Computer Science

AQA Computer Science (8520) accredited

Marc White (Subject Leader Computer Science & Science)

mwhite@honywoodschool.com

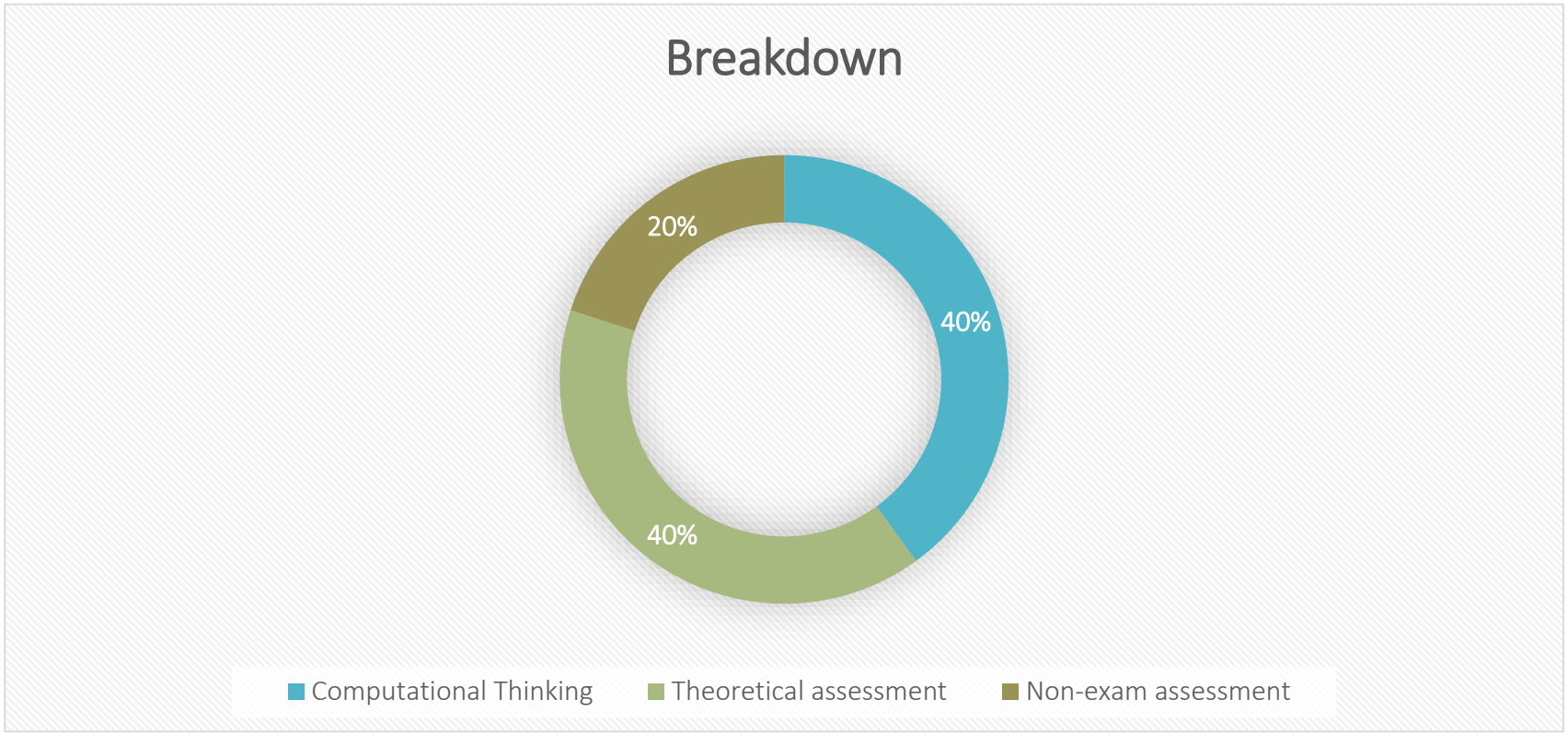
What is Computer Science?

Aims of the course

To provide learners with an opportunity to develop and practice real-world programming and provides a good understanding of the fundamental principles of computing.

The new specification also offers a significant emphasis on computational thinking.

Course Structure



Course Content

1. Fundamentals of algorithms
2. Programming
3. Fundamentals of data representation
4. Computer systems
5. Fundamentals of computer networks
6. Fundamentals of cyber security
7. Ethical, legal and environmental impacts of digital technology on wider society, including issues of privacy
8. Aspects of software development

Assessments

Paper 1 (Written exam)

Computational thinking, problem solving, code tracing and applied computing. **40% of GCSE (1hr 30 minutes)**

Paper 2 (Written exam)

Theoretical knowledge covering computer systems, networks, cyber security, impact of digital technology on society. **40% of GCSE (1hr 30 minutes)**

Non-exam assessment (Controlled assessment/Coursework)

Learners will tackle a practical programming problem. **20% of GCSE (20hr)**

0 4 The algorithm in **Figure 4** is the binary search algorithm designed to search for a value within an array.

Figure 4

- Line numbers are included but are not part of the algorithm.
- For this algorithm, array indexing starts at 1.

```
1    val ← 43
2    arr ← [3, 5, 13, 43, 655, 872]
3    left ← 1
4    right ← LENGTH(arr)
5    WHILE left ≠ right
6      mid ← (left + right) DIV 2
7      IF val ≤ arr[mid] THEN
8        right ← mid
9      ELSE
10       left ← mid + 1
11     ENDIF
12   ENDWHILE
```

0 4 . 1 Complete the trace table for the algorithm in **Figure 4** (you may not need to use all of the rows in the table). The final value of `left` is already given.

[5 marks]

val	left	right	mid	arr[mid]
	4			

0 4 . 2 Why would the binary search algorithm shown in **Figure 4** not work when the array `arr` contains `[5, 3, 13, 872, 655, 43]`?

[1 mark]

0 8 . 5 In recent years, there has been a large growth in the use of cloud storage.

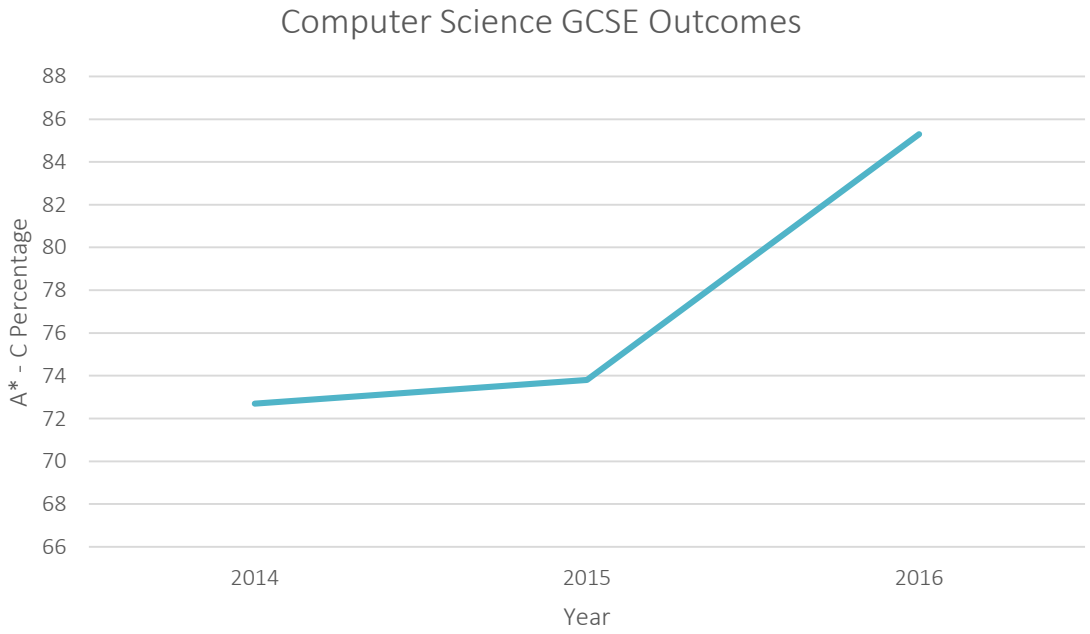
Discuss the advantages and disadvantages of using cloud storage.

In your answer you should include an explanation of the reasons for the large growth in recent years and consider any legal, ethical and environmental issues related to the use of cloud storage.

[9 marks]

GCSE Results

2014	72.7%
2015	73.8%
2016	85.3%



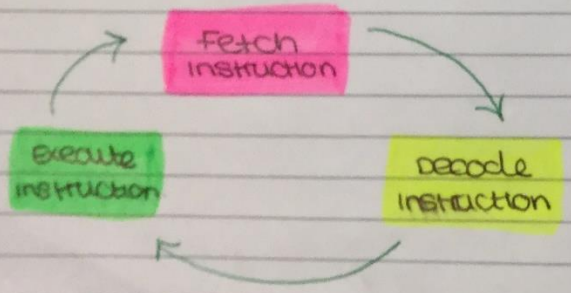
Wednesday 25th January

computer systems

Hardware - anything you can physically touch
Software - operating systems, programs that run on the hardware.

Input comes from the real world. It is then ~~processed~~ processed. It may make use of stored data or store data. The computer system will generate outputs.

CPU - Fetches the next instruction and Decodes it working out what it means and then executes it - the instructions are carried out / run.



CPU performance.

clock speed
the speed at which the processor operates. The faster the clock speed, the faster instructions are fetched, decoded and executed.

cache
Cache is a small amount of memory very close to the processor that is used to store frequently used instructions.

cores
Modern processors have more than one core. Each core acts as a mini-processor. Each core has its own clock speed, so theoretically 2 cores have 2Ghz and processor has 2 x 2Ghz clock speed.

Revision. wednesday 12th october.

pixels dont have a fixed size. Their size is relative to the screen's resolution. An image of a yellow triangle has the same number of pixels in all examples, but shows different sizes due to resolution of the screen.

Huffman coding is a compression method used to store text. It's designed to reduce the number of bits to store and send messages. Its based on the frequency of a data item. After writing a frequency table of all the characters used you start the tree progress. you take the top two characters and add them together to make a node. you then rearrange your table from lowest to highest frequency and repeat this again until you reach the top of your tree. (0 = Left 1 = Right).

Run length encoding involves images. It counts how many pixels of the same colour repeated in a line. The first character shows the colour, the second character represents the frequency of the colour in the line.

Sounds created on a computer is encoded in audio files. Digital sound is broken down into thousands of samples per second. Each sound samples is stored as binary.

Binary shift left operation. A left shift 1 place is the same as multiplying by 2. Shifting 2 places = multiplying by 4, 3 places = multiplying by 8 etc.

Binary shift Right operation. A Right shift 1 place is the same as dividing by 2. etc.

Hexadecimal to binary, Shorter method...
Numbers x 16, Letters = Number equivilant.
e.g. 8A = (8×16 = 128 + 10) = 138
Then convert to binary. e.g.
138 = 10001010.

input		output
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

AND gate
Truth Table

When switch A is on, B is off, the light will remain off. When switch A is off and B is on, the light will also remain off, but when both switch A and B are on the light will be on.

input		output
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

OR gate
Truth Table.

When switch A is on and switch B is off the light will be on. When switch A is off and switch B is off, then the light will be on. When both switch A and B are on, the light will be on, but when both switches are off, the light will also be off.

input		output
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

NOR Gate
Truth Table

When the switch is off the light is on and when the switch is on the light is off

input	output
A	Q
0	1
1	0

NOT gate
Truth Table

3.3 Fundamentals of data representation

Character sets

A defined list of characters recognized by hardware and software.
A coding method

ASCII

- is a way of representing text. It can represent 128 characters (0-127) with a 7 bit binary number - it encodes alphabetic, numeric, or special characters.

Unicode

- is a character encoding system that currently encodes 129,172 characters. It uses different alphabets and a range of different symbols and even emojis.

What are the advantages of unicode over ASCII?

- Unicode is a 16 bit system which can support many more characters than ASCII.
- The first 128 characters are the same as ASCII system.
- There are 6400 characters set aside for the user or software
- There are still characters which have not been defined yet, future-proofing the system.
- It means more languages can use it as all alphabets are included.

Data compression

What is data compression?

- It lets devices transmit or store the same amount of data in fewer bits. It uses a series of algorithms to reduce the space needed to store. It avoids using space unnecessarily.

Huffman coding

- is a compression method used to store text. It is designed to reduce the number of bits to store and send messages. After working a frequency table of all the characters used you then the first process. You take the top 2 characters and add them together to make a node. You then rearrange the table from smallest to highest and repeat.
When you go left it is represented as 0.
When you go right it is represented as 1.

Representing images

What is a pixel?

PICture ELements are the smallest identifiable area of an image. Each pixel is a single colour and given a binary value. Pixels don't have a fixed size their size is relative to the screens resolution.

Bitmap images

A bitmap graphic is made up of individual pixels. Since the computer has to store info about every single pixel in the image, the file size of bitmap images are usually large. Each pixel is many different colours, so we use colour depth to represent this. It is possible to edit each individual pixel.

Binary to B+W images

As the colour depth is only two, each colour only needs one bit. Either 0 or 1.
1 = Black 0 = White
meaning binary data can be used to store black and white images

width x height = how many pixels used to create an image

Colour depth

the number of bits per pixel to represent a colour. The more bits per pixel, the higher the colour variety you will have.

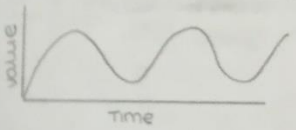
1 bit = 1 colour
2 bits = 2 colours
3 bits = 4 colours
4 bits = 8 colours etc.

Calculating file sizes

Number of pixels x colour depth = file size

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

Representing sound



Sample rate - How many pieces of information you take within a second

Sample resolution - How many bits you use to store each sample.

File storage - Sample resolution x sample rate x length of audio (seconds)

Sound is analogue and must be converted to a digital form for storage and to be processed into a computer.

3.4 Computer systems

Von Neumann architecture

Contain three main building blocks: CPU, memory, input/output devices. These are connected together by the bus.

Operating systems

Performs several key functions

- **Memory** — Storage of information (data/program)
- **Interface** — Provides a user interface so it is easy to interact with the computer
- **Manages the CPU** — Runs applications and executes and cancels processors
- **Multi-tasks** — Allows multiple applications to run at the same time
- **Manages Memory** — Transferes programs into and out of memory, allocates free space between programs, and keeps track of memory usage.
- **Manages Peripherals** — opens, closes and writes to peripheral devices such as storage attached to the computer.
- **Utilities** — Provides tools for managing or organising hardware
- **organiser** — Creates a file system to organise files and directories.
- **security** — Provides security through user accounts and passwords

Boolean Logic

Logic circuits

AND — Both inputs need to be true (High) in order for the output to work (high).

NOT — opposite - When inputs are high, the output is low and when the input is low, the output is high.

OR — when one input is high and the other is low, the output is high. Doesn't work when both inputs are the same, the output is low

INPUT		OUTPUT
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

AND gate Truth Table

INPUT		OUTPUT
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

OR gate Truth Table

INPUT	OUTPUT
A	Q
0	1
1	0

NOT gate Truth Table

Hardware

What is hardware?

Anything you can physically touch within the computer.

- **Input** — Means of getting information into the computer e.g keyboard, mouse
- **Output** — Means of getting information out of the computer e.g. Printer, monitor
- **Processing unit** — computation/processing of information
- **control unit** — makes sure that all the other parts perform their tasks correctly and at the right time

Software

What is software?

Programs that run on hardware, e.g. operating systems

- **Application Software** — Are programs designed to perform a set of tasks which benefits the user. Including:
  - Word processors
  - Spreadsheet software
  - Web browsers
  - Media players (Music/video)
  - Games
  - Graphics editing software
- **System Software** — Software which performs a specific function to aid the function of the computer system or provide a service to another piece of software including:
  - Operating systems
  - Antivirus
  - Firewall
  - Disk management
  - Device Drivers

Wednesday 25th January 2017

Computer Systems

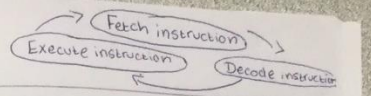
Hardwear and softwear working together

Hardwear - things you can touch

Softwear - operating system

Input comes in from the real world. Input is then processed. It may make use of stored data or store data. The computer system will then generate outputs

Fetch execute cycle



The CPU continuously reads instructions stored in main memory and executes them as required:

Fetch: the next instruction is fetched to the CPU from main memory.

Decode: the instruction is decoded to work out what it is

Execute: the instruction is executed (carried out). This may include reading/writing from/to main memory.

CPU Performance:

Clock Speed:

Clock speed is the speed at which the processor operates. The faster the clock speed the faster instructions are fetched, decoded and executed.

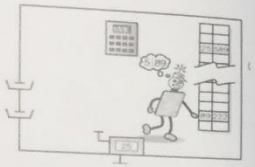
Cache:

Cache is a small amount of memory very close to the processor that is used to store frequently ~~or~~ used instructions.

Cores:

~~most~~ modern processors generally have more than one core. Each core is like a mini-processor in itself. Each core has its own clock speed so theoretically a dual core 2Ghz processor has 2x2Ghz clock speed.

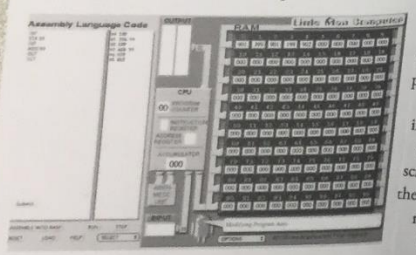
Little man computer learning experience



What is the little man computer?

The Little Man Computer (LMC) is an instructional model of a computer, created by Dr. Stuart Madnick in 1965. The LMC is generally used to teach students, because it models a simple von Neumann architecture computer - which has all of the basic features of a modern computer. This was created as a teaching mechanism by the simple idea that someone (the little man) was 'living' inside of a computer which lead to thesis programme.

This is the LMC (little man computer) programme. In here you will be able to do all of your coding.



For further help please look at the following websites:

Instructions:
http://www.yorku.ca/sychen/research/LMC/LittleMan.html
http://www.yorku.ca/sychen/research/LMC/LMCInstructions.html

Inputs and Outputs:
http://www.yorku.ca/sychen/research/LMC/LMCInstructions.html

Using memory:
http://www.yorku.ca/sychen/research/LMC/LMCMemory.html

Adding and subtracting:
http://www.yorku.ca/sychen/research/LMC/LMCMath.html

Decisions:
http://www.yorku.ca/sychen/research/LMC/LMCDecisions.html

The full program:
http://www.yorku.ca/sychen/research/LMC/LMCExample.html

Features of the little man computer.

For the little man computer to work you must have several features for or to do so such as;

INP ,HLT ,OUT,DAT ,STA ,DAT,LDA and many more. By using this code you are using making the 'little man' work for example by if you input a number in the input box it will then be shifted up into the Accumulator which then uses the program counter to see how many clicks you have used which is also registered in the instruction register. By storing the input by using STA it will give the input a 'address' basically the little 'mailboxes' or boxes in the right hand side of the screen. To complete this simple task you must input this into the first box on the left hand side and to make the code on the right hand side appear you press the ASSEMBLE INTO RAM button to do so which just translates it into the computers language (Ram)

Wednesday 23 November

Bitmap stores each individual pixel and then puts them into rows and when the computer zooms out you can then see the image. Each pixel has a binary value which represents its colour. All of this gets stored and the order of the bit patterns for the individual pixels indicates where the pixel will appear in the image.

A bitmapped image with a colour depth of one can represent images that use two colours. How many more colours can be represented in a image if the colour depth is increased from 1 to 4.

14 ~~because~~ because the maximum amount of ~~of pixels~~ colours that can be created is 16 which is two more than 14.

Sampling resolution

The Sampling resolution is the number of bits that are used to represent a sample.

Figure 1 → 01001110

Convert to hexidecimal

answer 4E

128	64	32	16	8	4	2	1
0	1	0	0	1	1	1	0
	4				14		
	4				E		

4E

Thursday 24th November

Searching and Sorting algorithms

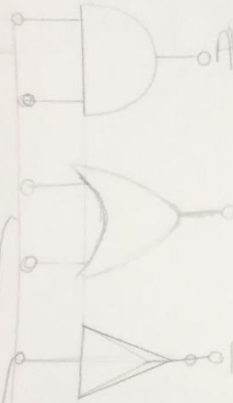
Linear Search

Going through a list randomly or sequentially to find the answer

Binary Search

Going through a list using the midale value repeatedly to get the answer and neglecting the un-needed parts however this only works if you have a numeric ordered list.

BOOLEAN LOGIC



AND — For this 'gate' to work both inputs must be true in order for the circuit to work.

OR — For the OR 'gate' to work only one input must be true and the other false.

NOT — For the Not 'gate' to work both inputs must be False for the circuit to work.

Truth-tables

Inputs		Outputs
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

Inputs		Output
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

Inputs		Outputs
A	B	Q
0	1	1
1	0	0

Truth-Tables are tables which are dependant on weather the inputs are either true or false in order to get the output/the answer. In this case the switch inputs would be on/off which is true/false.

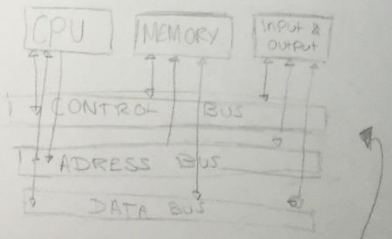
SOFTWARE CLASSIFICATION

System software is a type of computer program that is made to run a computer's hardware and application programs. Application software broadly are programs which are designed to perform a set of tasks which will benefit the user. Typical application software includes, word processors, spreadsheet software, web browsers, music/video, games and graphics editing software.

Computer Systems

VON NEUMANN ARCHITECTURE

The Von Neumann Architecture, which also known as the Von Neumann model and Princeton architecture is a computer architecture based on that described in 1945 by the mathmatician and Physicist Jon Von Neumann and others in the First Draft of a Report on the EDVAC.



VON NEUMANN MODEL

CPU →

(central Processing unit)

ARITHMETIC LOGIC UNIT (ALU) →

The ALU is a digital circuit used to preform arithmetic and logic operations. It represents the fundamental building block of the CPU of a computer.

CONTROL UNIT (CU) →

The CU is a component of a computers CPU that directs the operation of the processor. It tells the computers memory, the arithmetic and logic unit and output devices how to respond to a programs instructions.

PROCESSOR →

A processor, or microprocessor is a small chip that resides in computers and other electronic devices. Its basic job is to recive input and provide the appropriate output.

MEMORY →

Computer memory is any physical device capable of storing information either permanently or temporarily. E.G Ram (Random Access Memory) is volatile memory that stores information on a intergrated circuit used by the operating system, hardware & software.

HARDWARE & SOFTWARE

Hardware	Software
Hardware is the collection of physical parts of a computer system. This includes, monitor, keyboard, mouse and computer case. It also includes the inner case parts such as hard disk drive, motherboard, Video card and many others.	Software is a term for organised collections of computer data and instructions, which is often divided into two major sections: System software and application software.

In order for any computer to provide a useful output. Both hardware and software must work together to work to do a good job as they both compliment eachother. The same hardware can be loaded with different software to make a computer system preform different tasks, e.g music and films.

CLOCK →

The shortest time any computer is capable of preforming is one clock or one vibration of the clock chip. The speed of a computer is measured in clock speed. E.G 1MHz is one million cycles/vibrations per second. 2GHz is two billion cycles/vibrations a second.

BUS →

A bus is a collection of wires through which data is transmitted from one component to the other. Main memory will be considered to be any form of memory that is directly accessed by the CPU except for cache and registers.

CPU PREFORMANCE

The clock speed, number of processor cores, cache size and cache type all effect the Preformance of the CPU depending on how well they work or dont work. The clock works in the sense of the faster the clock the more instructions the processor can complete. The cores work as the more cores the more programs can be run at the same time. The bigger the cache the quicker memory can be accessed and so on. It all changes the CPU preformance.

INPUT & OUTPUT (I/O) →

The term I/O is used to describe any program, operation or device that transfers data to or from a peripheral or from a computer an to or from a peripheral device. Every transfer is an output from one device and an input into another.

APPLICATIONS →

An Application / application software, is a program that function your computer. Web-browsers, e-mail programs, word processors, games & utilities are all applications.

OS →

The operating system/os handles the management of all of these things and needs them to run your computer.

SECURITY →

computer security, also known as cybersecurity or IT security is the protection of computer systems from theft of hardware / software & their information.

Sounds created on a computer exists as digital information encoded as audio files. Digital sound is ~~brock~~ broken down into thousands of samples per second. Each sound sample is stored as binary data.

Wednesday 19th October

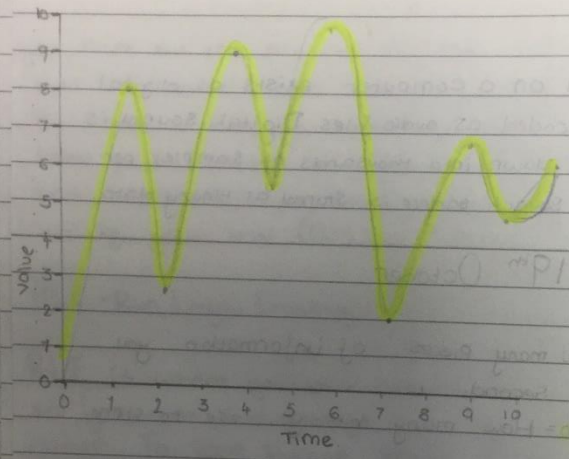
Sample rate = How many pieces of information you take within a second.

Sample resolution = How many bits you use to store each sample.

File Storage = Sample resolution x Sample rate x time

Sound needs to be converted into binary for computers to be able to process it. To do this, sound is captured - usually by a microphone - and then converted into a digital sound. An analogue to digital converter will sample a sound wave at regular time intervals.

Time Sample	1	2	3	4	5	6	7	8	9	10
Denary	8	3	7	6	9	7	2	6	6	6
Binary	1000	0011	0111	0110	~~0111~~ 1001	0111	0010	0100	0110	0110



Kilo, 1KB is 1,000 bytes
mega, 1MB is 1,000 kilobytes
giga, 1GB is 1,000 megabytes
tera, 1TB is 1,000 Gigabytes

Monochrome images are where you use 0's and 1's to create a image

Mia, you have some excellent notes here. To improve add answered & annotated exam questions from the following topics: ① Representing images ② Sound ③ character encoding ④ Hexadecimal

Wednesday

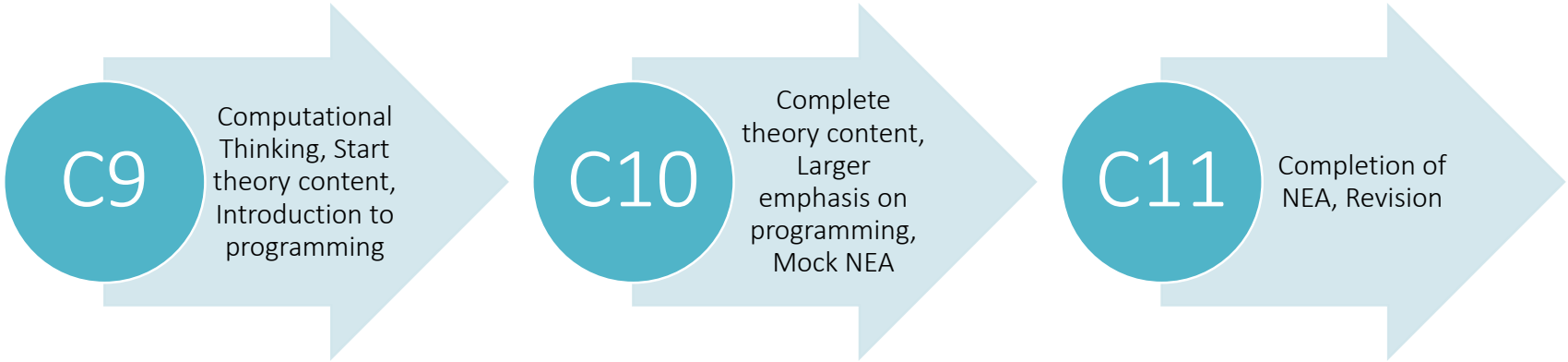
Computational Th

When are you
what is your bu
What's the weath
what are your
Where could we
How far away
who can take
What do you
How should w
Inside or ou
What do you

Decomposition
Breaking down
more manageabl
Pattern Recognitio
looking for simil
Abstraction
focuses on the
information

Algorithms
a step by step solu

Learning Timeline



Programming Languages

C#

Java

Pascal/Delphi

Python

VB.Net.

Questions