1.2 MEMORY and STORAGE

RANDOM ACCESS MEMORY (RAM)

- RAM is the computer's main memory that holds the data, programs and files while they are being used.
- RAM is volatile (power off = the data is lost)
- The CPU will fetch instructions from the RAM in the fetch – decode – execute cycle.
- When the RAM is full the computer uses **VIRTUAL MEMORY**. It uses the secondary storage as temporary RAM so that the computer can continue running (but slowly).

READ ONLY MEMORY (ROM)

- The ROM is on a chip build into the motherboard
- It contains the BIOS (boot up sequence for the computer)
- ROM is non-volatile (data still stored after power is off)

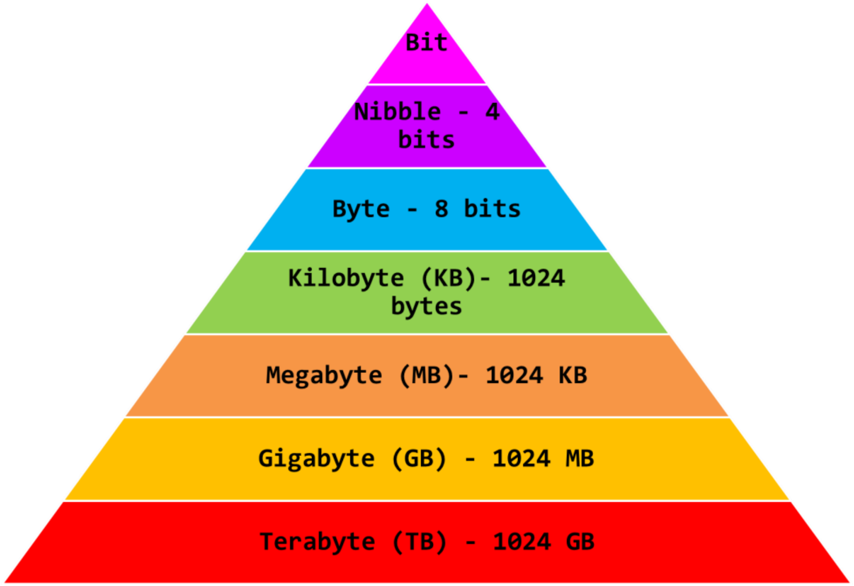
TYPES OF STORAGE

- Secondary Storage: where all data including the programs are stored when they are not being used.

Storage	Key Information
Hard Disk Drive (HDD)	Magnetic, has moving parts, large capacity, lower cost than SSD
Solid State Drive (SSD)	Flash memory, no moving parts, more robust than HDD, faster and more expensive than HDD
Flash memory	Eg: USB memory sticks, memory cards.
Optical Storage	Eg: CDs, DVDs. Cheap, portable and fairly robust.
Magnetic tape	Used for archive storage (back ups). Very large capacity, low cost, slow.

STORAGE CAPACITY

Some storage methods such as a HDD or SSD have a large capacity (they can store lots of data. Other devices such as CDs and SD cards have smaller capacity. Measurements of capacity are shown below:



Bit

Nibble - 4 bits

Byte - 8 bits

Kilobyte (KB)- 1024 bytes

Megabyte (MB)- 1024 KB

Gigabyte (GB) - 1024 MB

Terabyte (TB) - 1024 GB

EXAM QUESTIONS

1. Explain how the RAM works with the CPU in the fetch –decode – execute cycle
2. Explain the difference between volatile and non-volatile memory giving an example of each
3. Tom is buying a new laptop, he is not sure whether to get a magnetic HDD or SSD. Discuss the benefits and drawbacks of each.

1.2 MEMORY AND STORAGE CONTINUED

DENARY

Denary is the decimal number system that we are used to. It uses the numbers 0-9 and the column headings go up in powers of 10.

100 (Hundreds)	10 (Tens)	1 (Units)
2	**3**	**8**
2 lots of 100	3 lots of 10	8 lots of 1

BINARY

Binary uses the numbers 0 and 2. The column headings go up in power of 2:

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

64 + 4 + 2 + 1 = 71

HEXADECIMAL

Hexadecimal uses 0- F (A=10, B=11, C=12, D=13, E=14, F=15). The headings go up in powers of 16.

16	1
3	**D**
3 lots of 16	D (13) lots of 1

To convert a binary number to Hexadecimal, split into 2:

128	64	32	16
1	**1**	**0**	**0**

8	4	2	1
1	**1**	**0**	**0**

3* 16 = 48
D (13) * 1 = 13
48+13=61

= C

= 7

BINARY ADDITION

$$\begin{array}{cccccccccc}
 & & 1&0&0&1&0&1&0&1\\
+ & & 1&1&0&1&1&0&1&1\\ \cline{3-10}
 & 1 & 1&1&1&1&0&0&0&0\\ \cline{3-10}
 & 1 & & &1&1&1&1&1&
\end{array}$$

This binary addition gives an overflow error as the total does not fit in 8 bits (a byte).

BINARY SHIFT

A binary shift to the left multiplies the number by 2. A binary shift to the right divides it by 2. Below is an 8 bit binary number which has been shifted 2 places to the right.

Original number	**1**	**1**	**0**	**0**	**1**	**1**	**0**	**1**
Shifted number	0	0	1	1	0	0	1	1

CHARACTERS

Character sets = the characters that are recognised or represented by a computer system

ASCII = Each character is represented by a 7 bit number with a 0 in front to make it up to a byte.

Extended ASCII = Each character is represented by an 8 bit binary number. This gives 256 different possibilities.

Unicode = Each letter is represented by a 16-bit or 32-bit binary number. This gives at least twice as many character options as ASCII and allows the character set to represent characters and symbols from all languages.

1.2 MEMORY AND STORAGE CONTINUED

IMAGES

Images are made up of pixels
The colour of each pixel is represented by a binary number
If an image uses 1 bit to represent each colour then it will only have 2 colours:

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

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

This is a 1-bit image so it uses 2 colours.

0=white and 1=black

Using more bits allows for more colour options:

10	11	00	11	10
11	11	00	11	11
00	00	01	00	00
11	11	00	11	11
10	11	00	11	10

10	11	00	11	10
11	11	00	11	11
00	00	01	00	00
11	11	00	11	11
10	11	00	11	10

This is a 2-bit images so it uses 4 colours.

00=white, 01=blue, 10=red, 11=black

Colour depth = the number of bits used for each pixel

Resolution = how many pixels are in a certain space – this is measured in "dots per inch". If there are more dots per inch then there are more pixels in the image so it will have a higher resolution and a better picture quality.

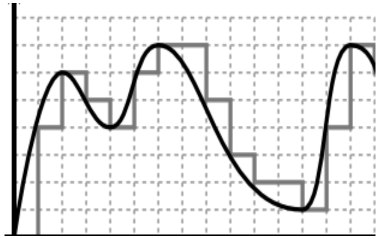
The higher the resolution or the colour depth, the more bits used, so the bigger the file size.

Metadata = the information about the image file that is stored within it. This makes sure the file is displayed correctly. It can include: the height, width, colour depth, resolution and file format as well as the time and date that the image was created.

SOUND

When sound is recorded it is an analogue signal (waves). It has to be converted to a digital signal so that it can be stored by a computer. This is done by sampling

Sampling: The amplitude of the wave is measured at regular intervals which creates a digital representation of the wave. If samples are taken more frequently then you will end up with a more accurate sound file but it will be a larger file size.



The analogue wave is smoother and shows continuous data. The digital sampling shows the amplitude of the wave at different points.

COMPRESSION

Compression is used to make file sizes smaller. Smaller file sizes means that data will be faster to send, quicker to download (so webpages will load faster) and it will take up less storage space.

Lossy Compression: permanently removes some of the data from a file to make the file size smaller. The file – eg: an image or sound track – will be a lower quality than the original.

Lossless Compression: data is temporarily removed from the file and then put back together when it is opened. This is good for program files or documents where you do not want to lose any content but the files can only be made a little bit smaller.