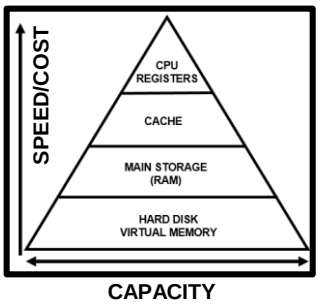
GCSE COMPUTING
KNOWLEDGE ORGANISER

1.2 MEMORY AND STORAGE

1.2.1 PRIMARY STORAGE (MEMORY)

The need for primary storage
The difference between RAM and ROM
The purpose of RAM in a computer system
The purpose of ROM in a computer system
Virtual memory



This shows speed vs capacity of primary/secondary storage

-**PRIMARY STORAGE** is used to store programs and data *currently used* by the computer. When a user needs to run a program, it is loaded from disk to primary storage.
-Another term for primary storage is **RAM** or **Random Access Memory**. It is given this name because data can be stored anywhere within the available memory.
-**RAM** is **volatile** (i.e. any data stored in RAM is lost when the device is powered off)
-**ROM or Read Only Memory** is **non-volatile** (i.e. any data stored in RAM is not lost when the device is powered off) – it is stored **permanently**.
-**ROM** can be used to store the **BIOS** (i.e. the program that boots up and loads the **Operating System** when the computer turned on)

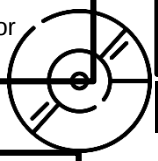
- **VIRTUAL MEMORY** is used when the computer is short of RAM. This involves the hard disk being used as memory instead of RAM.
- *This is not ideal as the speed of a hard disk is MUCH slower then RAM.*

1.2.2 SECONDARY STORAGE)

The need for secondary storage
Common types of storage:

- ❑ Optical
- ❑ Magnetic
- ❑ Solid state

- **Optical Storage** includes CD, DVD and Blu-ray. Data is written to optical storage media using a laser.
- The capacity of this type of media ranges from 640 megabytes (CD) to 50 gigabytes (Blu-ray)
- Since it involves the use of moving parts, access/data transfer speeds are slower than for other types of media.



Examples – CD, DVD, Blu-ray

- **Magnetic Storage** media include hard drives and tape and can have a huge capacity (100's of terabytes)
- Magnetic storage media devices involve the use of moving parts.
- This means that they have comparatively slow data read and write speeds and can be prone to damage.

Examples – hard drive, magnetic tape, external hard drive

- **Solid state** media is also known as electrical or flash storage.
- Solid state has the fastest transfer speed out of all the three types of media, since it features no moving parts
- This also makes it more robust than other forms of storage and in addition they consume less power
- However this form of storage offers lower capacity than other forms of media and is still comparatively expensive.

Examples – Solid State Drive, flash drive, SD Card

Criteria for choosing secondary storage

Criteria	Meaning
Cost	How much does it cost per GB of storage?
Capacity	How much space is there to store files?
Speed	How fast can it read / write data?
Portability	Can it be carried easily or is it a device that is hard or impractical to carry/move?
Durability	How robust is it? Will it break or damage easily?
Reliability	How likely to fail is it? How long will it last?

REVISION NOTE
When recommending a method of secondary storage, always consider the context in which the data will be used

1.2.3 UNITS

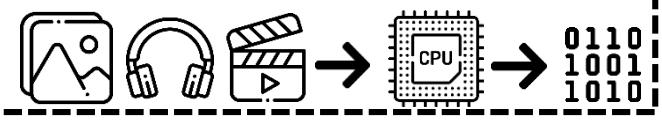
The units of data storage:

- ❑ Bit
- ❑ Nibble (4 bits)
- ❑ Byte (8 bits)
- ❑ Kilobyte (1,000 bytes or 1KB)
- ❑ Megabyte (1,000 KB)
- ❑ Gigabyte (1,000 MB)
- ❑ Terabyte (1,000 GB)
- ❑ Petabyte (1,000 TB)

How data needs to be converted into a binary format to be processed by a computer
Data capacity and calculation of data capacity requirements

Computers are electrical devices; their components are made up of millions of circuits. Each circuit contains switches which can be Either 'on' or 'off'. These can be represented by the values 1 and 0. **This is called binary.**

ALL data is stored and processed in binary form – this includes text, images, sound and video.



1.2.4 DATA STORAGE

Numbers

- ❑ How to convert positive denary whole numbers to binary numbers (up to and including 8 bits) and vice -versa
- ❑ How to add two binary integers together (up to and including 8 buts) and explain overflow errors which may occur
- ❑ How to convert positive denary whole numbers into 2-digit hexadecimal numbers and vice versa
- ❑ How to convert binary integers to their hexadecimal equivalents and vice versa
- ❑ Binary shifts

Characters

- ❑ The use of binary codes to represent characters
- ❑ The term 'character set'
- ❑ The relationship between the number of bits per character in a character set, and the number of characters which can be represented , e.g.:
  - ASCII
  - Unicode

Every character (letters, numbers, symbols) sent to the computer or typed in, is stored as 7-bit binary code*. For example, if the user types in the message below*, **H** is represented by the number '072'. This character set is called **ASCII**

```
Hello, world
>_
```

```
你好，世界
>_
```

UNICODE uses 16 bits to allow an even wider range of characters to be stored, including one used for foreign languages:

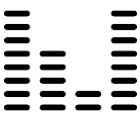
Images

- ❑ How an image is represented as a series of pixels, is represented in binary
- ❑ Metadata
- ❑ The effect of colour depth and resolution on:
  - The quality of the image
  - The size of a sound file

Sound

- ❑ How sound can be sampled and stored in binary form
- ❑ The effect of sample rate, duration and bit depth on;
  - The playback quality
  - The size of a sound file

Sound waves are **ANALOGUE** and must be converted in to **DIGITAL** (0's and 1's) in order to be stored/ processed by computer. This is called **SAMPLING**.



-The height of a sound wave is its **AMPLITUDE**.
-The **SAMPLE RATE** is the number of samples captured per second.
-**SAMPLE RESOLUTION** is the number of bits used to capture the sound

1.2.5 COMPRESSION

The need for compression

- ❑ The need for compression
- ❑ Types of compression;
  - Lossy
  - Lossless

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

To convert 25 to binary:
- ✓ Start with the column nearest 25 (i.e. 16 or 2^4)
- ✓ Put a one in that column
- ✓ Check each remaining column, adding either a 1 or 0 onto the end of our number
- ✓ In this case **16 + 8 + 1 = 25** ($2^4 + 2^3 + 2^0$)
- ✓ So… 25 in binary is**11001**

To convert 101010 into decimal:
- ✓ Work which column the left digit is in (i.e. 32 or 2^5)
- ✓ Work left to right – add up the column value each time there is a 1
- ✓ For example: 32 + 8 + 2 = **42**)

Hex	Dec
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
A	10
B	11
C	12
D	13
E	14
F	15

Converting to/from Hex

To convert decimal to hex:

✓ First convert the number to binary:

i.e. 25 in binary = **00011001**

✓ Then split the number into two groups of 4 bits:

i.e. **0001 1001**

✓ Then convert each group of 4 bits to HEX:

i.e. **0001 = 1**
1001 = 9

Then join (don't add) both digits together:

i.e. 1 + 9 = **19**

To convert hex to decimal, just work through this process backwards

Binary arithmetic 0110 1001 1010

Use binary shift to:

- **Multiply**

```
00110111 x 2=
01101110
[left shift]
```

- **Divide**

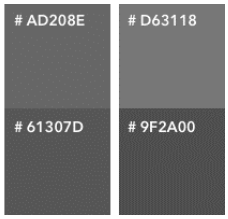
```
00110111/2=
00011011
[right shift]
```

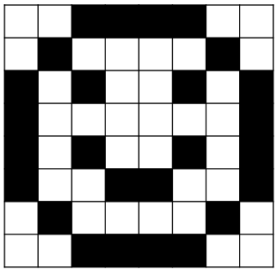
Rules for binary addition		
00 + 00 =	0	No remainder
00 + 01 =	1	No remainder
01 + 01	10	Carry 1
10 + 01	11	Carry 1

If there are insufficient bits to store the answer, this causes **OVERFLOW**

Hexadecimal has many uses in computing**:**
- **assembly language**,
- to store a **MAC Address**
- representing colour codes

Hexadecimal numbers can be represented in fewer digits then in binary making them easier for humans to remember and more economical in terms of storage



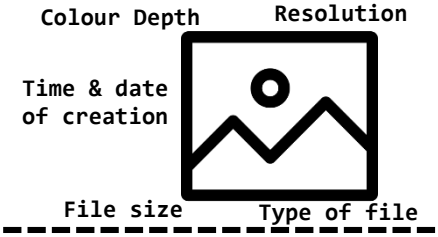


0	0	1	1	1	1	0	0
0	1	0	0	0	0	1	0
1	0	1	0	0	1	0	1
1	0	0	0	0	0	0	1
1	0	1	0	0	1	0	1
1	0	0	1	1	0	0	1
0	1	0	0	0	0	1	0
0	0	1	1	1	1	0	0

00111100
01000010
10100101
10000001
10100101
10011001
01000010
00111100

-Bitmap images are made up of individual **pixels**. The more pixels stored in an image, the higher the detail (**resolution**) will be.
-Each pixel will be represented in binary as a 1 (on) or a 0 (off). These binary digits are combined into binary numbers that can be stored by a computer.
-Colour images need additional binary code to store the colour. The more bits available to store the colour, the wider the possible colour range. This binary value is called **colour depth**.

METADATA = ***'data about data'*** i.e. additional information stored when an image files is saved



COMPRESSION can be applied to any file type and is used to reduce the size of a file. This is useful when files need to be uploaded/downloaded to/from the internet or sent via email.

LOSSY	LOSSLESS
File size is reduced at the expense of quality	File size is reduced with no loss of quality