

AS-level Paper 1 Exam: Question 2

(b) The images contained in the magazines are produced using either bitmap or vector graphics software.

Give **four** differences between bitmap and vector graphics.

1 ....

....

2 ....

....

3 ....

....

4 ....

....[4]

AS-level Paper 1 Exam: Answer 2

(a) **One mark** for the name and **one mark** for the explanation for **three** utility programs

- Disk formatter
- Prepares a hard disk to allow data to be stored on it

- Virus checker
- Checks for viruses <u>and then</u> quarantines removes any virus found

- File compression
- Reduces file size by removing redundant details (lossy / lossless)

- Backup software
- Makes copy of files on <u>another medium</u> in case of corruption / loss of data

- Firewall
- Prevents unauthorised access to computer system from external sources [6]

AS-level Paper 1 Exam: Answer 2

(b) **Four** from:

- Bitmap is made up of pixels
  // Vector graphic store a set of instructions about how to draw the shape
- Bitmap files are usually bigger than vector graphics files // Take up more memory space
- Enlarging a bitmap can mean the image is pixelated
  // vector graphic can be enlarged without the image becoming pixelated
- Bitmap images can be compressed (with significant reduction in file size)
  // Vector graphic images do not compress well
- Bitmaps are suitable for photographs / scanned images
  // Vector graphics are suitable for more geometric shapes
- Bitmap graphics use less processing power than vector graphics
- Individual elements of a bitmap cannot be grouped
  // Individual elements of a vector graphic can be grouped
- Vector graphics need to be 'rasterised' in order to display or print [4]

1.2 Multimedia:

B)-Sound :

Sampling rate is the number of sound samples taken per second. The higher the sampling rate and/or sampling resolution, the greater the file size. For example, a 16-bit sampling resolution is used when recording CDs to give better sound quality.

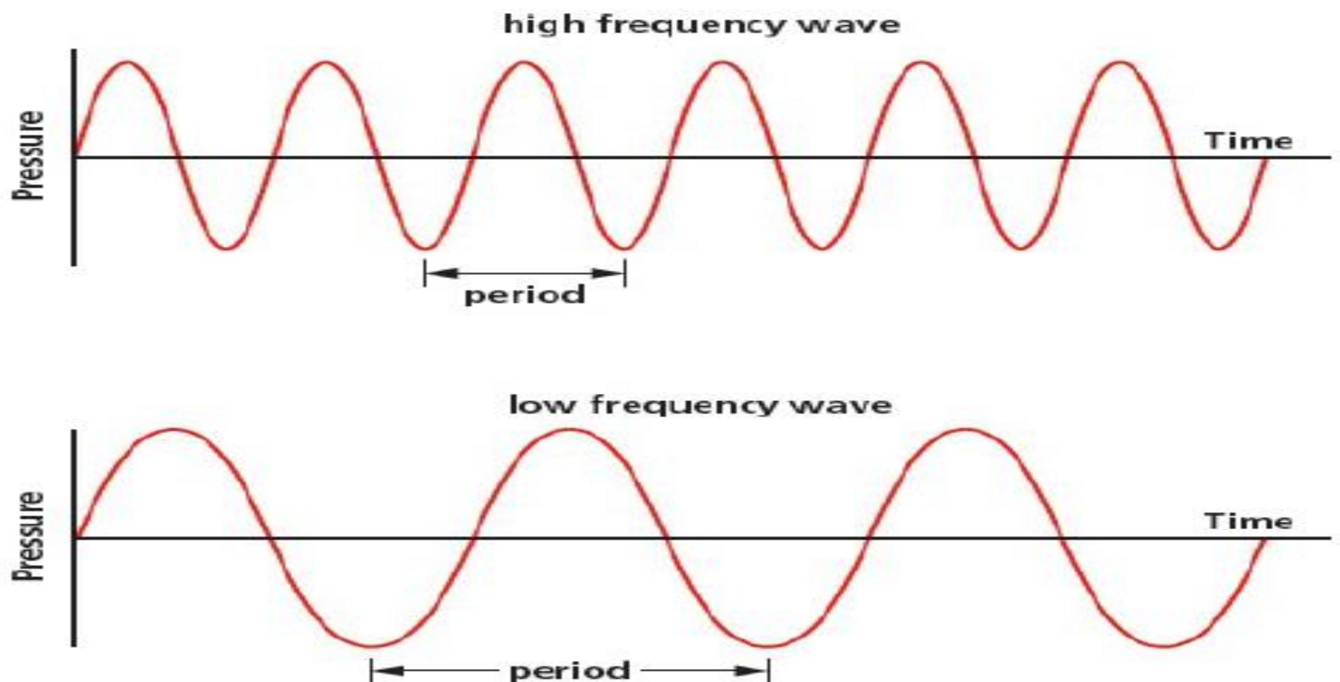
Let's explore more about sampling by clicking the link below:

https://www.bbc.co.uk/bitesize/guides/z7vc7ty/revision/2

1.2 Multimedia:

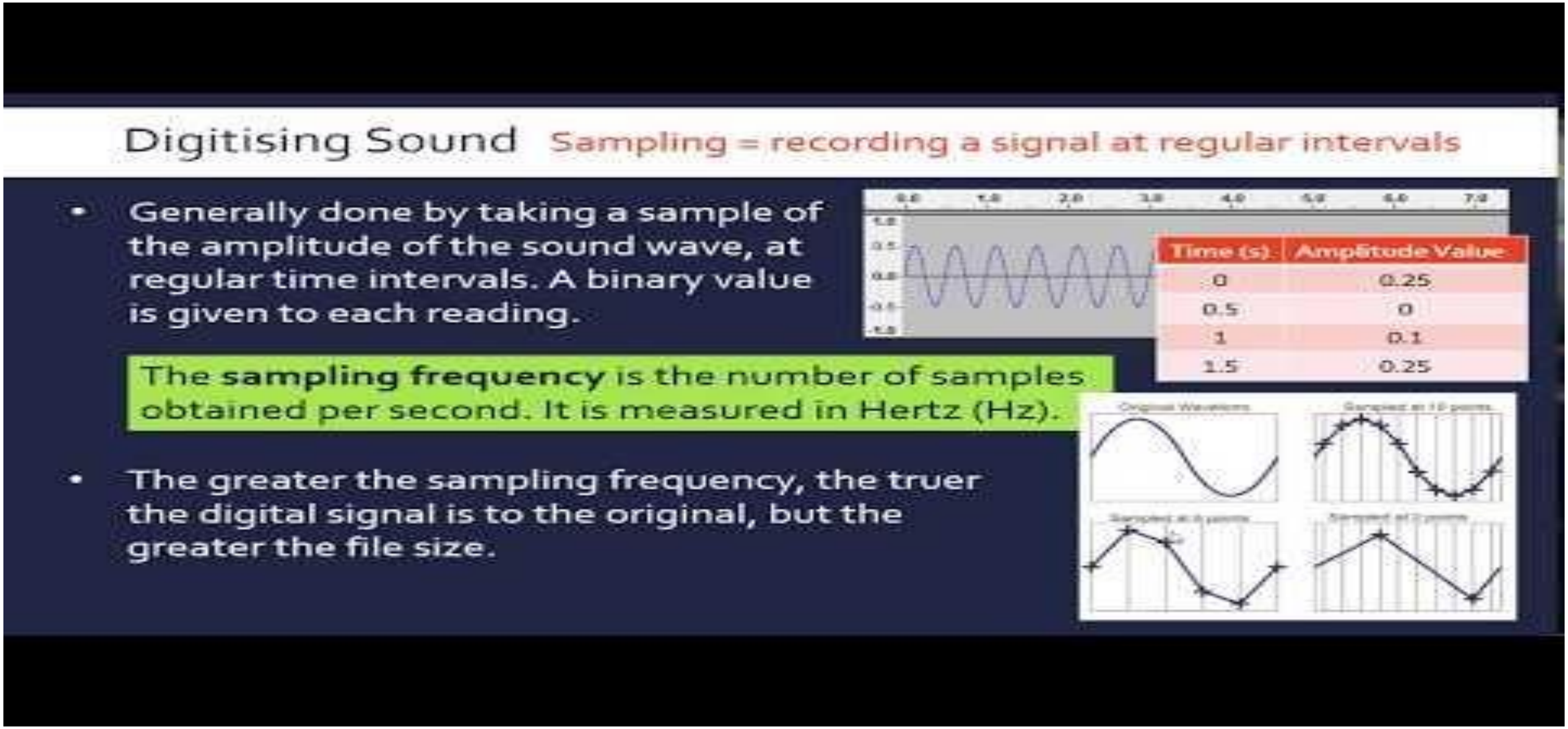
B)-Sound :

Sound requires a medium in which to travel through (it cannot travel in a vacuum). This is because it is transmitted by causing oscillations of particles within the medium. The human ear picks up these oscillations (changes in air pressure) and interprets them as sound. Each sound wave has a frequency and wavelength; the amplitude specifies the loudness of the sound.



Sound

Watch the video for the Representing Sound in Binary
https://www.youtube.com/watch?v=HlOTuCFtuV8 (4 minutes)



1.2 Multimedia:
B)- Sound

- Sound arises from pressure changes
- Sound is an irregular analogue waveform
- Sound has to be sampled to be stored
- Sampling has a defined sampling resolution and a defined sampling rate
- A sound encoder contains a band-limiting filter and an analogue to digital converter

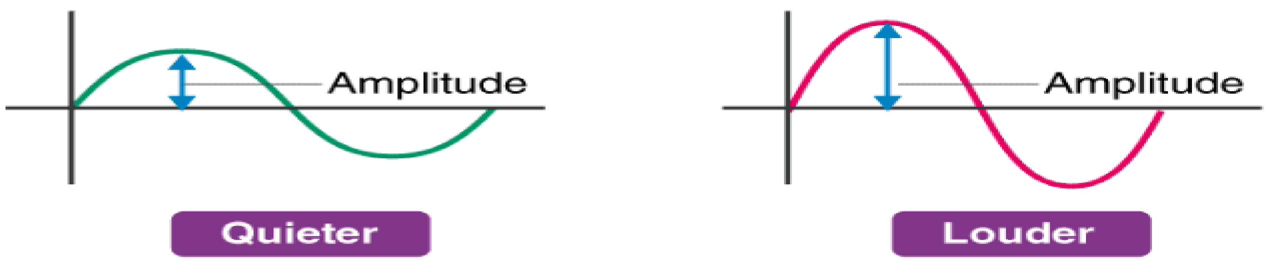
1.2 Multimedia:

B)-Sound :

Sound is an analogue value; this needs to be digitized in order to store sound in a computer. This is done using an **analogue to digital converter** (**ADC**). If the sound is to be used as a music file, it is often filtered first to remove higher frequencies and lower frequencies which are outside the range of human hearing. To convert the analogue data to digital, the sound waves are sampled at a given time rate. The amplitude of the sound cannot be measured precisely, so approximate values are stored.

What is Amplitude of Sound?

The amplitude of a sound wave is the measure of the **height** of the **wave**. The amplitude of a sound wave can be defined as the loudness (Volume) or the amount of maximum displacement of vibrating particles of the medium from their mean position when the sound is produced. It is the distance between the crest or trough and the mean position of the wave and its measure in decibel (**db**)

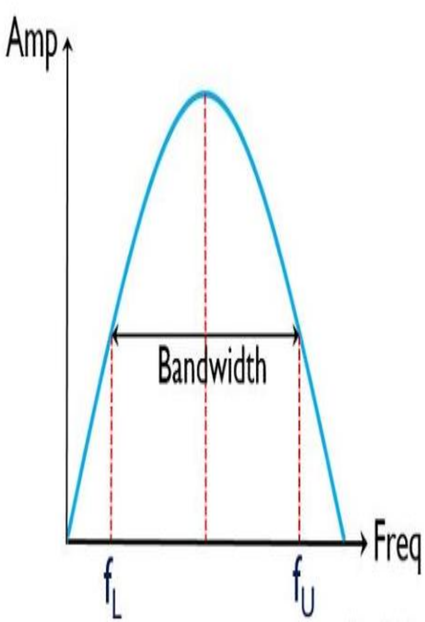


1.2 Multimedia:

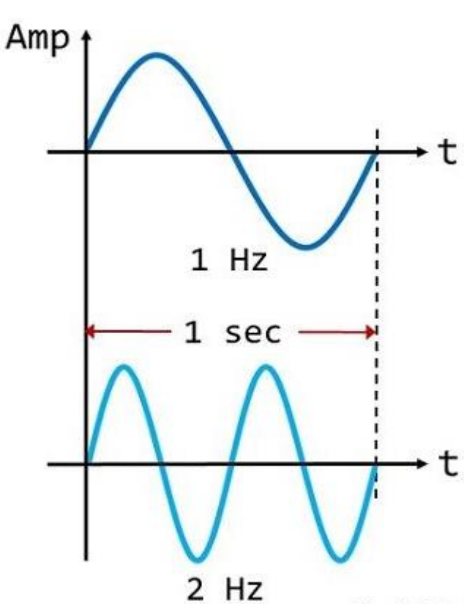
B)-Sound :

What is bandwidth of frequency?

Bandwidth is **a range of frequencies within a continuous set of frequencies**. It is measured in Hertz (Hz). The purpose of a communication system is to transfer information from the transmitter which is located in one place to a receiver which is usually far away from the transmitter.



Basis for Comparison	Frequency	Bandwidth
Basic	It defines the number of complete cycles in unit time.	It defines the amount of data transmitted in unit time.
Specified in terms of	cycles/sec	bits/sec
Denoted as	f	B



1.2 Multimedia:

B)-Sound :

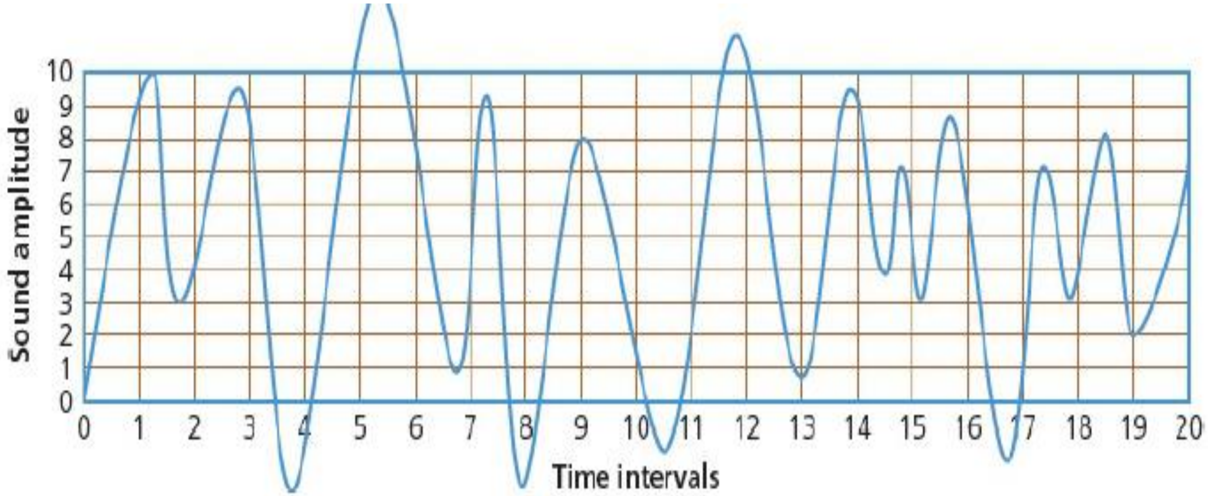


Figure above shows a sound wave. The x-axis shows the time intervals when the sound was sampled (**0** to **20**), and the y-axis shows the amplitude of the sampled sound (the amplitudes above **10** and below **0** are filtered out in this example).

At time interval **1**, the approximate amplitude is **9**; at time interval **2**, the approximate amplitude is **4**, and so on for all **20** time intervals. Because the amplitude range in Figure above is **0** to **10**, then **4** binary bits can be used to represent each amplitude value (for example, **9** would be represented by the binary value **1001**).

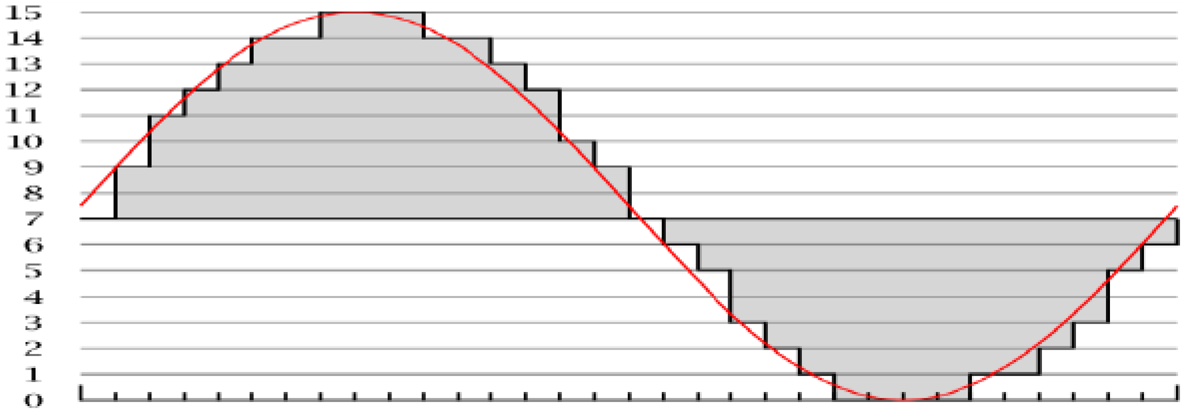
Increasing the number of possible values used to represent sound amplitude also increases the accuracy of the sampled sound (for example, using a range of **0** to **127** gives a much more accurate representation of the sound sample than using a range of, for example, **0** to **10**). This is known as the **sampling resolution** (also known as the **bit depth**).

1.2 Multimedia:

B)-Sound :

The process of **converting an analogue signal** into a **digital** one is known as sampling.

Using this image we can count that there have been **32 samples** taken



We can also see, using the y axis that there are **16 possible sound states** which needs to be represented using **4 bits per sample.**

To calculate the size of the sound file you simply need to **multiply** the bit depth by the number of samples…

32 X 4 = 128 bits
128 / 8 = 16 Bytes

AS-level Paper 1 Exam: Question 1

(a) Sound can be represented digitally in a computer.

Explain the terms sampling resolution and sampling rate.

Sampling resolution ....

....

....

....

Sampling rate ....

....

....

....[4]

AS-level Paper 1 Exam: Question 1

(b) The following information refers to a music track being recorded on a CD:

- music is sampled 44 100 times per second
- each sample is 16 bits
- each track requires sampling for left and right speakers

(i) Calculate the number of bytes required to store one second of sampled music.
Show your working.

....

....

....

....[2]

(ii) A particular track is four minutes long.

Describe how you would calculate the number of megabytes required to store this track.

....

....

....

....[2]

AS-level Paper 1 Exam: Answer

(a) Sampling resolution (two marks)

- representation used to write samples in digital sound recording
- resolution is the number of distinct values available to encode/represent each sample
- specified by the number of bits used to store/record each sample
- sometimes referred to as bit depth
- the higher the sampling resolution the smaller the quantization error
- a higher sampling resolution results in less distortion of the sound
- usually 8 bit, 16 bit, 24 bit or 32 bit

Sampling rate (two marks)

- number of times that the amplitude of (analogue) sound wave is taken/measured
- per unit time/per second
- higher sampling rate results in <u>more accurate</u> digital representation [4]

(b) (i) **one mark** for correct calculation, **one mark** for the answer

$$\frac{44100 \times 16 \times 2}{8}$$ (1 mark)

176 400 bytes (1 mark)

[2]

(ii) Allow follow through from part **(i)** on 176 400

$$\frac{4 \times 60 \times 176400}{1024 \times 1024}$$

one mark for numerator
one mark for denominator [2]

AS-level Paper 1 Exam: Question 2

A group of students broadcast a school radio station on a website. They record their sound clips (programmes) in advance and email them to the producer.

(a) Describe how sampling is used to record the sound clips.

....

....

....

....

....

....[3]

AS-level Paper 1 Exam: Answer 2

(a) **Three** from: **[3]**

- The height/amplitude of the (sound) wave is determined.
- At set (time) intervals // by example of sensible time period.
- To get an approximation of the sound wave
- And encoded as a sequence of binary numbers // and converted to a digital signal.
- Increasing the sampling rate will improve the accuracy of the recording.

AS-level Paper 1 Exam: Question 3

(a) A computer has a microphone and captures a voice recording using sound editing software.

The user can select the sampling resolution before making a recording.

Define the term **sampling resolution**. Explain how the sampling resolution will affect the accuracy of the digitised sound.

Sampling resolution ....

....

....

Explanation ....

.... [3]

AS-level Paper 1 Exam: Answer 3

Question	Answer	Marks
3(a)	*Definition*: **Max two from:** ☐ The number of distinct values available to encode/represent each sample 1 ☐ Specified by the number of bits used to encode the data for one sample 1 ☐ Sometimes referred to as bit depth 1 *Explanation*: **Max two from:** ☐ A larger sampling resolution will mean there are more values available to store each sample 1 ☐ A larger sampling resolution will improve the accuracy of the digitised sound // A larger sampling resolution will decrease the distortion of the sound 1 ☐ Increased sampling resolution means a smaller quantization error 1	**Max 3**

AS-level Paper 1 Exam: Question 4

A student has recorded a sound track for a short film.

(a) Explain how an analogue sound wave is sampled to convert it into digital format.

....

....

....

....

....

....[3]

(b) Explain the effects of increasing the sampling resolution on the sound file.

....

....

....

....[2]

AS-level Paper 1 Exam: Question 4

(c) The original sound was sampled at 44.1 kHz. The sample rate is changed to 22.05 kHz.

Explain the effects of this change on the sound file.

....

....

....

....

....

....

....

.... [3]

AS-level Paper 1 Exam: Question 4

-

(d) The student uses sound editing software to edit the sound file.

Name **two** features of sound editing software the student can use to edit the sound file.

Describe the purpose of each feature.

Feature 1 ....

Purpose ....

....

....

Feature 2 ....

Purpose ....

....

....

[4]

AS-level Paper 1 Exam: Answer 4

Question	Answer	Marks
5(a)	**1 mark** per bullet to **max 3** ☐ Amplitude (of the sound wave) measured ☐ At <u>set / regular</u> time intervals / per time unit / time period ☐ Value of the sample is recorded as a binary number	**3**
5(b)	**1 mark** per bullet to **max 2** ☐ (Increasing the sampling resolution means) more bits per sample // larger range of values ☐ Larger file size ☐ More accurate representation of sound	**2**
5(c)	**1 mark** per bullet to **max 3** ☐ Fewer samples (per unit time) ☐ File size will decrease ☐ Larger gaps / spaces between samples // Greater quantization errors ☐ Sound accuracy will reduce // not as close to original sound	**3**

Question	Answer	Marks
5(d)	**1 mark** for naming feature/tool, **1 mark** for description. **Max 2 features** e.g. ☐ Fading ☐ Change the volume of a section of the sound for it get louder/quieter ☐ Removing sound / elements ☐ Delete sections of the sound wave, for example, background noise ☐ Copy ☐ Repeat elements of the sound wave	**4**

Learning objectives

1.3 Compression

Show understanding of the need for and examples of the use of compression	
Show understanding of lossy and lossless compression and justify the use of a method in a given situation	
Show understanding of how a text file, bitmap image, vector graphic and sound file can be compressed	Including the use of run-length encoding (RLE)

Learning objectives

1.3 Compression

Key terms

Lossless file compression – file compression method where the original file can be restored following decompression.

Lossy file compression – file compression method where parts of the original file cannot be recovered during decompression, so some of the original detail is lost.

JPEG – Joint Photographic Expert Group – a form of lossy file compression based on the inability of the eye to spot certain colour changes and hues.

MP3/MP4 files – file compression method used for music and multimedia files.

Audio compression – method used to reduce the size of a sound file using perceptual music shaping.

Perceptual music shaping – method where sounds outside the normal range of hearing of humans, for example, are eliminated from the music file during compression.

Bit rate – number of bits per second that can be transmitted over a network. It is a measure of the data transfer rate over a digital telecoms network.

Run length encoding (RLE) – a lossless file compression technique used to reduce text and photo files in particular.

1.3 Compression

- Any binary data can be compressed
- Original data is recoverable intact if compression is lossless but not if lossy
- Text data compression must be lossless
- Run-length encoding and Huffman coding are examples of lossless compression
- Lossy used for multimedia files

Compression

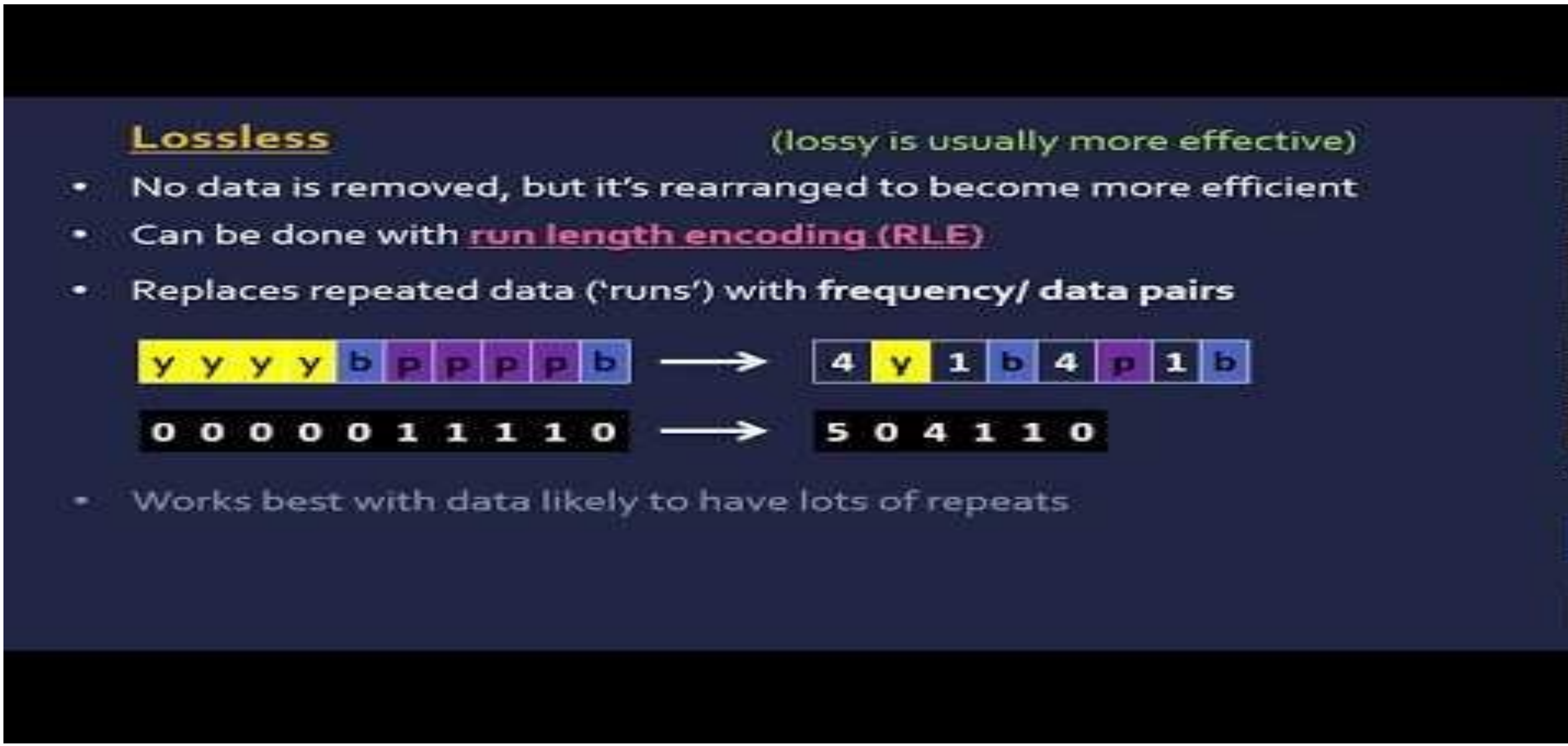
Watch the video for the Compression 95 minutes)

https://www.youtube.com/watch?v=kOFA8FPL5kE

Compression

Watch the video for the Lossy and Lossless (RLE) Compression (4 minutes)

https://www.youtube.com/watch?v=v1u-vY6NEmM



Compression

The Lossy and Lossless Compression

Compression

- Reducing the number of bits in a file.
- Making the storage capacity of the file lower.
- Making data transfer of the file quicker.

- Useful because more data can be stored on a storage device, and transferred in a smaller amount of time.

Lossy compression

- Some of the data is lost and cannot be recovered.
- Greatly reduces the file size.
- Reduces the quality of the image/sound.
- Suitable for images, sound and video.
- Cannot be used on text and executable files.

Lossless compression

- None of the data is lost. It is encoded differently.
- Can be turned back into original format.
- Can be used on all types of data.
- Is usually less effective than lossy compression at reducing the file size.
- Mostly suitable for documents and executable files.

Compression

Run-length encoding (RLE)

Run–length encoding (RLE) is a simple form of lossless data compression that runs on sequences with the same value occurring many consecutive times. It encodes the sequence to store only a single value and its count. For example, consider a screen containing plain black text on a solid white background.

What is RLE used for?

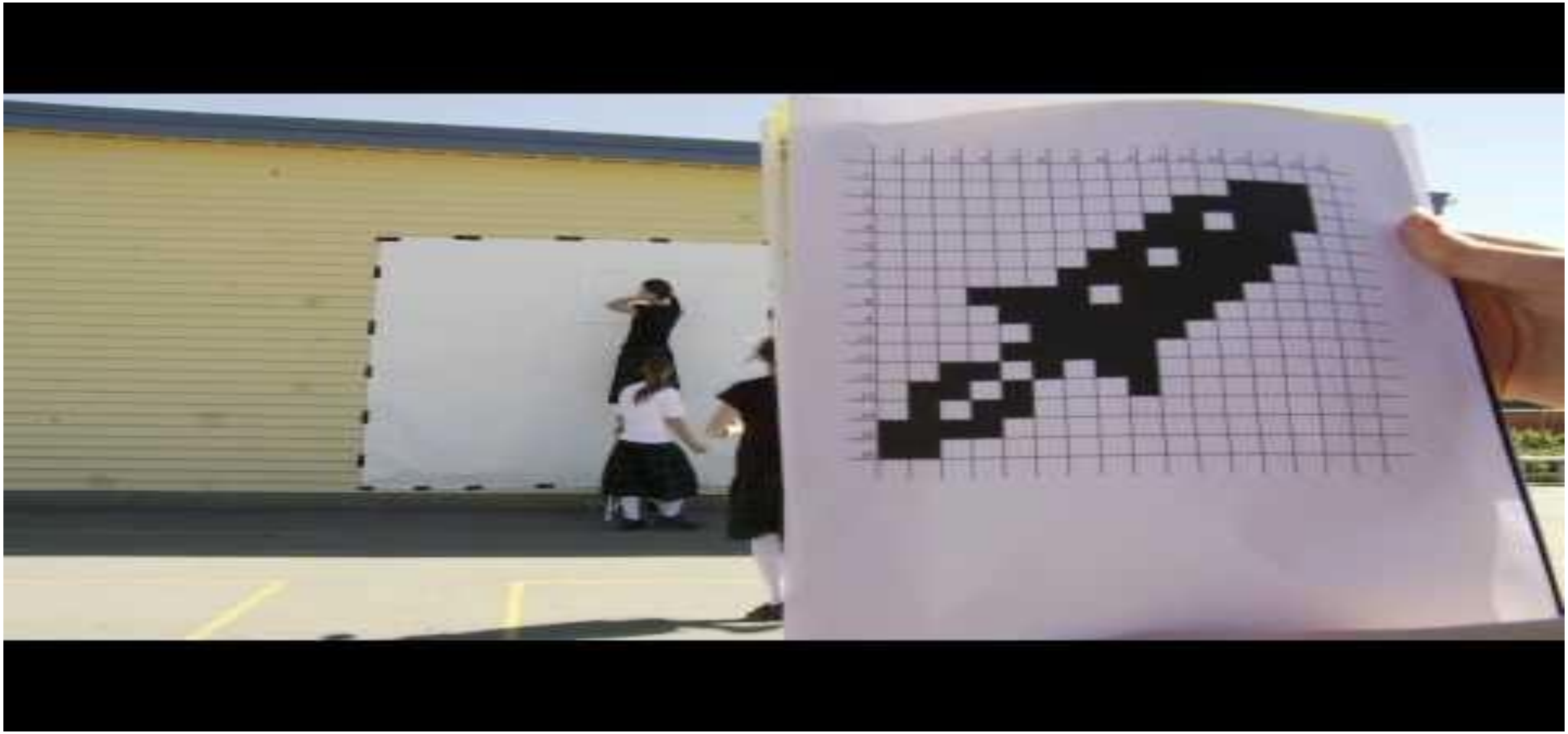
RLE is particularly well suited to **palette-based bitmap images such as computer icons**, and was a popular image compression method on early online services such as CompuServe before the advent of more sophisticated formats such as GIF

Example: The sequence of data is stored as a single value and count. For example, **for a minute of a scene filmed at a beach there would be similar colours on screen for the duration of the shot, such as the blues of the sky and the sea, and the yellows of the sand**.

Compression

Watch the video for Run-length encoding (RLE) (6 minutes)

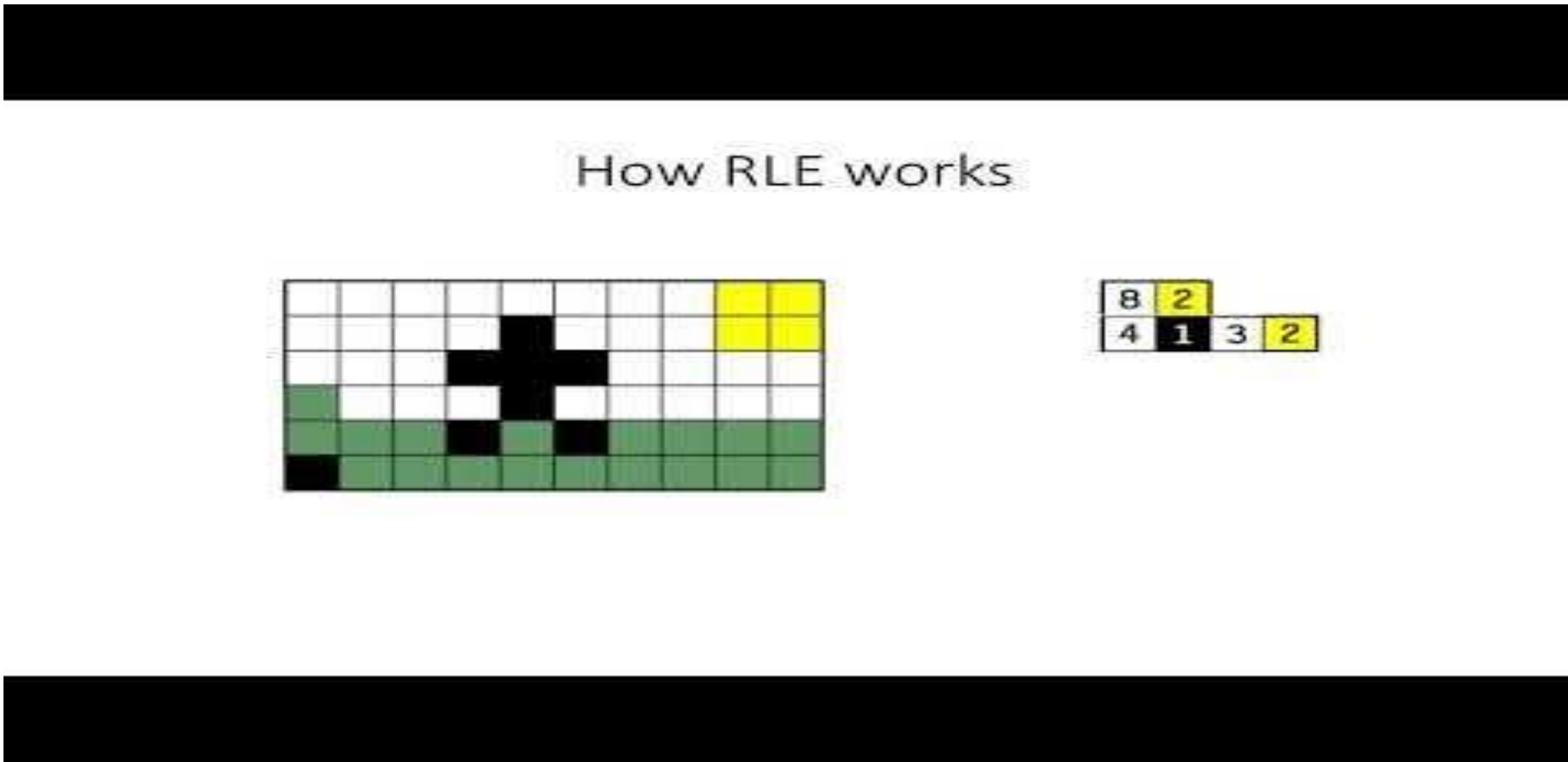
https://youtu.be/uaV2RuAJTjQ



Compression

Watch the video for Run-length encoding (RLE) (6 minutes)

https://www.youtube.com/watch?v=cAAeSn8_aCU



Key terms

- **Binary** – a base 2 number, can be 1 or 0
- **Denary** – a base 10 number, can be 0, 1, 2, 3, 4, 5, 6, 7, 8 or 9
- **Analogue** – the stream of data used in the 'real world', e.g. a sound wave
- **Digital** – data that is represented in 1s and 0s (binary)
- **Register** – a small piece of memory that can hold a piece of data or an instruction
- **Hexadecimal** – a base 16 number, can be 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- **Character set** – the numbers, letters and symbols that can be represented by a computer
- **ASCII** – a character set that uses 7 or 8 bits per character
- **Bitmap** – an image made up of pixels
- **Pixel** – a small square within an image that can contain only one colour
- **Sampling** – reading the height of a sound wave at a set interval; this is converted into a binary number
- **Data compression** – reducing the size of a file
- **Lossy compression** – when decompressed, the file will not be identical to the original
- **Lossless compression** – when decompressed, the file will be identical to the original

AS-level Paper 1 Exam: Question 1

(c) When storing music tracks in a computer, the MP3 format is often used. This reduces file size by about 90%.

Explain how the music quality is apparently retained.

....

....

....

....

....

....[3]

AS-level Paper 1 Exam: Answer 1

(c) any **three** from:

- mp3 is a lossy compressed format
- uses psycho-acoustic modelling
- and perceptual music/noise shaping
- certain parts of the music can be eliminated without significantly degrading the listener's experience
- removes sound that the human ear can't hear
- only keeps sounds human ear can hear better than others
- discards softer sound if two sounds played together [3]

AS-level Paper 1 Exam: Question 2

(b) The students use software to compress the sound clips before emailing them.

(i) Circle your chosen method of compression and justify your choice.

Lossy / Lossless

Justification: ....

....

....

....[3]

Students also email images to the radio station for use on its website.

These are compressed before sending using run-length encoding (RLE).

(ii) Explain what is meant by run-length encoding.

....

....

....

....

....

....[3]

AS-level Paper 1 Exam: Question 2

(iii) The following diagrams show:

- the denary colour code that represents each colour
- the first three rows of a bitmap image

Colour symbol	Colour code (denary)
B	153
W	255

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	B	B	B	B	B	B	B	B	B	B	W	W	W	B	B	B
1	B	B	B	B	B	B	B	B	B	W	W	W	W	W	W	B
2	B	B	B	B	B	B	B	W	W	W	W	W	W	W	W	W
...																
95																

Show how RLE will compress the first three rows of this image.

Row 1: ....

Row 2: ....

Row 3: ....[2]

AS-level Paper 1 Exam: Answer 2

(b) (i) **No mark** awarded for identifying method. **Three marks** for justification. [3]

Lossy – Three points from:

- The human ear will not notice that the decompressed stream will not be identical to the original (file) / that parts of the original data have been discarded / removed / deleted.
- File size reduction is greater than using lossless.
- Email has limits on file sizes (on attachments) / a smaller file will take less time to transmit.
- The file may not need to be of high precision / accuracy.
- The producer has requested an mp3 file.

Lossless – Three points from:

- The file needs to be high precision / accuracy.
- None of the original data is lost / the decompressed file will be identical to the original.
- The producer has requested a flac file.

AS-level Paper 1 Exam: Answer 2

(ii) **Three** points from: **[3]**

- Lossless method of compression.
- Reduces (the physical size of) a string of adjacent, identical characters/pixels / bytes etc..
- The repeating string (a run) is encoded into two values.
- One value represents the number of (identical) characters in the run (the run count).
- The other value is the code of the character / colour code of pixel etc. in the run (the run value).
- The run value and run count combination may be preceded by a control character.
- Any valid example given.

(iii) **Two marks** for **three** correct rows, **one mark** for **two** correct rows. **[2]**

Row 1: 153 10 255 3 153 3
Row 2: 153 9 255 6 153 1
Row 3: 153 7 255 9

Alternative correct answer:

Row 1: 153 9 255 2 153 2
Row 2: 153 8 255 5 153 0
Row 3: 153 6 255 8

AS-level Paper 1 Exam: Question 3

(b) The computer also has bitmap software.

(i) Define the term **image resolution**.

....

....[1]

(ii) A picture is drawn and is saved as a 16-colour bitmap image.

State how many bits are used to encode the data for one pixel.

....[1]

(iii) A second picture has width 8192 pixels and height 256 pixels. It is saved as a 256-colour bitmap.

Calculate the file size in kilobytes.

Show your working.

....

....

....

....

....[3]

(iv) The actual bitmap file size will be larger than your calculated value as a bitmap file has a file header.

State **two** items of data that are stored in the file header.

1 ....

2 ....[2]

AS-level Paper 1 Exam: Answer 3

3(b)(i)	One from: □ The <u>number of pixels</u> per <u>unit measurement</u> 1 □ The number of pixels in an image 1 □ The number of pixels wide by the number of pixels high 1 □ Number of pixels per row by the number of rows 1	1
3(b)(ii)	4	1
3(b)(iii)	*Working*: **Max two from:** □ Number of pixels is 8192 □ 256 1 □ One pixel will be stored as one byte 1 □ Number of kilobytes = (8192 □ 256) / 1024 1 *Answer*: One mark: Number of kilobytes = 2048 KB 1	3
3(b)(iv)	Two from: □ Confirmation that the file is a BMP 1 □ File size 1 □ Location/offset of image data within the file 1 □ Dimensions of the image (in pixels) // image resolution 1 □ Colour depth (bits per pixel, 1, 4, 8, 16, 24 or 32) 1 □ Type of compression used, if any 1	**Max 2**

AS-level Paper 1 Exam: Question 4

A logo is designed as a bitmap image.

(a) Describe what is meant by a **bitmap image**.

....

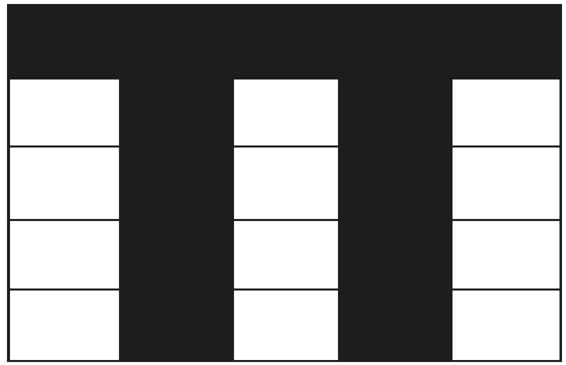
....

....

....[2]

AS-level Paper 1 Exam: Question 4

(b) A black and white bitmap image is shown.



(i) Explain how a computer can store this bitmap image.

....

....

....

....[2]

(ii) The image is compressed before it is attached to an email.

Explain how run-length encoding (RLE) will compress the image.

....

....

....

....[2]

AS-level Paper 1 Exam: Question 4

(c) The finished logo is 500 pixels by 1000 pixels and uses 35 different colours.

Estimate the file size for the logo. Give your answer in kilobytes. Show your working.

Working ....

....

....

....

....

Answer ....

[4]

(d) The logo is redesigned as a vector graphic.

State **two** benefits of a vector graphic compared to a bitmap image. Give a reason for each benefit.

Benefit 1 ....

....

Reason 1 ....

....

Benefit 2 ....

....

Reason 2 ....

....

[4]

AS-level Paper 1 Exam: Answer 4

Question	Answer	Marks
2(a)	**1 mark** per bullet, **max 2** ☐ Made up of pixels ☐ Each pixel has one colour ☐ Colour of each pixel stored as a binary number	**2**
2(b)(i)	**1 mark** per bullet, **max 2** ☐ Each pixel requires only one bit (as there are only two colours) ☐ Black represented by 1 and white by 0 (or vice versa) ☐ Bits are stored for each pixel in sequence ☐ 11111 01010 01010 01010 01010	**2**
2(b)(ii)	**1 mark** for the explanation ☐ Stores the colour and the number of times it occurs **1 mark** for example from ☐ An example from the bitmap given e.g. B5, W1, B1 and so on	**2**
2(c)	**1 mark** per bullet ☐ Number of pixels 500*1000 (= 500 000) ☐ 35 colours require 6 bits per pixel ☐ Number of bytes (500 000 * 6) / 8 = 3 000 000 / 8 (= 375 000) ☐ **= 375 Kb**	**4**

Question	Answer	Marks
2(d)	**1 mark** per bullet to **max 2** marks per benefit ☐ Can resize it without pixilation ☐ Image is redrawn/recalculated with each adjustment ☐ Smaller file size ☐ Storing points/equations/commands etc., not individual pixels	**4**

AS-level Paper 1 Exam: Question 5

Xander creates a presentation that includes images, video and sound.

(a) The images are bitmap images. A bitmap image can be made up of any number of colours. Each colour is represented by a unique binary number.

Draw **one** line from **each** box on the left, to the correct box on the right to identify the minimum number of bits needed to store each maximum number of colours.

Maximum number of colours	Minimum number of bits
68	1
256	2
127	3
2	7
249	8
	9

[3]

AS-level Paper 1 Exam: Question 5

(b) One of the videos has a frame rate of 40 fps (frames per second).

(i) State what is meant by **40 fps**.

....

.... [1]

(ii) One video uses interlaced encoding, and a second video uses progressive encoding.

Describe **two** differences between interlaced and progressive encoding.

1 ....

....

....

....

2 ....

....

....

....

[4]

AS-level Paper 1 Exam: Question 5

(c) The sound track has a sampling rate of 88.2 kHz and a sampling resolution of 32 bits.

State what is meant by a **sampling rate of 88.2 kHz** and a **sampling resolution of 32 bits**.

Sampling rate of 88.2 kHz ....

....

....

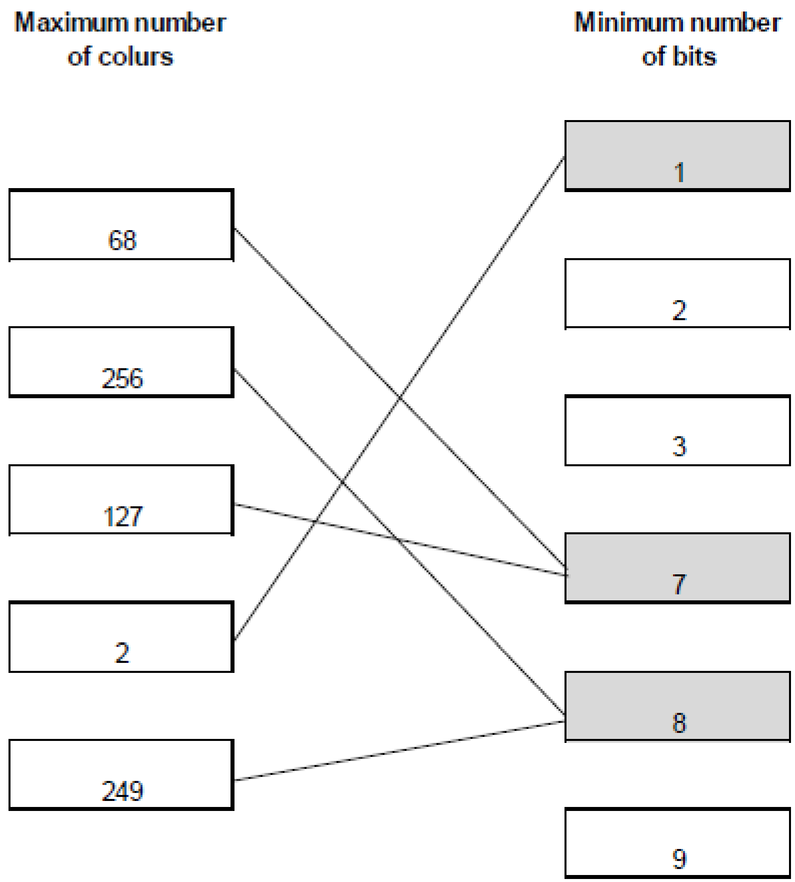
Sampling resolution of 32 bits ....

....

....

[2]

AS-level Paper 1 Exam: Answer 5

Question	Answer	Marks
5(a)	**1 mark** for each correctly linked box on the right 	**3**

AS-level Paper 1 Exam: Answer 5

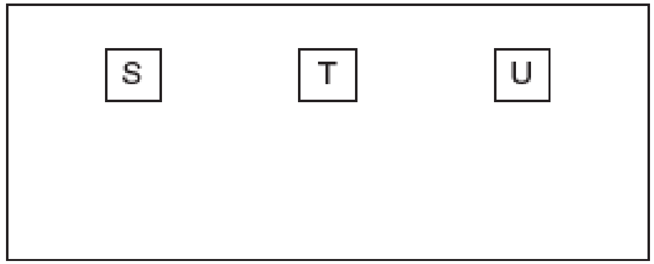
5(b)(i)	**1 mark** for correct answer 40 images or frames are displayed/recorded each second	**1**
5(b)(ii)	**1 mark** per bullet to **max 4** ☐ Progressive – each frame contains (all the lines for) the complete image ☐ Interlaced – each frame contains half the (number of lines) of the complete image ☐ Progressive – frames are not divided into fields ☐ Interlaced – each frame divided into two fields // One field contains the data for the even numbered rows / lines and the other has the data for the odd numbered rows / lines. ☐ Progressive – complete frames are displayed in sequence ☐ Interlaced – data from two frames is displayed simultaneously ☐ Progressive – the number of images stored is the same as the frame rate // the rate of picture display is the same as the frame rate. ☐ Interlaced – the rate of picture display (the field rate) is twice the rate of image frame display (the frame rate). ☐ Progressive means the entire frame is refreshed each time ☐ Interlaced means only half the frame is refreshed ☐ Progressive has high bandwidth requirements ☐ Interlaced halves the transmission bandwidth requirements.	**4**

AS-level Paper 1 Exam: Answer 5

Question	Answer	Marks
5(c)	**1 mark** per bullet 88.2 kHz - The sound wave is sampled 88200 times per second 32 bits - Each sample is stored as a 32-bit binary number	**2**

AS-level Paper 1 Exam: Question 6

3 A touch screen has three squares where a selection can be made:



(a) The x-coordinate of the centre of the three squares is held in three memory locations:

	Address	**Memory contents**
S	40	0000 1011 0100
T	41	0010 0101 0100
U	42	0100 0110 1100

(i) Give the hexadecimal value of the memory contents for U.

....

....[1]

(ii) Convert the denary number 40 into binary.

....

....[1]

AS-level Paper 1 Exam: Question 6

(b) Bitmap graphics are used to represent squares S, T and U.

These can be saved in a number of different image resolutions.

(i) Give the number of bits required to store each pixel for a black and white bitmap.

....[1]

(ii) Identify how many bits are required to store each pixel for a 256-colour bitmap.

Explain your answer.

....

....

....[2]

AS-level Paper 1 Exam: Answer 6

3 (a) (i) 4 6 C [1]

(ii) 1 0 1 0 0 0 [1]

(b) (i) 1 bit [1]

(ii) – 8 bits are needed
– Each colour is represented by one of 256 values
– values 0 to 255/0000 0000 to 1111 1111
– $256 = 2^8$ [2]

AS-level Paper 1 Exam: Question 7

4 (a) Sound can be represented digitally in a computer.

Explain the terms sampling resolution and sampling rate.

Sampling resolution ....

....

....

....

Sampling rate ....

....

....

....[4]

AS-level Paper 1 Exam: Question 7

(b) The following information refers to a music track being recorded on a CD:

- music is sampled 44 100 times per second
- each sample is 16 bits
- each track requires sampling for left and right speakers

(i) Calculate the number of bytes required to store one second of sampled music.
Show your working.

....

....

....

....[2]

(ii) A particular track is four minutes long.

Describe how you would calculate the number of megabytes required to store this track.

....

....

....

....[2]

AS-level Paper 1 Exam: Question 7

(c) When storing music tracks in a computer, the MP3 format is often used. This reduces file size by about 90%.

Explain how the music quality is apparently retained.

....

....

....

....

....

....[3]

AS-level Paper 1 Exam: Answer 7

4 (a) **Sampling resolution** (two marks)

- representation used to write samples in digital sound recording
- resolution is the number of distinct values available to encode/represent each sample
- specified by the number of bits used to store/record each sample
- sometimes referred to as bit depth
- the higher the sampling resolution the smaller the quantization error
- a higher sampling resolution results in less distortion of the sound
- usually 8 bit, 16 bit, 24 bit or 32 bit

Sampling rate (two marks)

- number of times that the amplitude of (analogue) sound wave is taken/measured
- per unit time/per second
- higher sampling rate results in <u>more accurate</u> digital representation [4]

AS-level Paper 1 Exam: Answer 7

(b) (i) **one mark** for correct calculation, **one mark** for the answer

$$\frac{44100 \times 16 \times 2}{8}$$ (1 mark)

176 400 bytes (1 mark)

[2]

(ii) Allow follow through from part **(i)** on 176 400

$$\frac{4 \times 60 \times 176400}{1024 \times 1024}$$

one mark for numerator
one mark for denominator

[2]

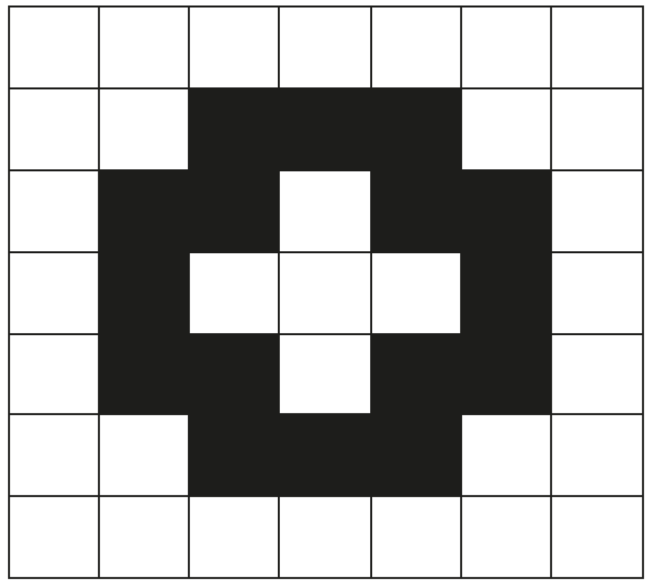
(c) any **three** from:

- mp3 is a lossy compressed format
- uses psycho-acoustic modelling
- and perceptual music/noise shaping
- certain parts of the music can be eliminated without significantly degrading the listener's experience
- removes sound that the human ear can't hear
- only keeps sounds human ear can hear better than others
- discards softer sound if two sounds played together

[3]

AS-level Paper 1 Exam: Question 8

6 A black and white bitmap image is shown.



(a) State the **minimum** number of bits needed to represent each pixel in this image.

....[1]

AS-level Paper 1 Exam: Question 8

(b) Run-length encoding (RLE) is used to store the image with the following colour codes.

Colour	Code
Black	1A
White	3B

Show how run-length encoding is used to store the image.

....

....

....[3]

(c) An image has 30 different colours.

State the **minimum** number of bits needed to represent each pixel in the 30-colour image.

....[1]

AS-level Paper 1 Exam: Question 8

(d) When the image is saved, a header is added to the file.

State the purpose of the **file header**. Give **two** examples of the file header contents.

Purpose ....

....

Example 1 ....

....

Example 2 ....

....

[3]

AS-level Paper 1 Exam: Question 8

(e) Graphics software is used to edit a digital photograph.

Give **three** features of graphics software that can be used to edit the photograph.

Describe the effect each has on the photograph.

Feature 1 ....

Effect ....

....

....

Feature 2 ....

Effect ....

....

....

Feature 3 ....

Effect ....

....

.... [6]

AS-level Paper 1 Exam: Answer 8

Question	Answer	Marks
6(a)	1	1
6(b)	**1 mark for correct method (colour code and number of pixels)** **1 mark for first 7 groups correct** **1 mark for remainder correct** - 3B9 1A3 3B3 1A2 3B1 1A2 3B2 - 1A1 3B3 1A1 3B2 1A2 3B1 1A2 3B3 1A3 3B9	3
6(c)	5	1

AS-level Paper 1 Exam: Answer 8

Question	Answer	Marks
6(d)	**1 mark** for purpose □ Stores data about the file contents/image/metadata **Max 2 marks** for examples of contents □ Confirmation that the file is a BMP // confirmation of file type □ File size □ Location / offset of image data within the file □ Dimensions of the image (in pixels) // image resolution □ Colour depth (bits per pixel, 1, 4, 8, 16, 24 or 32) □ Type of compression used (if any)	**3**
6(e)	**1 mark** for naming tool, **1 mark** for describing effect **on the photograph** e.g. □ Resize □ Increase / decrease the size of the image □ Crop □ Remove part of the image □ Blur □ Reduce the focus □ Red eye reduction □ Reduces red (light reflected from human eyes)	**6**

AS-level Paper 1 Exam: Question 9

1 A student is creating a short video and needs to record music to play in the background.

(a) The student uses a microphone to capture the music.

Explain how the microphone captures the music.

....

....

....

....

....

....[3]

AS-level Paper 1 Exam: Question 9

(b) An analogue-to-digital converter uses sampling to encode the sound.

Explain how different sampling resolutions affect the sound file and the sound it represents.

....

....

....

....

....

....[3]

AS-level Paper 1 Exam: Question 9

(c) The student needs to edit the sound file.

Describe **two** features of sound editing software that can be used to edit the sound file.

Feature 1 ....

....

....

....

Feature 2 ....

....

....

....
[4]

AS-level Paper 1 Exam: Question 9

(d) The video is recorded with a frame rate of 60 frames per second (fps) and uses progressive encoding.

(i) Describe what is meant by **a frame rate of 60 fps**.

....

....[1]

(ii) Describe what is meant by **progressive encoding** in video recording.

....

....

....

....[2]

(e) MP4 multimedia container format is used to save the video.

State what is meant by **multimedia container format**.

....

....[1]

AS-level Paper 1 Exam: Answer 9

Question	Answer	Marks
1(a)	**1 mark** per bullet point to **max 3** □ The microphone has a diaphragm □ The incoming sound waves cause vibrations □ … causing a coil to move past a magnet (dynamic microphone) // changing the capacitance (condenser microphone) □ An electric current is generated / changed	**3**
1(b)	**1 mark** per bullet point □ The sampling resolution number of bits used to store each sample □ Increasing the (sampling) resolution means a larger file size // Decreasing the (sampling) resolution means a smaller file size □ Increasing the (sampling) resolution gives a more accurate representation of the analogue sound // Decreasing the (sampling) resolution gives a less accurate representation of the analogue sound □ Increasing the (sampling) resolution means a greater range of values can be stored // Decreasing the (sampling) resolution gives a smaller range of values that can be stored □ Increasing the (sampling) resolution reduces the quantization errors // Decreasing the (sampling) resolution causes greater quantization errors	**3**

AS-level Paper 1 Exam: Answer 9

1(c)	**For 2 features** **1 mark** for identifying feature, **1 mark** for describing what it does. For example: ☐ Cut/delete ☐ ... Remove part of the sound file ☐ Copy and paste ☐ ... Replicate part of the sound ☐ Amplify ☐ ... Increase the volume of a section of sound	**4**
1(d)(i)	60 images are recorded per second	**1**
1(d)(ii)	**1 mark** per bullet point to **max 2** ☐ Each frame contains (all the lines for) the complete image ☐ All the frame data is recorded at the same time ☐ Each frame contains all the scan lines ☐ The number of images stored is the same as the frame rate	**2**
1(e)	**1 mark** per bullet point to **max 1** ☐ A meta file / wrapper ☐ Contains various different types of data	**1**

AS-level Paper 1 Exam: Question 10

1 A company is designing a website.

(a) The company creates a 4-colour bitmap image for the website as shown.

Each colour is represented by a letter, for example, G = grey, K = black.

G	R	G	K	W	R
G	R	G	K	W	R
G	R	G	K	W	R
G	R	G	K	W	R
G	G	G	K	K	R
W	W	W	W	K	R

(i) State the minimum number of bits needed to represent each pixel in the image in **part (a)**.

.... [1]

(ii) Calculate the minimum file size of the image shown in **part (a)**. Show your working.

Working ....

....

....

....

File size ....

[3]

AS-level Paper 1 Exam: Question 10

(b) The company takes a photograph of their office to put on the website. The photograph has a resolution of 1000 pixels by 1000 pixels. Two bytes per pixel are used to represent the colours.

(i) Estimate the file size of the photograph in megabytes. Show your working.

Working ....

....

....

....

Estimated file size ....

[4]

AS-level Paper 1 Exam: Question 10

(ii) The file size of the photograph needs to be reduced before it is placed on the website.

Draw lines to link each method of reducing the file size of the image to:

- its description and
- its compression type, where appropriate.

Description	Method	Compression type
Removes pixels	Crop the photograph	Lossy
Reduces number of pixels per inch	Use run-length encoding	Lossless
Uses fewer bits per pixel	Use fewer colours	
Stores colour code and count of repetitions		

[5]

(c) The company has created a logo for the website. The logo is a vector graphic.

Describe **two** reasons why a vector graphic is a sensible choice for the logo.

Reason 1 ....

....

....

....

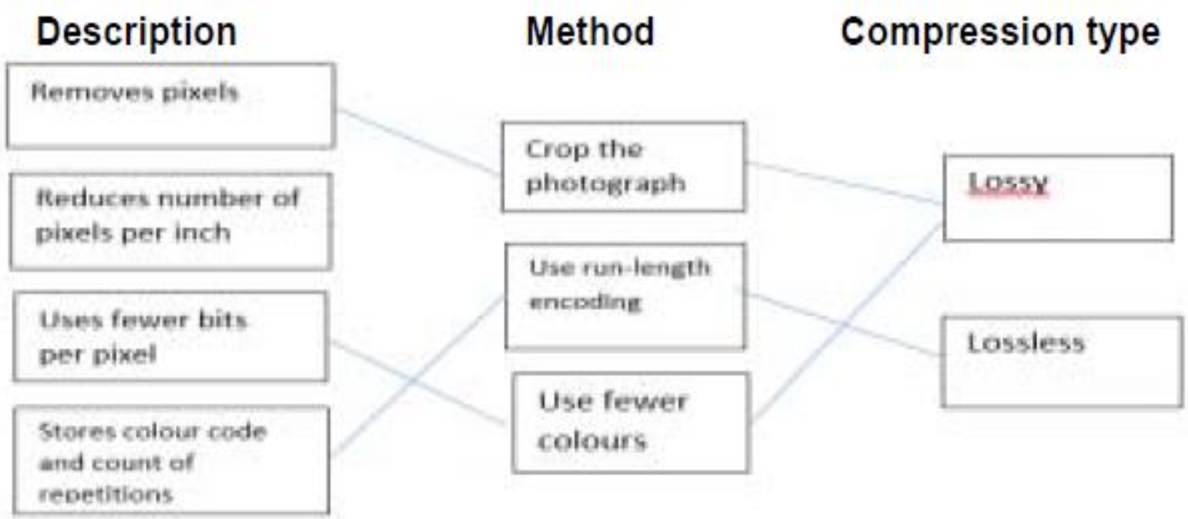
Reason 2 ....

....

AS-level Paper 1 Exam: Answer 10

Question	Answer	Marks
1(a)(i)	2	**1**
1(a)(ii)	**1 mark** per bullet point • Number of pixels: 6 × 6 // 36 • Number of bits: Number of pixels (36) × 2 … • … = 72 bits // 9 bytes	**3**
1(b)(i)	**1 mark** per bullet point • Number of pixels: 1000 × 1000 // 1 000 000 • Number of bytes: Number of pixels (1 000 000) × 2 // 2 000 000 // Number of bits: Number of pixels (1 000 000) × 16 // 16 000 000 • Conversion to megabytes • 2 (MB) // 1.91 (MB)	**4**

AS-level Paper 1 Exam: Answer 10

1(b)(ii)	**1 mark** per method correctly linked to its description **max 3** **1 mark** for each compression type correctly linked to its method(s). **max 2** 	**5**
1(c)	**1 mark** per bullet point. **Max 2** marks for each reason. • Smaller file size • Can be transferred quicker/downloaded quicker • Enlarges without pixilation • Needs to be used on different screens / devices / resolutions	**4**

AS-level Paper 1 Exam: Question 11

1 A product designer is creating a poster.

(a) The designer creates a 6-colour bitmap image for the poster as shown.

Each colour is represented by a letter, for example, R = red, B = blue.

R	R	P	P	P	G
B	R	R	P	G	G
B	W	B	B	O	O
B	W	W	P	P	O
B	B	R	P	G	O
B	R	R	P	G	O

(i) State the minimum number of bits needed to represent each pixel in the image in **part (a)**.

....[1]

AS-level Paper 1 Exam: Question 11

(ii) Calculate the minimum file size of the image shown in **part (a)**. Show your working.

Working ....

....

....

File size ....

[3]

(b) **(i)** The designer takes a photograph to put on the poster. The photograph has a resolution of 50 000 pixels by 50 000 pixels. The colours are represented using 4 bytes per pixel.

Estimate the file size of the photograph in gigabytes. Show your working.

Working ....

....

....

....

Estimated file size ....

[4]

AS-level Paper 1 Exam: Question 11

(ii) The photograph needs to be sent by email but the file size is too big. It needs to be compressed.

The table lists several methods of making an image file size smaller.

Tick (✓) **one** box on each row to indicate whether each method is lossy or lossless.

Compression method	Lossy	Lossless
Cropping the image		
Reducing the resolution of the image		
Using run-length encoding (RLE)		
Reducing the colour depth of the image		

[4]

(c) Explain how run-length encoding would compress the image in **part (a)**.

....

....

....

....

AS-level Paper 1 Exam: Answer 11

Question	Answer	Marks
1(a)(i)	**3**	**1**
1(a)(ii)	**1 mark** per bullet point • Number of pixels: $6 \times 6 = 36$ • Number of bits: Number of pixels (36) $\times$ 3 • 108 bits / 13.5 bytes	**3**
1(b)(i)	**1 mark** per bullet point • Number of pixels: 50 000 $\times$ 50 000 = 2 500 000 000 • Number of bytes: Number of pixels (2 500 000 000) $\times$ <u>4</u> // 10 000 000 000 // Number of bits: Number of pixels (2 500 000 000) $\times$ <u>32</u> // 80 000 000 000 • Conversion to gigabytes • 10 GB / 9.3 GB	**4**

AS-level Paper 1 Exam: Answer 11

1(b)(ii)	**1 mark** for correct tick in each row. <table><tr><th>Compression method</th><th>Lossy</th><th>Lossless</th></tr><tr><td>Cropping the image</td><td>✓</td><td></td></tr><tr><td>Reducing the resolution of the image</td><td>✓</td><td></td></tr><tr><td>Using run-length encoding (RLE)</td><td></td><td>✓</td></tr><tr><td>Reducing the colour depth of the image</td><td>✓</td><td></td></tr></table>	**4**
1(c)	**1 mark** per bullet point to **max 3** • Looks for runs of consecutive pixel of the same colour • Stores the colour value once and the number of times it occurs • Lossless method of compression • Reference to the given image in context	**3**

AS-level Paper 1 Exam: Question 12

6 A student records a video using a digital camera.

(a) The recording uses interlaced encoding.

Describe **interlaced encoding**.

....

....

....

....

....

....

.... [3]

(b) State **one** benefit of using interlaced encoding compared to progressive encoding.

....

.... [1]

AS-level Paper 1 Exam: Question 12

(c) A video can be compressed using spatial redundancy or temporal redundancy.

Explain how **temporal redundancy** compresses a video.

....

....

....

....

.... [2]

(d) A sound track is recorded for the video.

(i) Describe how a computer encodes the sound track.

....

....

....

....

....

.... [3]

AS-level Paper 1 Exam: Question 12

(ii) Explain how the sampling rate and sampling resolution affect the file size of the sound track.

Sampling rate ....

....

Sampling resolution ....

....

[2]

AS-level Paper 1 Exam: Answer 12

Question	Answer	Marks
6(a)	**1 mark** per bullet point to **max 3** □ The data from a single frame is split into two separate fields □ One field has data for the odd numbered rows/lines and the other field has data for the even numbered rows/lines □ Odd numbered line fields alternate with even numbered line fields □ The viewer sees data from two frames simultaneously	**3**
6(b)	**1 mark** per bullet point to **max 1** □ Produces what appears to be a higher refresh rate □ Lower bandwidth needed // Halves the bandwidth requirements	**1**
6(c)	**1 mark** per bullet point to **max 2** □ Identifies pixels that do not change between frames □ Records only the differences between the frames	**2**

AS-level Paper 1 Exam: Answer 212

6(d)(i)	**1 mark** per bullet point to **max 3** □ The amplitude of the wave is measured /sound wave is sampled □ At set/regular time intervals □ Each sample is stored as a binary number □ Samples are stored in order in a file	**3**
6(d)(ii)	**1 mark** per bullet point to **max 1** for each Sample rate: □ Increasing the sample rate means more samples per second hence more bits per second and larger file size □ Decreasing the sample rate means fewer samples per second hence fewer bits per second and smaller file size Sample resolution: □ A higher sampling resolution means more bits per sample and a larger file size □ A lower sampling resolution means fewer bits per sample. a smaller file size	**2**

AS level Paper 1 Exam: Chapter 1: Information Representation more exercises

Adobe Acrobat Document

Adobe Acrobat Document