Zig Zag Education

Computer Science GCSE (9–1) | AQA | 8525

Revision Guide

for AQA GCSE (9–1) Computer Science

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Teacher's Introduction

This guide has been produced specifically to support learning of the AQA GCSE (9–1) Computer Science specification, with first examinations in summer 2022.

As the specification is split into eight sections, this guide has been split into eight chapters, with content precisely mirroring the order of topics in the specification. As such, it is quite straightforward for learners to keep track of where they are in the material, and what remains to be done. The checklists, which are intended as a working document, are also useful in this regard.

Remember!
Always check the exam board website for new information, including changes to the specification and sample assessment material.

Each chapter contains, along with the theory material and illustrations, a series of exam-style questions with model answers and commentaries. Throughout the guide, a full range of question types is covered, from single-word answers and definitions to long-answer descriptions and discussions.

In terms of algorithms and programming, the AQA standard version of pseudocode is used throughout this guide, supplemented by Python code where relevant. Some key differences between Python, C# and VB.NET are also highlighted.

One chapter can be distributed to students each week or fortnight, and can be used to supplement taught material by aiding such homework/classwork tasks as providing written summaries of a chapter and/or completing the end-of-chapter questions.

More imaginative supplementary tasks that can use this guide as a starting point include the following (you may want to build some or all of these into a weekly routine, each week focusing on a different chapter):

- Providing students with lines from the appropriate section of the specification and asking them to treat each line as if it were a question. The structure of this guide can aid them in locating the answer.
- Asking students to produce five multiple-choice questions based on each chapter. Each question they produce needs to contain a correct answer, three realistic wrong answers and an indication of which answer they believe is correct. The better sets of questions can be archived to produce a half-term multiple-choice quiz, generated by students.
- Asking students to produce a mind map of each chapter as a means of aiding revision. Where applicable, Venn diagrams, flow charts and other graphic organisers can be used in this way.
- Dividing students into groups to deliver presentations on different areas of a chapter. If the group is fairly mature, these presentations can be peer-assessed.
- Using this guide as the basis for flipped learning.

I hope this guide proves useful to both teachers and students.

May 2023

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Revision Checklist

Paper 1: Computational thinking and programming	
3.1. Fundamentals of Algorithms	☐ Define the term 'algorithm' ☐ Define the term 'decomposition' ☐ Define the term 'abstraction' ☐ Define an algorithm using pseudocode ☐ Define an algorithm using a flowchart ☐ Define an algorithm using a program code ☐ Determine an algorithm's inputs, outputs and processes ☐ Determine an algorithm's purpose using a trace table ☐ Compare algorithms in terms of time efficiency ☐ Outline the nature of a linear search ☐ Outline the nature of a binary search ☐ Compare linear and binary search algorithms ☐ Outline the nature of a merge sort ☐ Outline the nature of a bubble sort ☐ Compare merge sort and bubble sort algorithms
3.2. Programming	☐ Define the term 'data type' ☐ Use integers, reals, Booleans, characters and strings ☐ Describe and declare variables and constants ☐ Describe and use variable/constant assignment ☐ Describe and use iteration and selection ☐ Use and describe definite and indefinite iteration ☐ Use and describe nested programming structures ☐ Use and describe the following arithmetic operations in progra ☐ Addition and subtraction ☐ Multiplic ☐ Real and integer division ☐ Modulo (☐ Use and describe the following relational operations in program ☐ Equal to ☐ Not equa ☐ Less than ☐ Greater t ☐ Less than or equal to ☐ Greater t ☐ Use and describe the Boolean operations AND, OR and NOT in p ☐ Define the term 'data structure' ☐ Use records and one to two dimensional arrays in programming ☐ Obtain user input from the keyboard and display output to the ☐ Use and describe the following string operations in programmi ☐ Length ☐ Position ☐ Substring ☐ Concaten ☐ Conversion between character code and character in bot ☐ Conversion between string and numeric types (integer, r ☐ Use random number generation in programming ☐ Use and describe the need for subroutines ☐ Use and describe parameters and return values ☐ Use and explain the benefit of local variables ☐ Use and explain the need for subroutines ☐ Describe the nature and benefits of the structured approach to ☐ Write simple validation and authentication routines ☐ Identify, categorise and correct errors within algorithms and pr ☐ Implement testing using normal, boundary and erroneous test ☐ Select and justify test data in a given situation ☐ Distinguish between syntax and logic errors

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Paper 2: Computing concepts	
3.3. Fundamentals of Data Representation	☐ Define the term 'number base' ☐ Use decimal, hexadecimal and binary number bases and conver ☐ Explain the use of hexadecimal in computer science ☐ Use binary to represent whole numbers ☐ Define the term 'number base' ☐ Convert between each of the following: ☐ Bit ☐ Megabyte ☐ Byte ☐ Gigabyte ☐ Kilobyte ☐ Terabyte ☐ Perform addition on up to three binary numbers ☐ Carry out and understand left and right binary shifts ☐ Define the terms 'character set', 'ASCII' and 'Unicode' ☐ Describe the way in which images are stored as a sequence of b ☐ Describe the effect of colour depth and image size on the quality ☐ Calculate storage requirements of image files ☐ Convert between binary data and a bitmap image in both direc ☐ Define the term 'analogue' in the context of sound ☐ Define the terms 'sampling', 'sampling rate' and 'sample resolu ☐ Calculate storage requirements of sound files ☐ Define 'data compression' and explain why it is necessary ☐ Explain Huffman coding and interpret a Huffman tree ☐ Calculate storage requirements of compressed and uncompres ☐ Explain and implement run length encoding
3.4. Computer Systems	☐ Define the terms 'hardware' and 'software' ☐ Construct truth tables for AND, OR, XOR and NOT, as well as co ☐ Create and interpret diagrams using AND, OR, XOR and NOT log ☐ Write Boolean expressions using appropriate symbols for AND, ☐ Convert between a Boolean expression and a logic circuit in bot ☐ Distinguish between system software and application software, ☐ Outline the role of operating systems in managing the following ☐ Processors ☐ Memory ☐ Input and output devices ☐ Applicati ☐ Security ☐ Describe the differences between high-level and low-level prog ☐ Explain the need for code translation ☐ Compare interpreters, compilers and assemblers ☐ Outline the von Neumann architecture ☐ Explain the roles of the following components: ☐ Arithmetic Logic Unit ☐ Control U ☐ Clock ☐ Bus ☐ Register ☐ Explain the fetch-execute cycle ☐ Explain the purpose of, and differences between, the following for ☐ RAM ☐ ROM ☐ Cache ☐ Register ☐ Explain the need for secondary storage ☐ Explain the operation of solid-state, magnetic and optical stora ☐ Describe the nature, advantages and disadvantages of cloud st ☐ Describe the nature of embedded systems, with examples

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3.5. Fundamentals of Computer Networks	☐ Define the term 'computer network' and describe the advantag computer networks ☐ Distinguish between PANs, LANs and WANs ☐ Distinguish between wired and wireless networks ☐ Draw and describe star and bus topologies ☐ Select an appropriate topology for a given situation ☐ Distinguish between PANs, LANs and WANs ☐ Describe the purpose and key features of the following protoco ☐ Ethernet ☐ Wi-Fi ☐ TCP (Transfer Control Protocol) ☐ UDP (User Datagram Protocol) ☐ IP (Internet Protocol) ☐ HTTP (Hypertext [illegible] Protocol) ☐ HTTPS (Hyper[illegible] Transfer Protocol Secure) ☐ [illegible] Transfer Protocol) ☐ SMTP (Simple Mail Transfer Protocol) ☐ IMAP (Internet Message Access Protocol) ☐ Describe the importance of network security ☐ Describe the following methods of network security: ☐ Authentication ☐ Encryption ☐ Firewalls ☐ MAC address filtering ☐ Describe the four-layer TCP/IP model
3.6. Cyber Security	☐ Define the term 'cyber security' ☐ Describe the following cyber security threats: ☐ Social engineering ☐ Malicious ☐ Pharming ☐ Weak an ☐ Misconfigured access rights ☐ Removab ☐ Unpatched/outdated software ☐ Describe the nature of penetration testing ☐ Describe the social engineering techniques of blagging, phishing ☐ Describe viruses, Trojans and spyware ☐ Describe the following cyber security measures: ☐ Biometric measures ☐ Password systems ☐ CAPTCHA ☐ Email confirmation ☐ Automatic software updates
3.7. Relational Databases and Structured Query Language	☐ Define the terms 'database' and 'relational database' ☐ Describe the following database concepts: ☐ Table ☐ Record ☐ [illegible] ☐ Data type ☐ Primary key ☐ Foreign k ☐ Describe the following SQL keywords: ☐ SELECT ☐ FROM ☐ WHERE ☐ ORDER B ☐ ASC ☐ DESC ☐ INSERT ☐ VALUES ☐ UPDATE ☐ DELETE

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3.8. Ethical, Legal and Environmental Impacts	☐ Define the terms 'ethical', 'legal' and 'environmental' ☐ Describe the impact of digital technology upon society ☐ Outline the ethical, legal and environmental principles in the fo ☐ Cyber security ☐ Mobile technologies ☐ Wireless networking ☐ Cloud storage ☐ Hacking (unauthorised access to a computer system) ☐ Wearable technologies ☐ Computer-based implants ☐ Autonomous vehicles

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3.1. Fundamentals of Algori

3.1.1. Representing Algorithms

Algorithm – a sequence of steps that can be followed to complete a t
not a computer program, although a computer program is one way o
For example, if you were to follow a recipe to bake a cake, you will ha
without using a computer.

Decomposition – breaking down a prob[illegible] smaller 'sub-problem
accomplishes a clear and specific task. This has a number of advanta

- Smaller problems are easier to solve than larger problems
- Each sub-problem can be developed separately, making planning
[illegible] easier
- Sub-problems are easier to distribute among a team than one la
- If a sub-problem is too complex to solve in isolation, it can be de

Abstraction – removing unnecessary detail from the problem in orde
understand and solve.

Commonly used methods of defining algorithms include **pseudocode**, **flowcharts**

The exam might contain questions on any combination of these methods. One w
this is to practise converting between them. Try turning a flowchart into pseudo

Pseudocode – a cross between English and a generic-looking programm
pseudocode would not compile, a competent programmer could conve

A pseudocode algorithm for selling tickets might be as follows. Larger purchases
per ticket:

```
OUTPUT "How many tickets?"
tickets ← USERINPUT
IF tickets > 5 THEN
    OUTPUT tickets * 3.45
ELSE
    OUTPUT ticket
ENDIF
```

Flowchart – a means of defining an algorithm using shapes and arrow
decisions are represented using specific shapes, and the directions of

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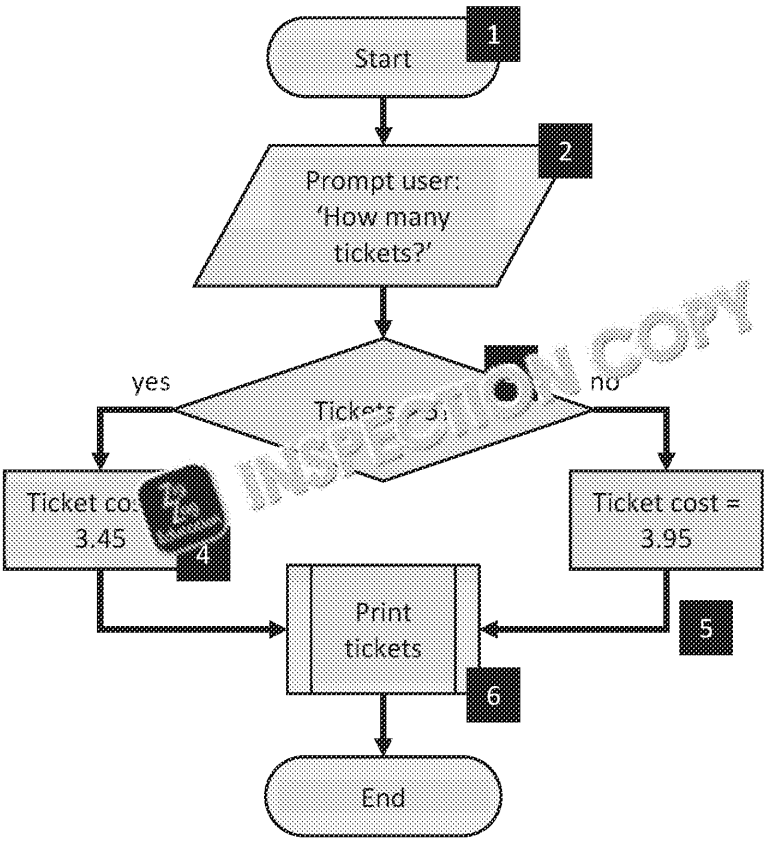
A flowchart does the same job as pseudocode in defining an algorithm, but it is n
who is not a programmer. The flowchart segment below defines a similar part o
above, but it looks very different:



1. Terminat
and one
used else
2. Input/ou
is enterin
3. Decision
available
answers
written a
this shap
4. Process –
instructio
common
5. Arrow –
events ta
6. Subprogr
need to e
tickets'.
flowchar
This allow
divided i

Program code – another means of defining an algorithm is to simply w
you're programming in Assembly or machine code, you're using a high-
include Python, Visual Basic, Java and C#. Although it's quicker to go st
language, designing first using flowcharts or pseudocode can reduce er

Trace Tables

You may be provided with an algorithm in pseudocode, and asked what it does o
you need to be able to read and understand algorithms.

```
1     number ← 3
2     result ← 1
3     WHILE number > 1
4         result ← result * number
5         number ← number - 1
6     ENDWHILE
7     OUTPUT result
```

rpreting an algorit
when you do so one li
computer would. A tr
should be used to kee
that change throughou
The variables in this p
'number' and 'result'.

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number	result	output	Commentary
3	1		In lines '1' and '2', the variables are given these v
3	1		In line 3, which is the start of a loop, we are told t 'number' is greater than '1'. Since 'number' is '3',
3	3		In line 4, 'result' is set to itself multiplied by 'num '1' times '3' is '3'.
2	3		Line 5 says that 'number' should have 1 subtracte
2	3		Line 6 marks the end of the loop, so we go back t
2	3		'number' is still greater th , so the loop runs
2	6		In line 4, 'res lt is e to itself multiplied by 'num '2' ti e '3', 6'.
1	6		mber is reduced by '1' again on line '5'.
1			Line 6 marks the end of the loop, so we go back t
1	6		The loop will not run a third time because 'number' ('1' is not greater than '1'), so we jump to the first li
1	6	6	'result' is displayed, which is currently '6'.

Looking at an algorithm as a whole can be daunting, but following it one line at good deal simpler; no individual line is particularly complicated, and errors can

As for what this algorithm does, it provides you with the **factorial** of 'number'. A whole numbers below it:

Factorial 3:	3 * 2 *1	6
Factorial 4:	4 * 3 * 2 * 1	24
Factorial 5:	5 * 4 * 3 * 2 * 1	120

In Python, one way to implement this algorithm would be as follows:

```
number = input("Enter a number: ")
answer = 1
while number > 1:
    answer = answer * number
    number = number - 1
print(answer)
```

The same algorithm in pseudocode would be as follows:

```
OUTPUT 'Enter a number'
number ← INPUT
answer ← 1
WHILE number > 1
    answer ← answer * number
    number ← number - 1
ENDWHILE
OUTPUT answer
```

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3.1.2. Efficiency of Algorithms

Efficiency – a measure of comparing two different algorithms that so
efficient algorithm is a better choice. Efficiency can be measured in a
at GCSE level, you need only worry about time efficiency. An algorith
instructions is more efficient than one that takes 30 instructions.

You may be expected to compare the efficiency of two different algorithms at so
sorting an array of numbers into order. When doing this, remember that a loop
efficient than the equivalent body of code copied and pasted 10 times.

3.1.3. Searching Algorithms

Searchin – determining whether a specific piece of data exists within
a search algorithm will reveal its location.

Linear search – a search algorithm that begins at one end of a data st
item in turn until the required item is found, or the end of the structu

5	8	4	2	9	6	7

If a linear search were being used to find the number 9, the numbers 5, 8, 4, 2 an
order. If the number 1 were being sought, it would not be found, but each elem
be examined to verify this.

If the item being searched for is found, the code returns the location within the
is numbered '0', the second '1', the third '2', and so on:

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

Binary search – a search algorithm that begins in the middle of a data
the remaining data with each pass. Binary searches are only appropr
sorted data structure.

A binary search for the number 9 in a diff ordered collection of values:

2	4	5	8	9	11	15

The value in the middle is 8; the value we are searching for is larger than that an
found somewhere to the right of 8. Consequently, the 8, and everything to its le

				9	11	15

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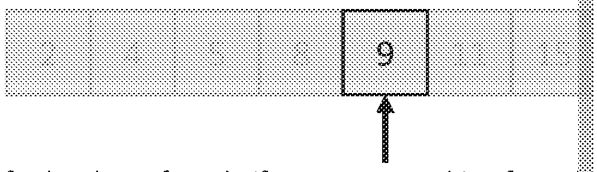
There are now three elements to be searched through. Again, the binary search
elements can be disregarded because they can only contain numbers larger than



The number we were searching for has been found. If we were searching for a d
could conclude at this point that this number isn't present, without needing to c
Binary searches are quicker because, at each stage, half of the remaining data is
one million elements was to be searched using a binary search, it would take no
particular piece of data or to discover that the data is not contained within the a
items would only require 30 iterations.

A binary search is more efficient than a linear search, since it will, on average, f
more quickly than a linear search. However, binary searches do not work on un
efficiency of the algorithm should be a consideration.

Linear Search		Bi	
+	Functions on unsorted data	+	Far more time eff
-	More time-consuming than a binary search in most instances	-	Will not work on

Although a binary search usually executes more quickly than a linear search, th
If the data being sought appears first in its data structure, a linear search would
attempt, whereas a binary search would not.

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3.1.4. Sorting Algorithms

Sorting – putting data into order, whether that be numerical order, a
(A–Z) or descending (Z–A) – or chronological order.

Not sorted:	5	8	4	2	9	6	7
Sorted:	2	4	5	6	7	8	9

There are several different methods for sorting data items into order, and here w

- Bubble sort
- Merge sort

There is no 'best' sort algorithm, and it's always good, as a programmer, to
attempting to solve any problem.

Bubble sort
(4 2 7 5 3) ← Unsorted data set

First pass
(2 4 7 5 3) ← The 2 and the 4 have been switched, as 4 is greater than 2
(2 4 7 5 3) ← The 4 and the 7 are not switched, as they are already in the corre
(2 4 5 7 3) ← The 5 and the 7 are switched, as 7 is greater than 5
(2 4 5 3 7) ← The 3 and the 7 are switched, as 7 is greater than 3

Second pass
(2 4 5 3 7) ← The 2 and the 4 are not switched, as they are already in the corre
(2 4 5 3 7) ← The 4 and the 5 are not switched, as they are already in the corre
(2 4 3 5 7) ← The 3 and the 5 are switched, as 5 is greater than 3
(2 4 3 5 7) ← The 5 and the 7 are not switched, as they are already in the corre

Third pass
(2 4 3 5 7) ← The 2 and the 4 are not switched, as they are already in the corre
(2 3 4 5 7) ← The 4 and the 3 are switched, as 4 is greater than 3
(2 3 4 5 7) ← The 4 and the 5 are not switched, as they are already in the corre
(2 3 4 5 7) ← The 5 and the 7 are not switched, as they are already in the corre

At this stage, the list is sorted, but one more pass would be performed because
complete pass has yielded no changes when n-1 (n being the number of elem
taken place.

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Merge sort

(4 9 5 1 3 2 7 8) ← Unsorted data set

(4) (9) (5) (1) (3) (2) (7) (8) ← Data is split into individual units

(4 9) (5) (1) (3) (2) (7) (8) ← The first pairing, 4 and 9, is brought toge

(4 9) (1 5) (3) (2) (7) (8) ← The next pairing is 5 and 1, whose positi

(4 9) (1 5) (2 3) (7 8) ← In this way, all data are merged into sort

Next, the pairs must be merged into groupings of four. We'll look at the first tw

(4 9) (1 5)

The values '4' and '1' are compared. Since these are the first within their respe
the four must be one of these two.

(4 9) (~~1~~ 5) (1)

Next, the f*maining* value in each pairing is compared with the other. Value

(~~4~~ 9) (~~1~~ 5) (1 4)

At any given point, two numbers are examined, with the next in order being ad
set. The copy is always in order:

(~~4 9~~) (~~1 5~~) (1 4 5 9)

The same principle is applied to the other two pairings to leave two sorted clus

(1 4 5 9) (2 3 7 8) ← Two sorted clusters of four data
(~~1~~ 4 5 9) (2 3 7 8) (1) ← '1' and '2' were compared
(~~1~~ 4 5 9) (~~2~~ 3 7 8) (1 2) ← '4' and '2' were compared
(~~1~~ 4 5 9) (~~2 3~~ 7 8) (1 2 3) ← '4' and '3' were compared
(~~1~~ 4 5 9) (~~2 3~~ 7 8) (1 2 3 4) ← '4' and '7' were compared

Eventually, this would result in a single, sorted data set, comprising eight data i
repeated to sort a data set containing any number of data items.

Bubble Sort	
+ Straightforward to program	More efficient in
+ Does not use much extra memory spa[illegible] wh[illegible] the sort is in progress	
- Can take a very lo[illegible]t ti[illegible] with a large set of data to so[illegible]	- More complex to - Requires lots of m

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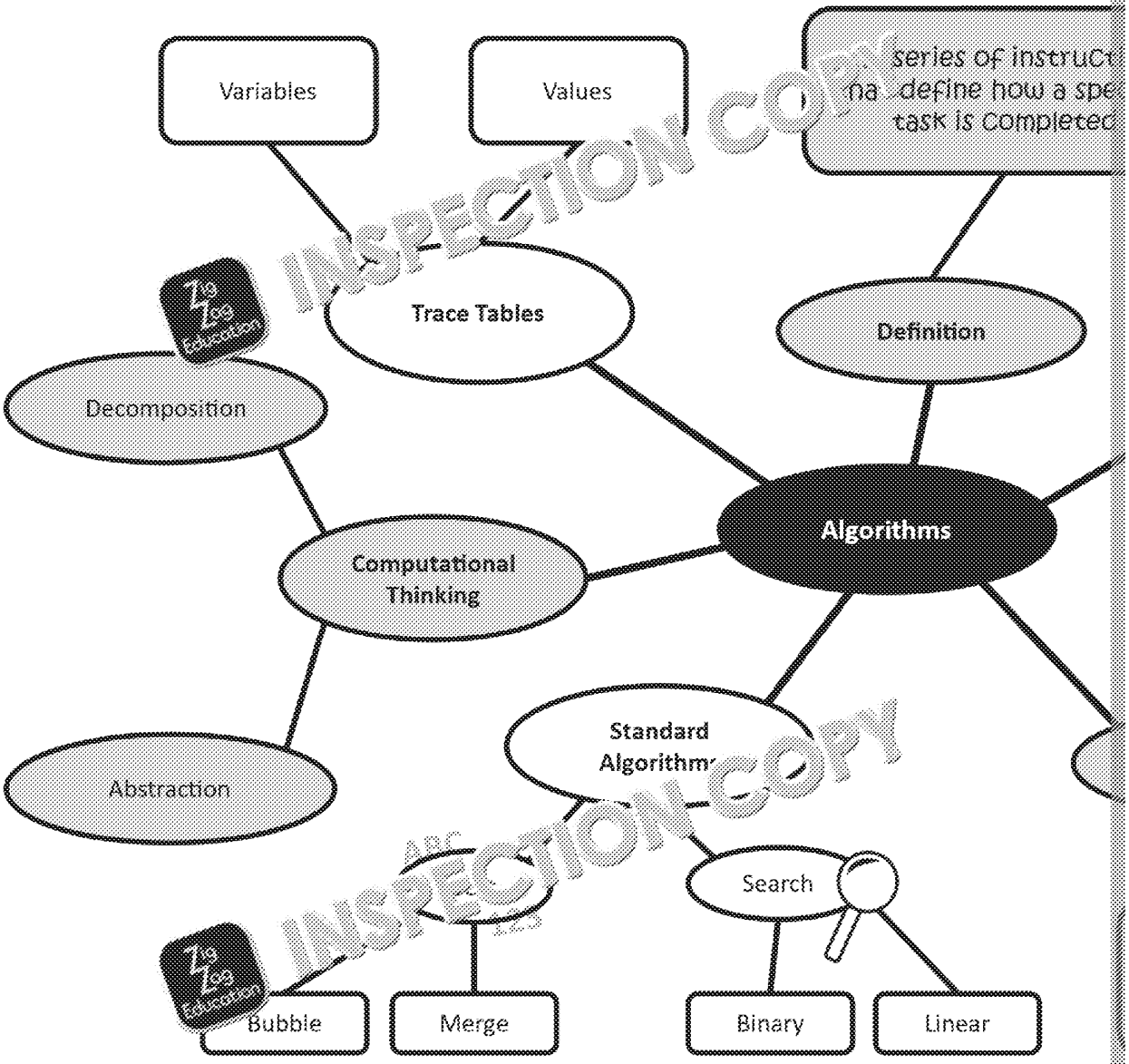
Fundamentals of Algorithms Mind Map



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Sample Examination-style Questions

1. What is meant by the term **algorithm**?

.....

.....

.....

2. State the name of each of the following flowchart shapes:

.....

.....

.....

3. Describe the operation of a **bubble sort** algorithm?

.....

.....

.....

.....

.....

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3.2. Programming

3.2.1. Data Types

Each item of data is of a particular type. Some types are numeric, and others are
of data determines the operations that can be performed upon it. For example,
and a real, but not a Boolean and a string.

Data Type	Description	Use in Python	Use in VB.Ne
Boolean	Can be either true or false.	`bn = True`	`Dim bn as Bool` `bn = true`
Character	A single letter, number, p... mark ... etc.	Python does not have a 'character' data type, but most other languages do.	`Dim cr as Char` `cr = 'a'`
Integer	Whole numbers – positive, negative or zero.	`i = 5`	`Dim i as Integ` `i = 5`
Real	Decimal numbers – positive or negative (zero can also be stored in a 'real' variable).	`pi = 3.142`	`Dim pi as Sing` `pi = 3.142`
String	A collection of characters used to store names, addresses, phone numbers, etc.	`name = "Bob"`	`Dim name as St` `name = "Bob"`

3.2.2. Programming Concepts

Variable – a named space in memory, large enough to store a single p
a data type. Although some languages, including Python, do not requ
the data type, each variable still has one.

Constant – a named space in memory with a v... that can never cha
running. Useful for pi (which will n... ve... ch... ge) or VAT (which seldom
allow for constants, but o... la... ges do.

C#:
```
const float vat = 0.2F;
```

VB.net:
```
Const vat as Single = 0.2
```

Assignment – the process of putting a value into a variable. Most lan
do this. In the instruction `x = 5`, the value '5' has been assigned to

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Programming Constructs

Sequence

Sequence means that instructions will always execute in the order in which the be executed once and only once.

```
hourlyRate ← USERINPUT
hours ← USERINPUT
OUTPUT hourlyRate * hours
```

This program asks for the hourly rate and the number of hours worked before c figures multiplied). At this point, the program ends.

Selection

Selection is when one path through the code is chosen where multiple possible the word 'if' is the most common indicator of selection, although there are othe

```
hours ← USERINPUT
rate ← USERINPUT
IF hours > 40 THEN
    OUTPUT 'Normal Earnings:     ' + (40 * rate)
    OUTPUT 'Overtime Earnings:   ' + ((hours - 40) *
ELSE
    OUTPUT 'Normal Earnings:     ' + (hours * rate)
    OUTPUT 'No Overtime'
ENDIF
```

The first two lines will always run; the program asks the user for the number of storing each value in a separate variable. Then a decision is made. If 'hours' is indented lines will run. Otherwise, the last two indented lines will run. There w when all four would be executed.

Condition-controlled (indefinite) iteration

Iteration means 'looping'. Code that is iterative might be executed multiple tim written once.

```
looping ← True
WHILE looping = True
    hourlyRate ← USERINPUT
    hours ← USERINPUT
    OUTPUT hourlyRate * hours
    yesOrNo ← USERINPUT
    IF yesOrNo = 'no' THEN
        looping ← False
    ENDIF
ENDWHILE
```

The secon specifies the condition that will make the rest of the code loop until the 'lo ing' variable is set to false.

Nesting – this involves placing one programming structure inside ano contains an IF structure (on the penultimate line) that is **nested** withi Additional nesting is also possible; that IF structure could have contai which itself contained another WHILE structure…

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Count-controlled iteration

The above code loops until the user enters the letter 'n'. It is impossible to kno
the loop will run. Sometimes, code is required that runs a predetermined num

```
FOR x ← 1 to 12
    OUTPUT x * 2
ENDFOR
```

This code will run 12 times, with the variable 'x' taking the values 1, 2, 3, 4, 5, 6,
The purpose of this code is to display the two times table.

Pre-check iteration – the condition th d. te ines whether the cod
will loop again is placed at th s f the structure. If this condition
within the iteration t uct r will never run:

```
WHILE x
    ...
ENDWHILE
```

Post-check iteration – the condition that determines whether the co
will loop again is placed at the end of the structure. This means the c
always run at least once, as it will run on the first pass without needin

```
REPEAT
    ...
UNTIL x >= 5
```

When you write program code, you should make use of **meaningful identifiers**.
you give to anything, such as a variable, should clearly identify its purpose. A va
as meaningful as a variable named `player1Score`. Meaningful identifiers are
as any other programmers who may need to work on your code.

3.2.3. Arithmetic Operations in a Programming Languag

Operator – in the context of computer science, an operator performs
pieces of data in order to produce additional data. There are **arithme**
operators and **Boolean** operators.

Arithmetic operator – performs a proces on e r more numbers.
operators are: + – * /

Pseudo	Explanatio
`total ← 10`	Addition **(15)**
`result ← 10 - 5`	Subtraction **(5)**
`product ← 5 * 10`	Multiplication **(50)**
`answer ← 10 / 5`	Division **(2)**
`outcome ← 13 DIV 5`	Quotient, also known as integer division **(2**
`solution ← 13 MOD 5`	Modulo **(3)** – divides but uses only the rem

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3.2.4. Relational Operations in a Programming Languag

Relational operator – a comparison between two values to check, for equal, or whether one is less than or greater than the other. Relation statements and as part of loops.

Pseudocode	E

`IF x > y THEN`
`...`
`ENDIF`
	If 'x' is greater than 'y'

`WHILE a < b`
`...`
`ENDWHILE`
	While 'a' is less than 'b

`IF q >= r THEN`
`...`
`ENDIF`
	If 'q' is either greater t

`WHILE j <= k`
`...`
`ENDWHILE`
	While 'j' is either less t

`IF e = f THEN`
`...`
`ENDIF`
	If 'e' and 'f' are equal..

`WHILE m != n`
`...`
`ENDWHILE`
	While 'm' and 'n' are *n*

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3.2.5. Boolean Operations in a Programming Language

Boolean operator – a logic expression can have one of only two outco
operator connects together logic expressions to produce a more com
and OR are the most commonly used logic operators.

Python Code	Explan
`if (age > 15 and age < 65):`	Age has to be both above 15 *and* contents of this IF structure woul
`if (age < 16 or age > 64):`	The conte of this IF structure w be low 16 above 64.
`if (not(age < 16)):`	translates to 'if age is *not* less tha the outcome of a logic expression to 'false' or from 'false' to 'true'.

Here is a pie of Python code that combines all three types of operator. It calcu
adults and children entering a zoo. How much would it cost for two adults and c

```
adults = int(input("How many adults: "))
children = int(input("How many children: "))

if (adults + children >= 5) or (adults >= 2):
    cost = adults * 9 + children * 4.5
else:
    cost = adults * 10 + children * 5
print(cost)
```

Here is the same functionality represented using pseudocode:

```
adults ← USERINPUT
children ← USERINPUT

IF (adults + children >= 5) OR (adults >= 2) THEN
    cost ← adults * 9 + children * 4.5
ELSE
    cost ← adults * 10 + children * 5
ENDIF
OUTPUT cost
```

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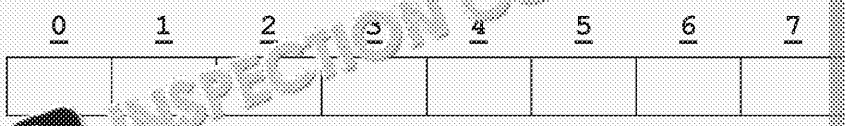
3.2.6. Data Structures

Data structure – a structured (organised) means of storing related da
store a single piece of data, a data structure can contain many.

Many data structures exist, and it's even possible to invent your own. In GCSE C
familiar with **one-dimensional arrays**, **two-dimensional arrays** and **records**.

One-dimensional array – a data structure for storing multiple data ite
Think of a one-dimensional array as a row of variables. Instead of eac
whole array has a single name, while each **elem** in the array has a
below. A one-dimensional array migh[illegible]e [illegible]upil's most recent spe



t element is always numbered '0', so the array above contains
c stored in each of the empty boxes.

Python Code	Explanatio
`myArray = [4,6,1,2,9,0]`	Creates an array called 'myArray' and pop
`myArray[0] = 5`	Places the number '5' into the first eleme
`print(myArray[2])`	Displays the third element of the array –

Two-dimensional array – a data structure for storing multiple data ite
much like a one-dimensional array, but can be considered as a grid ra

0, 0	0, 1	0, 2	0, 3
1, 0	1, 1	1, 2	1, 3
2, 0	2, 1	2, 2	2, 3

Elements are referred to, as seen here, with two numbers, much like
grid were larger, it could be used as a grid for a computerised game o
and crosses.

Python Code	Expl
`myArray2 = [["a","b"],["c","d"]]`	Create a two-dimensional ar a b c d It might help to visualise it in computer does not store arr
`myArray2[1][0] = "z"`	This would replace 'c' with 'z
`print(myArray2[0][1])`	Displays the requested lette

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Record – a data structure that can accept multiple data items that do
data type. As far as Python is concerned, there is no difference betwe
are managed in the same way. One record might store a student's na
test score. The next record would store the same details for another

Python Code	Explan
`student1 = ["Bob", 8, 89.2]`	Creates a record called 'student1';
`student1[1] = 9`	'Bob' has been moved from year 8
`print(student1[2])`	Displays 89.2 – Bob's average test

If you are asked to name a suitable data structure for a specific situation, it can
an array (at least this is true at GCSE level). If the data structure is going to stor
data types, a record is always the right choice.

3.2.7. Input/Output

Input – the process of introducing data into a computer system. In th
used as the input device.

Output – the process of communicating data beyond the system, typ
section, the visual display unit (VDU) will be used as the output device

Python Code	
`name = input("Name: ")`	Asks the user for th in a variable called
`age = int(input("Age: "))`	Asks the user for th *integer* in a variabl
`height = float(input("Height (m): "))`	Asks the user for th *real* number in the
`print("hello")`	Displays the text w
`print(hello)`	Without the speec ame of a variable the value stored in

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3.2.8. String Handling Operations in a Programming Lan

Python Code	

`firstName = "Richard"`
`lastName = "Lee"`
`fullName = firstName + " " + lastName`
	The third line uses strings (join them t The concatenated variable, 'fullName person's first and l locations, or entere

`firstName = "Richard"` `print(len(firstName))`	Displays the **length** string. This would
`fullNam Richard Lee"` `print(fullName.index(" "))`	Looks for one strin code will look for t 'Richard Lee'. This characters, like this 0 1 2 3 R i c h The space is in **pos** would be output b
`fullName = "Richard Lee"` `print(fullName[0:7])`	Displays a **substrin** location '0', and las would output 'Rich
`letter = 'a'` `print(ord(letter))`	The purpose of 'or contents (letter, or This would display
`code = 97` `print(chr(code))`	This performs the code 97 is displaye
`a = '123'` `b = int(a)`	The variable 'a' con numerals. The sec string to the intege three, storing that
`c = '123.456'` `d = float(c)`	The variable 'c' nov a real number. The data type, storing i
`e = 789` `f = str`	Here, we see a vari first line. The seco and would work in instead of an integ operations on 'e', b

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3.2.9. Random Number Generation in a Programming La

Random – a random number has been selected from a range of numb
range had an equal chance of being selected.

Random integers in Python:

```
import random                    ← Imports the 'random' library, allowi
print(random.randint(0,9))       ← Outputs a random integer between
```

Random numbers have many uses in computing:

- Encrypting data, making it difficult for unauth[illegible]eople to understand
- Causing simulations, such as flight si[illegible]o run differently every time
- Adding variability to comput[illegible]enemy units might have behaviour th
- Random sampling of [illegible]ticipants, i.e. randomly selecting names fron

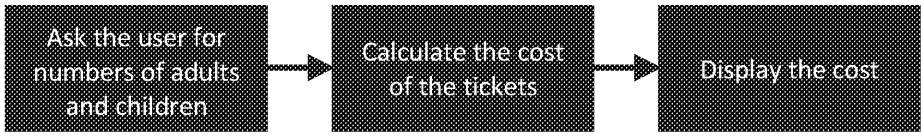
3.2.10. Structured Programming and Subroutines

Subroutine – an out-of-line block of code that can be called by typing it

There are benefits to using subroutines to write a program:

- Each subroutine can be assigned to a different programmer, enabling team
- Subroutines can be separately tested, so testing can begin long before the p
- Commonly used subroutines can be reused in other programs, saving time a

We could break a ticketing program into the following subroutines:



In Python, the subroutines would be declared like this:

```
def promptUser():
def calculateTotal():
def displayTotal(total):
```

Parameter – a piece of data that is passed into a subroutine in order t
In the above example, 'total' is a parameter that will be passed to the
other subroutin[illegible]o parameters. Multiple parameters can be p

```
def displayTotals(total1, total2, total3, etc.)
```

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The code within a subroutine will only be run if that subroutine is **called**.

Calling – a process where an instruction in one part of the code tells a to run. If you have a subroutine called `promptUser`, the code withi happen without that subroutine being called.

Examples of calling subroutines:

```
promptUser()
total = calculateTotal()
displayTotal(total)
```

These three instructions tell the subroutines to happen in a particular order. Co subroutines, so that the finished listing looks like this. Notice how spacing greatly

```
1    def promptUser():
2        global adults, children
3        adults = int(input("How many adults: "))
4        children = int(input("How many children: "))
5
6    def calculateTotal():
7        print("adults: " + str(adults))
8        if ((adults + children >= 5) or (adults >= 2
9            total = (adults * 9) + (children * 4.5)
10       else:
11           total = (adults * 10) + (children * 5)
12       print(total)
13       return total
14
15   def displayTotal(total):
16       print("Total cost: " + str(total))
17
18   promptUser()
19   total = calculateTotal()
20   displayTotal(total)
```

NB the numbered list below tells you the order in which things take place – these the line numbers in the program.

1. The first line to be executed is line 18, where the `promptUser` subroutine belong to the subroutines, which will only run when they are called.
2. Program execution jumps to lines 1–4, where the 'adults' and 'children' vari input. These variables are global, meaning they are visible in all other subro
3. Once lines 1–4 have been executed, control jumps back to line 18, which is `promptUser` call is finished, so control moves onto line 19. The `calculateTo` control now jumps to line 6.
4. Lines 6–13 calculate the cost of entry based on the number of adults and ch
5. The 'return' statement on line 13 passes the 'total' variable *back* to line 19, `calculateTotal` subroutine was called from. Whatever the value of th stored in the 'total' variable on line 19.
6. On line 20, the `displayTotal` method is called, with the contents of 'tot This value (received in brackets on line 15) is then output as part of line 16.

The best way to understand code is to write it. Using this program as a templat functionality. Try adding a discount code that takes 10% from the total. You m creating a `promptForDiscountCode` subroutine.

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The Structured Approach

When adopting a structured approach, you should take advantage of the followi

- Modularisation
- Well-documented interfaces
- Appropriate use of local variables

Modularisation – the process of breaking a program into smaller part is a type of module, and the advantages of dividing a program into eit the same.

Interface – nothing to do with the user int , is term means son of code. The interface is how yo lo ot programmers to use ar programming constructs t yo ve written. Specifically:

- Self-docu identifiers should be used; a subroutine's nam iti g to read and understand its inner workings. The s rameters and return values.
- nother programmer should not be required to understand *how what* it does. They provide the parameters and they receive the between should ideally be inaccessible to them (which is actuall

Scope – refers to the visibility of a variable, and can be either **local** or

Python Code	

`def setup():`
`  global vat`
`  vat = 0.2`
 	
`def sale():`
`  price = 1.99`
`  quantity = 5`
`  total = price * quantity * (1 + vat)`
`  print(total)`
 	
`def refund():`
`  amount = total / (1 + vat)`
	vat is **global** – it i
	You can see it use
	'sale' and 'refund
	
	The other variabl
	amount) are **loca**
	within the subrou
	The last line wou
	is local to the 'sal
	visible in the 'refu

Taking a structured approach is advantageous in several w

- All advantages to using subroutines apply he a wo king is easier, test readily reused).
- The code is easier to read, u and debug.
- Changes can be mor de to a module within the program without were t ge e of your subroutines worked, for example, its name remai ca , so no changes would need to be made by whoever is callin

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3.2.11. Robust and Secure Programming

Robust	
A robust program continues to function even when confronted with unexpected events, such as a lost network connection or a user inputting data of the wrong data type.	A secure program pre altering data that they Usernames and passw keeping a program sec

Validation – ensuring that data entered into the computer is reasonab checking that a person's date of birth isn't in the future. Validation doe

Different types of data can be input, so a rang of val ion checks exist to suit:

Range check ensur at ata is within a specified range, e.g. ensurin e. 0 and 30 seconds, or ensuring a person's birthd

```
isValid lse

while isValid == False:
    bedrooms = int(input("How many bedrooms:"))
    if bedrooms >= 1:
        isValid = True
    else:
        print("Please enter a positive number")
```

This c the us bedro equal rule w staten messa

Type check ensures that the correct data type has been entered (e.g

Length Check ensures that a string contains a valid number of characte number or national insurance number.

```
isValid = False

while isValid == False:
    name = input("Name: ")
    if len(name) >= 3:
        isValid = True
    else:
        print("Minimum length: 3 characters")
```

This c repea contai Replac would entere

Lookup check checks that what the se has ntered exists on a list, su of the week or si ter lists, the user can select the ite

Presence check ly checks that the user has entered something. This ensures that the length is greater than zero

Authentication – the software process of ensuring that the person ac who is *supposed* to access that system. The following might be used:

- Usernames and passwords
- Memorable information – prompting for something only the rea favourite place or the name of a first pet
- Checking that the user is using their usual computer, by logging t

Authentication techniques are used throughout the cyber security wo

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```
isLoggedIn = False

while isLoggedIn == False:
    name = input("Name: ")
    password = input("Password: ")
    if name == "user" and password == "pass":
        print("Valid login")
        isLoggedIn = True
    else:
        print("Invalid login")
```

Selecting Test Data

Choice of test data is important. Suppose you have written a program for an est
number of bedrooms in a hous which must be an integer between 1 and 15:

Type of T a	Description
Normal (typical)	Data that is valid and that represents how the program wo
Boundary (extreme)	Data that is just barely valid, to check that the extreme ran normal input work correctly. Also, data that is just barely invalid, to check that invalid da close it might be to valid data, is correctly rejected.
Erroneous	Data that should not be accepted by the system. This is in whether a programs validation and error messages work c

If you have a piece of code that is supposed to sort eight positive integers into as
of test data each have a specific purpose:

Test Data	Explanation
1 2 3 4 5 6 7 8	The data is already sorted, so the program s to be checked).
8 7 6 5 4 3 2 1	The values are in descending order, which re this is as far from being in ascending order a
2 6 4 3 8 7 5	How does the program react to having a nun
-1 2 3 4 5 6 7 8	How does the program react to having a neg
1 2 3 4.2 5 6 7 8	How does the program react to one piece of data type?
5 4 4 2 9 8 8 5	Does th sorti work correctly if there are

Errors

Even the m er ced programmers write code with errors. So many error
divided into nt types:

Syntax error – the grammar or rules of the language have not been fo
such as 'for' has been misspelled, or perhaps indentation has not bee
error causes a program to stop working or perhaps not even start.

Logic error – a piece of code is written incorrectly in a way that does
working. The programmer might have added when they meant to su
instead of 100 for a percentage calculation.

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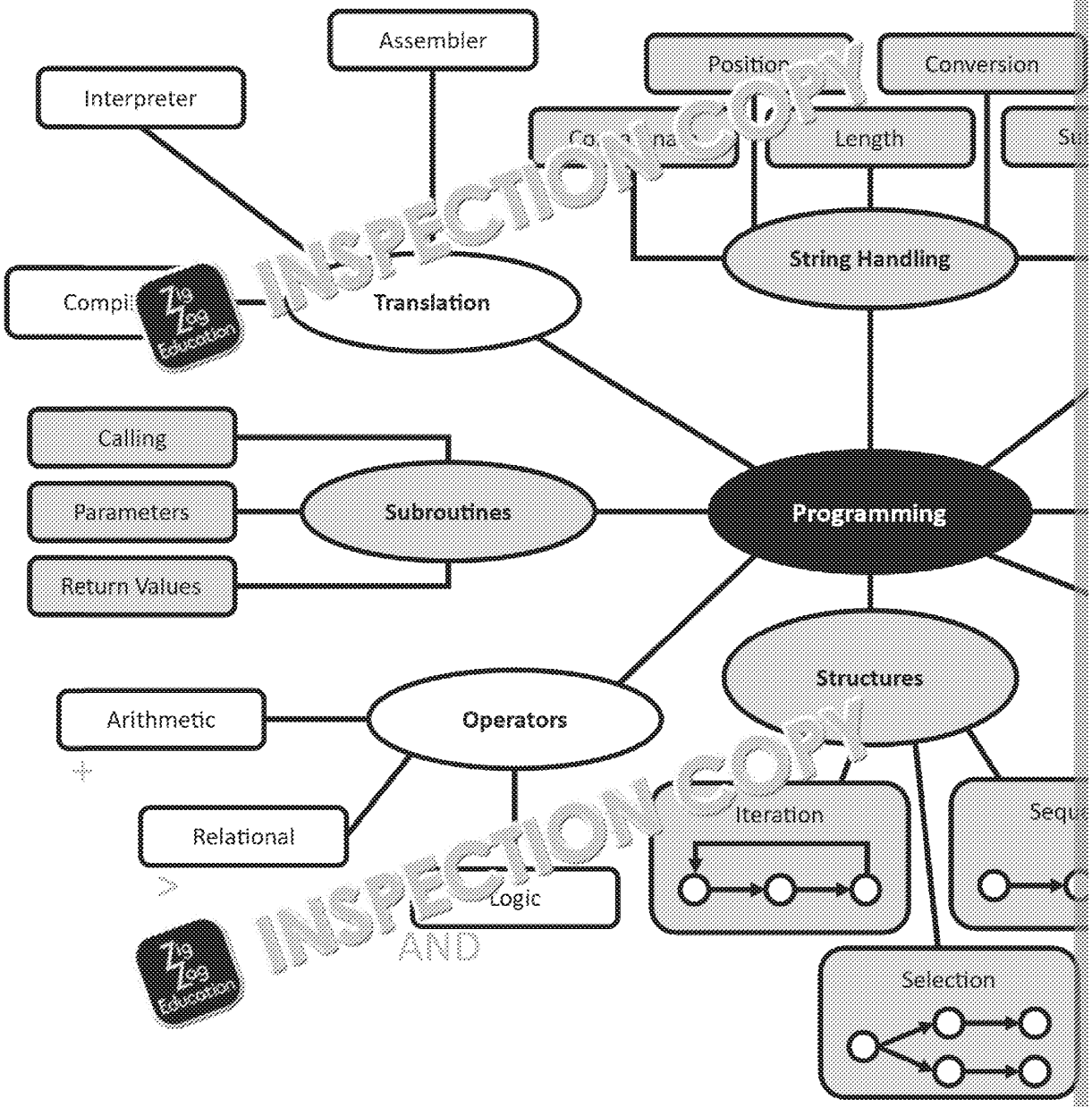
Programming Mind Map



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4. This question is based on the following program:

```
total ← 0                    #keeps a running total
count ← 0                    #logs how many are ent
mean ← 0                     #to store the mean
input ← USERINPUT
WHILE input > -1
      total ← total + input
      count ← count + 1
      input ← USERINPUT
ENDWHILE
mean ← total / count
OUTPUT mean
```

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a. Give an example of each of the following from the code:

i. Variable

.....

ii. Comment

.....

iii. Arithmetic operator

.....

iv. Relational operator

.....

v. Iteration keyword

.....

b. When the program is running, what would the user need to do in order have entered all of their numbers?

.....

.....

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5. A bank stores several pieces of data about each bank account. Identify the
each of the following pieces of data. Some data types are used more than o

Place **one** tick in each row.

Data	Integer	Real	Boolean	
Money in account				
Account holder's name				
Number of whole years the account has been active				
Account holder's [illegible]				
Whether or not an overdraft is permitted				
A single-letter code that identifies the account type				

6. An array called `data` contains 10 numbers, each being an integer between
programming language with which you are familiar, write an algorithm to co
the array are higher than 5.

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3.3. Fundamentals of Data Repre

3.3.1. Number Bases

Number base – the number of unique digits available in a numbering **decimal** (the numbering system you're most used to), there are 10 in 3, 4, 5, 6, 7, 8, 9), so it is also known as **base 10**.

Numbering System	Available Digi
Binary (base 2)	0 1
Decimal (base 10)	0 1 2 3 4 5 6 7 8 9
Hexadecimal (base 16)	0 1 2 3 4 5 6 7 8 9

Computer in to represent all data and instructions. Whatever a user e text, imag d or video, it is ultimately stored as a string of '0's and '1's.

Hexadecimal is often used in computer science as a human-readable alternativ hexadecimal digit is equivalent to four binary digits. The largest single-digit hex translates to 1111 in binary. Consider which of the following is easier for you t

`A42C` `1010010000101100`

They both represent the same value. The hexadecimal value is easier for a hum prone to error when being typed in.

3.3.2. Converting between Number Bases

The largest values you'll be expected to convert in an exam are 255 in decimal, and FF in hexadecimal (all of which are equivalent to each other).

Binary → Decimal

This conversion will use the example binary number `11001010`. The first step i binary digit. The placeholder above the rightmost bit is '1', and the value of eac to the left:

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

Add together the placeh a value that contain a '1':

128 + 64 + 8 = **200**

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Decimal → Binary

The following steps show you how the number **85** is converted, with no need for

Instruction	Answer so far
We know that there will be eight bits in our answer, so we create a space for eight digits.	
We can then write in the value of each digit immediately above. Start with '1' on the right-hand side, then double each time you add a new number to the left.	128 64 32 16 8
Now, we start with the left-most bit. 128 is higher than the number we're trying to convert, so we enter a '0'.	32 16 8
Next, we look at 64, which is [illegible] than the number we're trying to convert, so we enter a '1' and subtract 64 from our number.	128 64 32 16 8 0 1
The next number is 32, which is bigger than the number we're trying to convert (21 at this point, as we've subtracted 64 in our last step). We enter '0' and leave our number unchanged.	128 64 32 16 8 0 1 0
Our number (21) is larger than the next digit (16), so we enter a '1' and subtract 16.	128 64 32 16 8 0 1 0 1
With only 5 left to convert, which will clearly be made up of a '1' and a '4', we place '1's into each of these columns and '0's into the others.	128 64 32 16 8 0 1 0 1 0

The binary equivalent of '85' is '01010101'.

The right-most binary digit is always '1', then '2', '4', '8', etc., doubling each tim
the binary number varies from eight bits, the left-most bit will change, but the
always be '1'.

This topic is quite an easy one to practise without any past paper questions. Th
between 0 and 255, or use a random number generator. C[illegible]vert it to binary, t
check that you end up with the same number wi[illegible] you started.

This technique also applies to exa[illegible]st[illegible]s, if you have time. If you've been
number from binary to de[illegible] you can check it by converting your answer ba
you arrive back at [illegible] in the question.

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Hexadecimal → Decimal

The table below shows all single-digit hexadecimal values, along with their binary

Binary Representation	Decimal Representation	
0000	0	
0001	1	
0010	2	
0011	3	
0100	4	
0101	5	
0110		
0111	7	
1000	8	
1001	9	
1010	10	
1011	11	
1100	12	
1101	13	
1110	14	
1111	15	

Binary → Hexadecimal

1. This is a binary number we will convert to hexadecimal.
2. If the binary number has a number of digits divisible by four (4-digit, 8-digit, 12-digit, etc.), it can be left alone. Otherwise, add '0's **to the left** until you have such a number. Since our number has six digits, we will add two '0's to the left of it.
3. Next, split the number into 'nibbles' of four bytes each.
4. Finally, convert each nibble separately, using the table above. This table contains every possible value for a binary nibble.

So '011110' in binary is equivalent to '**1E**' in hexadecimal.

Hexadecimal → Binary

5. This is the hexadecimal number we will convert to binary.
6. Each hexadecimal digit will translate to a binary nibble, according to the table above. Translate each digit separately.
7. Attach the nibbles together. If you choose to, you may leave a space between them for readability, but you do not have to.

So 'A6' in hexadecimal is equivalent to '**10100110**'.

If you need to convert between decimal and hexadecimal numbers, the best way is to convert to binary number, so either **decimal → binary → hexadecimal** or **hexadecimal → binary → decimal**, depending on the conversion you are asked to make.

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3.3.3. Units of Information

Unit Name	Size	
Bit (b)	A single binary digit.	Either a nothing
Byte (B)	A sequence of eight bits.	An indiv as '#' or
Kilobyte (KB)	Approximately 1,000 bytes.	A parag 200 wo
Megabyte (MB)	Approximately 1,000 kilobytes or 1,000,000 (one million) bytes.	Around mp3 mu
Gigabyte (GB)	Approximately 1,000 megabytes or 1,000,000,000 (one billion) bytes.	About n definiti
Terabyte (TB)	Approximately 1,000 gigabytes or 1,000,000,000,000 (one trillion) bytes.	Depend hundre

Historical[ly] m[e]asure was sometimes considered to be 1,024 times larger measure, i[.e.] megabyte was often considered to be 1,024 kilobytes, rather th This is because 2^{10} is 1,024.

However, all other measurements with a mega- prefix (such as megawatt, meg are exactly 1,000 times their corresponding kilo-prefixed measurements (kilow kilojoule), and it's now understood that one megabyte is 1,000 kilobytes.

Your teacher may disagree, and isn't necessarily wrong (it's a bit like the argum pronunciation of 'gif'), but the AQA specification stipulates multiples of 1,000, n

Be aware of the difference between the shorthand form for bits (lower case 'b' case 'B'). If you look at your home broadband speed, it is probably measured in per second), not MBps (megabytes per second).

3.3.4. Binary Arithmetic

You need to be able to add up to three binary numbers together as well as to pe

Binary shift – moving (shifting) the values of a binary number left or r

a. 00011000 → Shift right by one place → 000

b. 00001100 → Shift left by two places → 001

When you shift left or right, any bits that fall off the end are lost forever; any bits other end are *always* '0':

Shift 1 place	Multiply by 2	
Shift 2 places	Multiply by 4	
Shift 3 p[laces]	Multiply by 8	

Addition of numbers in binary is similar to addition of numbers in decimal. The n of the other, and each pair is added, going from right to left. In binary, when ad five possible combinations of numbers, because we're only dealing with '1's and

```
0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 10          (seems strange, but '10' is binary for '2')
1 + 1 + 1 = 11      ('11' is binary for '3', and you will only need this one for
```


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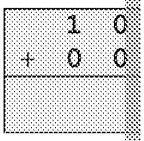
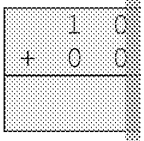
Binary Addition Walkthrough

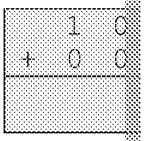
1. The two numbers to be added are stacked one on top of the other.



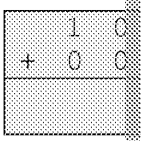
2. Starting from the right-most digits, the first pair is added together. 1 + 0 = 1.



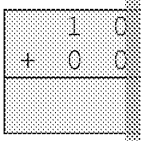
3. The next pair is just as straightforward: 0 + 0 = 0.



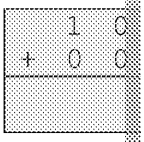
4. As for the next pair, 1 + 1 = 2, which is 10 in binary. Just as in adding decimal numbers, we carry the '1' and place a '0' in the answer.



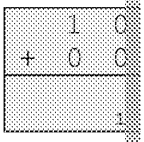
5. Here, we add 0 + 1 + 1 (the carried '1'). In binary, 0 + 1 + 1 = 10, so another '0' and another carried '1'.



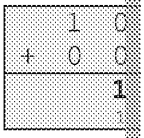
6. Here, it's 1 + 1 + 1 including the carried digit. In binary, 1 + 1 + 1 = 11.



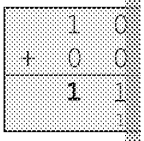
7. Again, 1 + 1 + 1 = 11.



8. Now, 0 + 0 + 1 (the carried '1') gives us '1'.



9. The final pair on the left is 1 + 0 = 1.



When adding together three numbers, if you can't perform the addition in a sin together two of them, then add the third to the result. In the exam, you should decimal, then add, then convert back to binary. This is likely to lose you marks.

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3.3.5. Character Encoding

Character – a single symbol, such as a letter, number, symbol or spac
cause one character to appear on the screen.

Character set – a list of all characters recognised by a computer syste
corresponding code, and the same codes are used by all computers th
ASCII (American Standard Code for Information Interchange) and **Uni**
character sets.

Character Value	ASCII Value	
A	100 0001	
a	110 0001	
#	010 0011	
	011 0011	

Characters are commonly grouped and run in the order that you would expect,
decimal representation of 65, 'B' is 66, 'C' is 67, 'D' is 68, etc. In lower case, 'a' i
99, etc. Numerals (0, 1, 2, 3, etc.) are similarly grouped together.

ASCII uses seven bits, meaning 128 different characters (2^7) can be represented.

Unicode uses sixteen bits, meaning 65,536 different characters (2^{16}) can be repre
of ASCII gives you access to far more alphabets, including Chinese, Japanese, and
but more storage space is required.

ASCII and Unicode use the same codes for characters up to code 127 (`111 11`
is `100 0001` in ASCII and `0000 0000 0100 0001` in Unicode.

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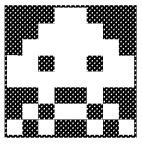
3.3.6. Representing Images

One way to store images is to divide them into pixels, each of which is a tiny dot
be one colour, and when a picture is saved, the colour of each individual pixel is
that are used to store each pixel, the more colours are potentially available.

Pixel – short for *picture element*, this term refers to the smallest poss
screen. A pixel cannot be divided up into smaller units, and a pixel ca
at a time.



When working with **monochrome** images,
or off, so one bit can represent one pixel.

The image above is eight pixels by eight, so 64 pixels in total. Only black and wh
be enough to store each pixel, set to '0' for black or '1' for white. This means 64
enough storage space for the pixels of this image.

If more colours are needed, more bits are needed. Many images store 24 bits, th
this way:

First byte	Second byte	
11111111	10001011	
Red	Green	

The 'red' value in the first byte is as high as it can be, so there will be lots of red i
will be some green, but not as much as red, and there will be no blue at all as the
Over 16 million colours are available, but a 64-pixel image saved in this format w
the pixels, compared with eight for the image above.

The amount of storage required for an image depends on a number of factors, in
- **Colour depth** – a measure of how many colours are available; the more colo
bits that must be assigned to store each pixel.
- **Image size** – the number of pixels in *height* and *width* for an image, often refe
A higher-resolution image (i.e. more pixels) requires more storage space than

Calculating an Image File Size

W	The width of an image, measured in pixels
H	The height of an image, measured in pixels
D	The colour depth; the number of bits used to store each pixel

File size in **bits**: W × H × D
File size in **bytes**: (W × H × D) / 8

To convert file size from **bytes** to **kilobytes**, divide the number of bytes by 1,00
bytes to **megabytes**, divide the number of bytes by 1,000,000.

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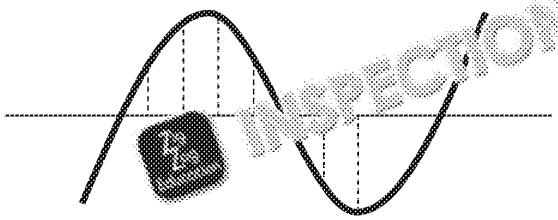
3.3.7. Representing Sound

Sound is analogue, and must be converted to digital before it can be stored or pr

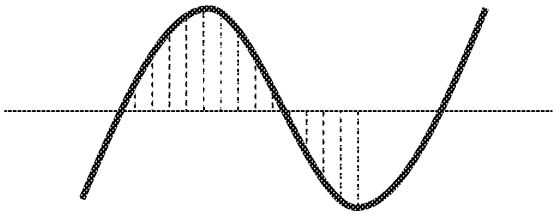
Analogue – sound is an analogue signal, which is the opposite of digit with digital signals, processing '0's and '1's – nothing else, nothing in b continuously variable. It might be one of two values, such as '0' or '1' as '0.1879'. Sound is an analogue signal, since frequencies do not occ

Analogue data needs to be converted to digital in order to be stored and process **samples** of the sound's **amplitude**. With sound, thousands of samples are taken measure of the amplitude at a specific point in time:



(each dotted line represents a sample)

Sampling rate – a measure of how often a sample is taken, measured per second. 1 MHz (megahertz) means one million times per second. higher sampling frequency:



A higher sampling rate results in higher accuracy but requires more storage spac second of audio.

Sample resolution – not to be confused with screen resolution, which *pixels*. Resolution in sound sampling refers to how many bits are req More bits means better quality, but also more storage space.

Calculating Sound File Size

Rate	Sam[illegible] the number of samples per second
Re	Sample resolution – the number of bits used to store each s
Secs	Seconds – the length, in seconds, of the whole sound file

File size in **bits**:	Rate × Res × Secs
File size in **bytes**:	(Rate × Res × Secs) / 8

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3.3.8. Data Compression

Compression – techniques to reduce the size of a file, so that it takes
be transmitted across a network more quickly. There are many differ
a small subset of which are covered at GCSE level.

Huffman Encoding

Huffman encoding – a form of lossless compression that represents c
smaller bit patterns, and rarely used characters with larger bit patter

Begin with the text, which would, in most cases, be more than a single word.	r
Identify all the unique letters.	r
Count how often each letter appears.	r1
At the bottom of your page, write down the letters in descending order of how often they appear.	z4
Create a V linking the two **lowest-frequency** letters, and write the combination of the letters, and their total frequency, at the peak of the 'V'.	z4 a3
Repeat the process, this time remembering that 'mt2' is now a possible option and that 'm1' and 't1' are not.	z4 a3
Continue until all letters have a path, however long, to the top of the tree.	zarmt1 z4 a3

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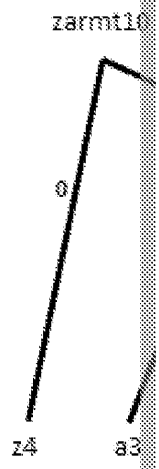
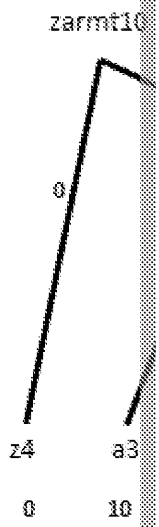
Label each left branch with a '0' and each right branch with a '1'.	
Give each letter a binary code made up of all the '1's and '0's encountered, in order, from the top of the tree.	

This is a **Huffman Tree**

To write 'razzmatazz', using this encoding, the following bit strings would be use

```
110 10 0 0 1110 10 1111 10 0 0
```

In fact, the spaces can be removed, since there is no way one code could be mist

```
11010001110101111000
```

An ASCII representation of the word 'razzmatazz' would have required 70 bits (multiplied by seven bits per char... The Huffman encoded representation, requires only 21 bits. This is because the most commonly used character, 'z', is code, '0'. Of course, much of this saving would be lost due to the fact that the would also need to be transmitted. However, for larger amounts of text, a sub be made in terms of file size, even when the size of the Huffman tree is factore

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Run Length Encoding (RLE)

Run length encoding – a form of compression that is effective when d
Instead of storing each item of repeated data, the data is stored once
it repeats.

A run length encoding algorithm is a straightforward means of lossless compress
storing or transmitting a file that contained lots of repeated data, such as:

- A text file that contains repeated characters, e.g. 'zzzzzzzzzzzzz'
- An image file where lots of adjacent pixels are an identical colour
- A sound file containing stretches of complete silence

If we consider a bit pattern, which could rep[illegible]ound, image, or any other fo
might operate in the following wa[illegible]

Uncompressed: 1111100000011110000000111111111
Compressed: 5 1 6 0 4 1 8 0 9 1

Each block of one symbol (1 or 0) is now reduced to that symbol, once, alongside
many consecutive instances exist. The first five '1's have been replaced by a 5 (t
This would not work for every file you attempt to compress:

Uncompressed: QWERTY
Compressed: 1Q1W1E1R1T1Y

Because no letters were repeated in the uncompressed file, the 'compression' pr
larger file.

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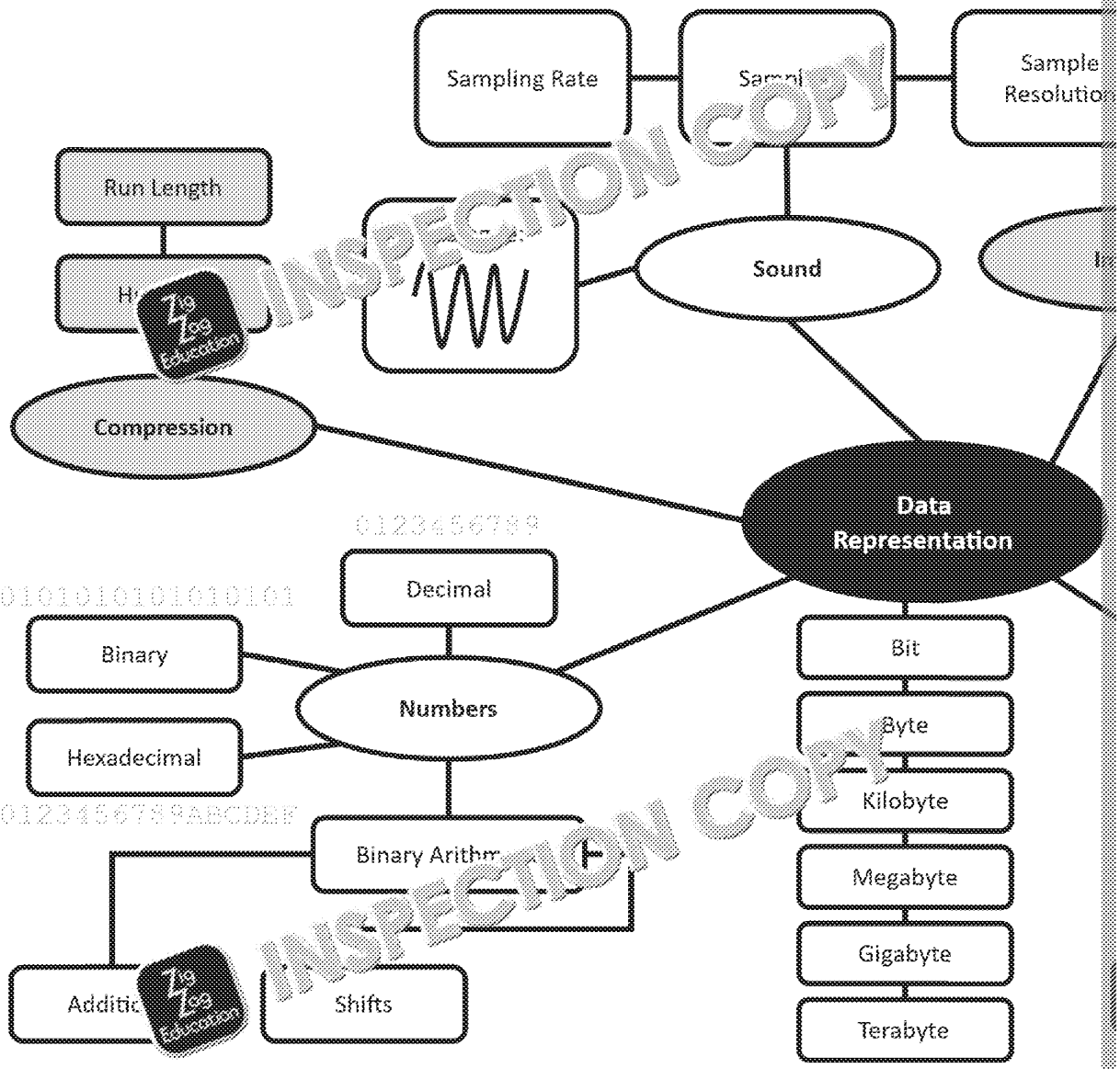
Fundamentals of Data Representation Mind Map



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7. The binary number `10011011` can have several values when translated int

   a. Convert it to decimal.

   .....

   b. Convert it to hexadecimal.

   .....

8. a. Carry out an arithmetic shift left by two places on the binary number 0

   .....

   .....

   b. State the effect of an arithmetic shift by two places.

   .....

   .....

9. a. State what is meant by the term **character set**.

   .....

   .....

   b. The ASCII code for 'P', in decimal, is 80. What is the corresponding cod

   .....

10. Each pixel in an image uses 8 bits of storage, and the resolution of the imag

    a. i. What is meant by the term **colour depth**?

    .....

    .....

    ii. State the colour depth used by this image.

    .....

    .....

    b. How much storage space is required for this image? Provide your answ

    .....

    .....

    .....

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3.4. Computer Systems

3.4.1. Hardware and Software

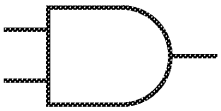
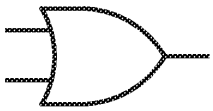
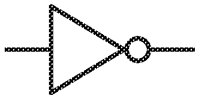
Hardware – the physical components that make up a computer syste
memory, storage, and input and output devices.

Software – the programs that run on a computer, including operating
application software (which includes mobile ap

The role of software, ultimately, is to tell hardware how to behave – what to do.
of no use from a computer science standpoint.

3.4.2. Boolean Logic

Logic – in computer science, 'logic' refers to producing **Boolean** outpu
on combinations of Boolean inputs.

Logic expression	Gate	Truth table (see symbo
AND all inputs must be '1' for the output to be '1'		A 0 0 1 1
OR if either input, or both inputs, is '1', the output is '1'		A 0 0 1 1
XOR (exclusive OR) if the inputs are different, the output is true; if the inputs are the same, the output is false		A 0 0 1 1
the output is simply the opposite of the input		A 0 1

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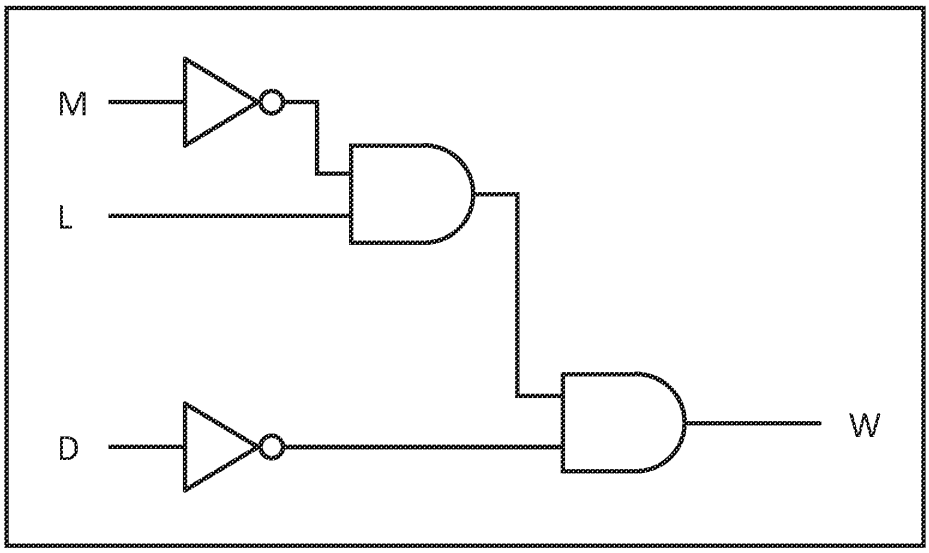
A truth table can be more complex. If we consider an automated greenhouse, w
automatic sprinkler (water = 1) only if the soil is dry (moisture = 0), it is daytime (
(door = 0). In all other events, the sprinkler is turned off (water = 0).

Inputs			Output
Moisture M	*Light L*	*Door D*	*Water W*
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

One possible logic circuit for this truth table would be as follows:



This logic circuit could also be written as a Boolean expression:

$W = \overline{M}.L.\overline{D}$ (water = (NOT moisture) AND light AND (NOT door))

3.4.3. Software Classificati

Syst – programs that are needed for effective communic
ching application software. Examples include:

- Operating system, such as Windows and Android
- Utility software, such as antivirus and compression software

Application software – programs launched from the operating syste
specific task or group of tasks. Examples include:

- Desktop applications such as browsers and word processing pack
- Mobile apps

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The Operating System

Operating system – a piece of system software that acts as an interfa hardware, managing all hardware and all other software. If another p launched, it will be launched from the operating system.

Operating systems are complex pieces of software, often requiring many years a them. The reason that they are complex is simply that computers are complex, w software that requires management. Among many things managed by the opera

Processor(s)	The operating system decides… • Which processes will be carried o which processors • If multiple processes are ... which one the process • How long a **time** ... process should be given, i.e. how attenti... swi...es to the next process
Memo	The ... system… • Loads programs and data from backing store to main me • Removes unneeded programs and data to make room fo • Manages **virtual memory** where part of secondary stora for main memory.
I/O devices	Regarding **input/output** devices, the operating system… • Acts as a go-between, passing data from input → applica software → output • Manages device drivers, which are programs telling the o communicate with attached input/output devices
Applications	The operating system… • Communicates between application software and hardw • Processes requests from application software for resour connection or a remotely stored file
Security	The operating system can… • Manage multiple user accounts, keeping users' data sepa • Automatically back up data, thereby increasing its securi • Handle usernames and passwords to prevent unauthoris • Recognise one user as an administrator, who would have

Utility software – programs that keep the computer functioning effic storage space, removing viruses or ensuring the files are backed up.

Utility	Purpose
Compression	Reducing the size o... so that it can be stored using less more quickly.
Defragmentation	... separate parts of a file physically together, to spee
Backing up	Creating a copy of files, either on the same disk, on a backu Backing up can be either full or incremental: • **Full** backup involves creating a copy of all files • **Incremental** backup involves creating a copy only of file edited since the last backup
Encryption	Allowing for data to be scrambled in order to prevent unauth understanding any files that they see. This might be for secur

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3.4.4. Classification of Programming Languages and Tra

	High-level	
What is it?	High-level languages are more understandable to humans than low-level language, so high-level languages are far more popular	More difficul be executed
Examples	• Java • Visual Basic • Python • C#	• Machin and '0') • Assemb making readabl instanc makes like ADD clue as
What do you need in order to run code written in these languages?	Either an interpreter or a compiler to enable the code that is typed to be translated into machine code so that the computer can run it.	Machine cod translated - language rec

What does code look like?	One line of code might do *several* things, e.g.:
	`A = B + C`
	This instruction finds out the values of B and C, adds them together, then stores the result in B.
	As one line of code can do several things, one line of a high-level language often translates into several lines of machine code.
		One line of c assembly lan
		`LDA B`
		`ADD C`
		`STA A`
		These instruc task as `A =` most people unintelligible assembly cod machine cod

Suitability	• More appropriate if the program is to be used on a variety of different computer builds • Far more people are proficient in high-level than low-level languages, so this may dictate the language type used	• Likely to systems location be addr • Suited t where e quickly

Machine c m specific, meaning a machine code program written fo not neces ork on another. This is because different computers sometim internal lay ts and components, which can affect the way that machine code

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Translator – a program that translates **source code** (which is written i
machine code (which can be executed by the computer). There are t

- **Assemblers** translate assembly language
- **Interpreters** translate then execute high-level code, one line at a
- **Compilers** translate an entire high-level program before executi

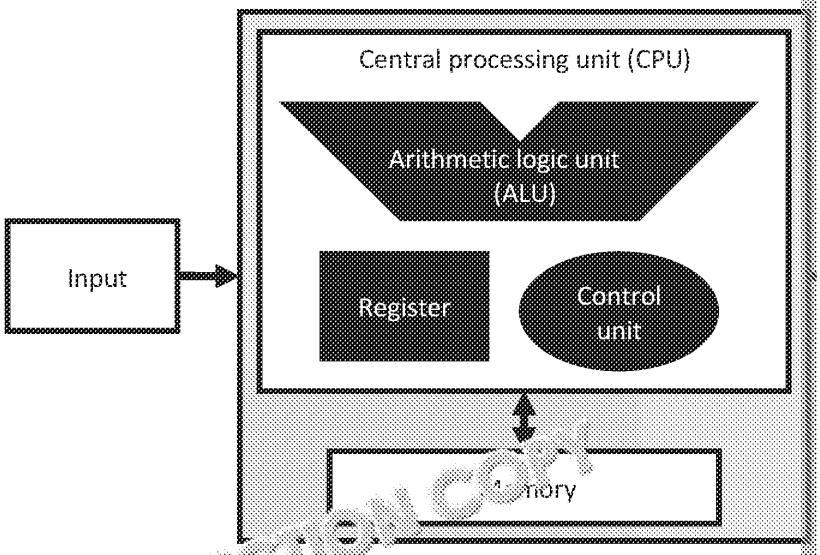
Computers can only execute machine code. If a program is written us
be translated to machine code before it can be executed.

For low-level translation, an assembler is the right tool for the job. For high-leve
compilers each have advantages and disadvantages.

Interpreter	
+ A program that contains er[illegible] be run, up to where the er[illegible]	+ A compiled objec than reinterpreti
+ Debu[illegible] is [illegible] the problematic line can be m[illegible]ily pinpointed	+ It is more difficul modify a compile
- Every time you run the program, it needs to be interpreted, which is time-consuming	- More memory is process than for i
- It is easier for unauthorised people to access your source code	- The entire progra order for it to co

3.4.5. Systems Architecture

The CPU is connected to other components, and the **von Neumann architecture**
how the CPU and other parts are connected:



Data is input, proces[illegible] CPU, which has several components of its own, a
allowing da[illegible] s[illegible]red. The arrows in this diagram indicate **buses**, which are
sent that co[illegible]ata.

This model defines the behaviour of many computers. The most advanced gam
processor (or several), an input in the form of a keyboard and mouse, an outpu
display and speakers, and vast memory to store the state of the game. A digita
is also a computer, has an input (the user can set the alarm), outputs (the curre
alarm sound), processing (keeping track of what time it is) and memory (it need
time of the alarm).

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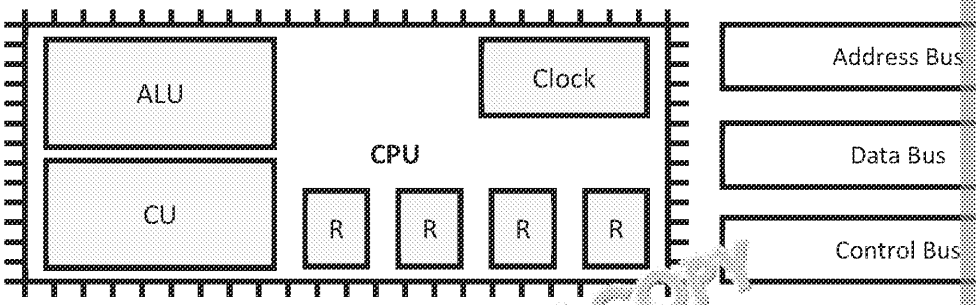
CPU – the central processing unit executes program instructions, perf comparisons, as well as coordinating the behaviour of other hardwar different components.



Component	Function
Arithmet U (A	rforms various operations: • Arithmetic operations (+ - * /) • Relational operations (< > =) • Logic operations (AND, NOT, OR).
Control Unit (CU)	Manages the execution of instructions by coordinatin other hardware.
Buses (collections of wires that transmit data between computer components)	**Data bus** – moves data back and forth between the C
	Address bus – transmits memory locations. Any data memory belongs in a specific address or memory loca
	Control bus – transmits commands to other compone from memory) or WRITE (put data in memory).
Registers	Short-term storage for small, specific pieces of data, w register would store data just retrieved from memory memory location from which that data came.
Clock	Every action performed by the CPU must begin during generates a pulse billions of times each second (in mo activities within the CPU.

CPU performance – a CPU with a higher rate of performance can exe than a CPU with a lower rate of performance. Several factors can affe

- Number of cores
- Clock speed
- Size of cache

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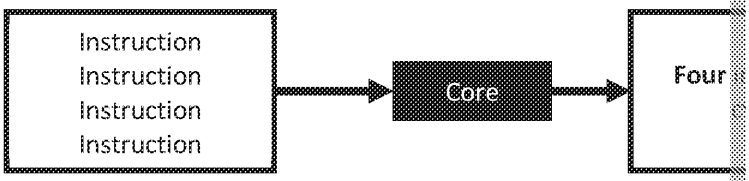
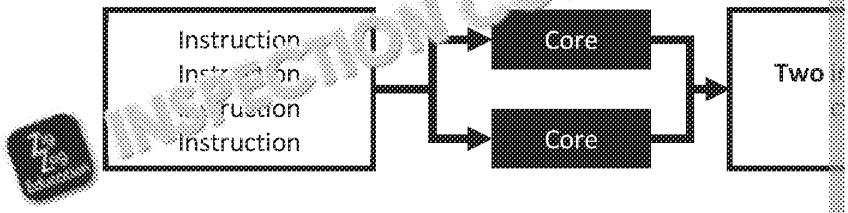
Core – a single unit, comprising an ALU and a Control Unit, which can
cores can execute instructions at the same time, so more cores mean
that can be executed.

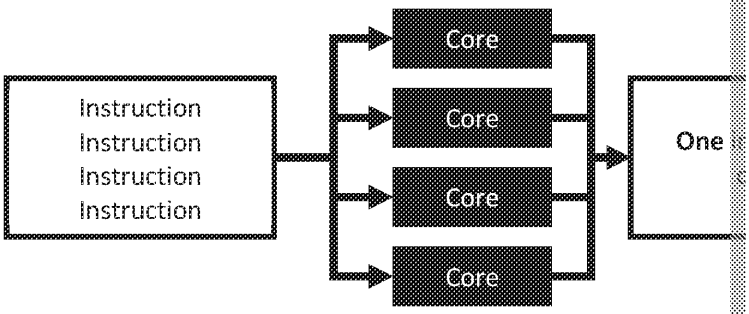
Four instructions with one core:



Four instructions with two cores (a **dual core** proces



Four instructions with four cores (a **quad core** processor):



A dual core processor is not quite twice as fast as a single core processor because s
organising which core will follow which instructions (this time is called the **overhea**
usually small enough that a dual core processor can be considered twice as fast as
same clock speed. It should be noted, however, that not all applications are desig

Clock speed – the number of clock pulses per second, typically measu
processor has a clock that pulses three billion times per second, mean
opportunities, each second, for an instruction to begin. Note that ins
a single clock pulse to complete.

Cache – stores copies of data or instructions from RAM (defined belo
regularly. This means that these data or instructions can be accessed

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The Fetch-Execute Cycle

Fetch-execute cycle – a continual sequence of tasks that results in ins
main memory, *decoded* so that the CPU knows what to do with them
them out. This cycle happens many millions of times per second in a

Fetch

1. The clock pulses. On a 3 GHz processor, this would happen three billion tim
only begin a task as the clock pulses, although a task may take more than on
2. One of the registers contains the location (in memory) where the next instru
is usually called the '**program counter**'.
3. This location, also called an 'address', is transmitted from the address bus t
instruction is transmitted along the control bus.
4. Memory responds by sending the contents of that address along the data bu
case, an instruction is being transmitted, and it is stored in a register called

Decode

5. The instruction is read by the control unit, which prepares the registers for
storing; the nature of this preparation depends on what the instruction was

Execute

6. Here, the instruction is carried out. It might be one of the following:
   - Retrieve a piece of data from memory and store it in a register
   - Perform some operation on data that is already in a register; if this is a
   comparison, the ALU will carry out this part of the task
   - Store something currently in a register, perhaps that has been processe
7. The program counter, which indicates the location of the next instruction, is
instruction has been executed. *Now, the entire cycle begins again.*

The terms 'fetch-execute cycle' and 'fetch-decode-execute cycle' refer to the sa
is a 'decode' phase, whichever term is used.

Memory – a generic term which, when applied to computers, refers t
(including instructions) in immediate use. There are several types wit

Term	Definition
RAM	Random Access Memory. When a pro is loaded from a com instructions are loaded into RAM, wh is generally much smalle disk. When a comput is turned off or subject to a loss of powe This means th RAM is **volatile**. If a has more RAM, it will be able to run more applicati
ROM	d Only Memory. 'Read Only' means that the content cannot is not volatile). As such, ROM stores data or instructions that wil will typically store **bootstrapping** instructions, which tell the com and initialising the operating system when the computer is turne
Cache Memory	Cache memory stores copies of data or instructions from RAM th This means that these data or instructions can be accessed very q cache memory will usually be very small, measured in kilobytes o gigabytes (see 'Data Representation').

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Term	Definition
Register	Short-term storage for small, specific pieces of data, within the C store data just retrieved from memory; another would store the that data came.

Secondary storage – long-term storage in a computer system, necess volatile (loses its contents when powered down) and will also run out of backing store are **optical**, **magnetic** and **solid state**. All of these de numbers of '1's and '0's, but they do so in different ways.

Device	How it works
Optical	Ones and zeros are ...te... nd read using lasers. At many poin particular l... n might be smooth, or there might be a pit (a t mo... ...different capacities, and some of each type (but no **...D**: Approximately 700 MB, although there is some **DVD**: 4.7 GB **Blu-Ray**: 50 GB
Magnetic	The surface of a magnetic disk comprises billions or trillions (or are each either magnetised or not. A read–write head can read change them, but magnetic disks need to spin to the correct loc which takes time.
Solid state	**Solid state** storage devices (of which flash drives are one type) moving parts, to store data electronically. With no moving part sturdier and quieter than magnetic or optical devices. With Fla using two transistors. One either holds a charge or does not (0 can read the state of the first.

Cloud storage – this involves storage on remote computers, usually m When a file is saved or loaded, it is transmitted across the Internet, a often exist around the world. Cloud storage uses magnetic and, incre

+ With data stored remotely, and usually in multiple physical locations, it is less likely to be damaged by fire, etc. or misplaced + Capacity on your local machine is freed up, granting you more storage space	- Cloud storage often - The speed at which limited by your Inter days to access a larg

Embedded system – a computer t... ...within a larger mechanica microwave oven or a p... ...e. Embedded systems are used wh viable (as in a m... ...) or when they have only a single, specific pu

Examples o... ...dded systems are kitchen appliances (microwaves, washing m technology (...tches, fitness trackers) and subsystems of vehicles (entertainmen systems, climate control systems).

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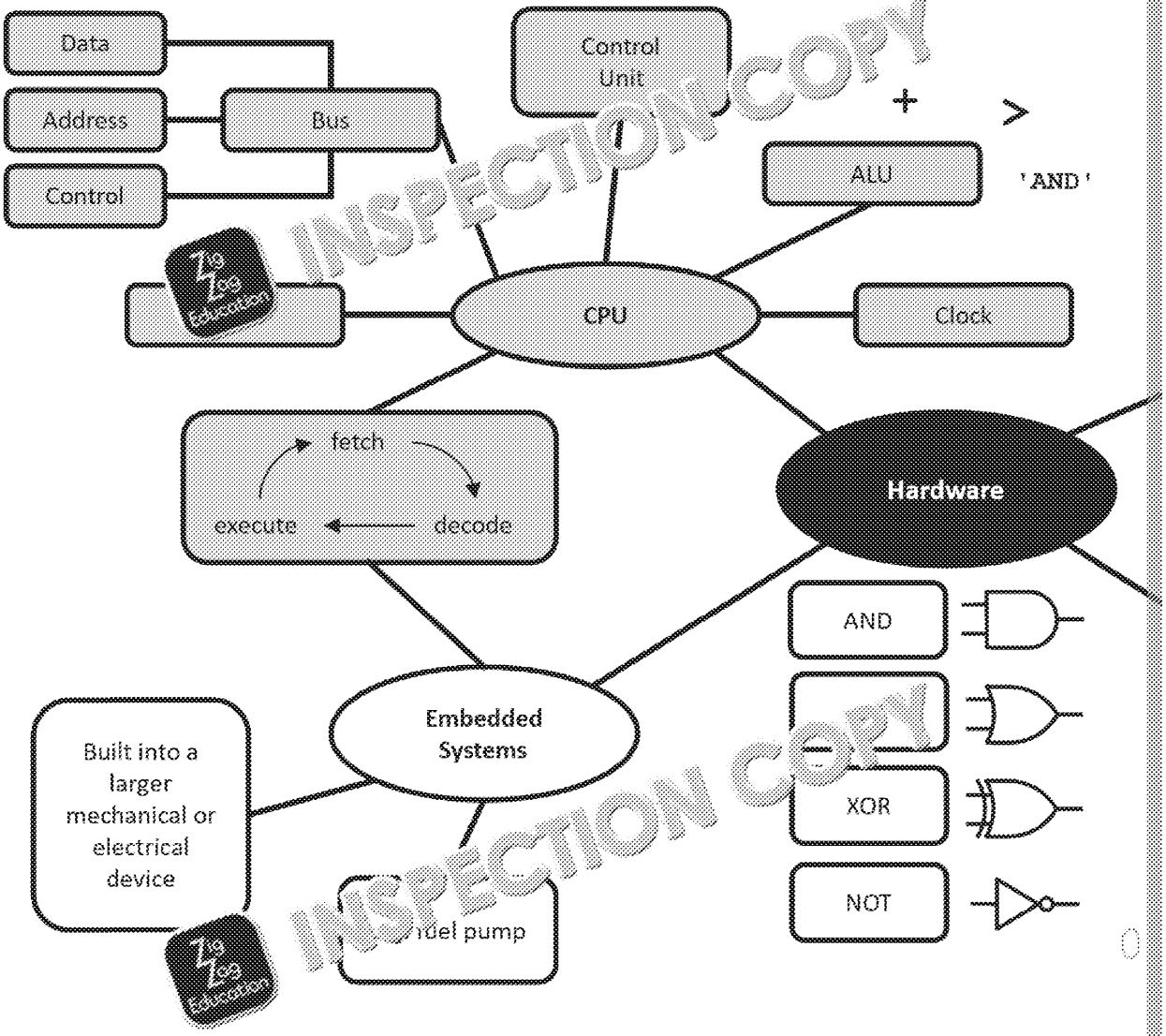
Computer Systems Mind Map (Hardware)



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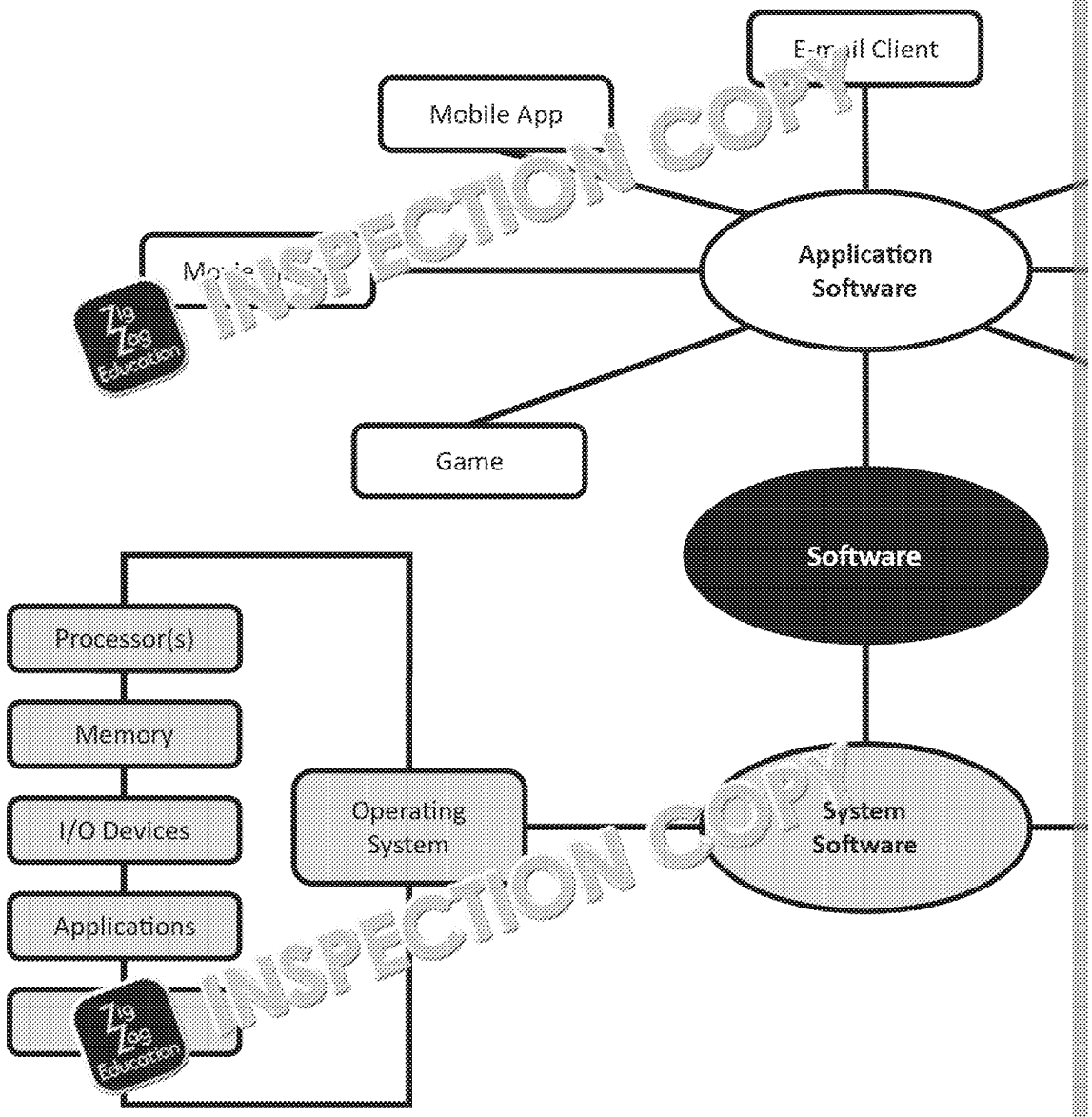
Computer Systems Mind Map (Software)



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11. A system that automatically waters a lawn will turn on sprinklers if **both** of t
    - The temperature is above 20 degrees Celsius
    - The lawn was last watered more than five days ago

    a. State the name of the logic operator that would apply between these c

    .....

    b. Draw the truth table for this logic operation. You can assume two inpu
    - Q is set to 1 if the temperature is above 20, otherwise it is set to
    - P is set to 1 if the lawn was last watered more than five days ago, o

12. Describe, with an example, what is meant by the term **embedded system**.

    .....

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    .....

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13. Describe how individual bits are stored within each of the following storage

Component	Description
Optical	
Magnetic	
Soli	

14. Describe in detail **three** functions of an operating system.

1. .....

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2. .....

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3. .....

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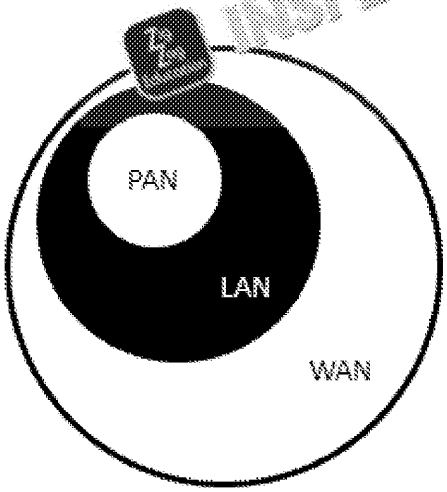
3.5. Fundamentals of Computer

Network – an interconnection of computers and other pieces of hard
communication and the sharing of resources.

+ Resources, such as printers, Internet connections and files can be shared, saving both money and effort	- Management of a ne can be quite expens
+ Communication can take place, via email or instant messaging	- Security procedures unauthorised access of computers
+ Backing up data to a different computer is far more straightforward	- etwork hardware, can be expensive

Types of Network

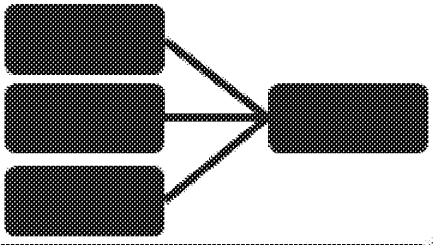
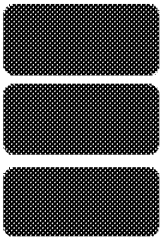


PAN – Personal Area Network. This
single user, connected via Bluetooth,
and headset.

LAN – Local Area Network. This is a
building or perhaps a campus. Usual
hardware that belongs to a LAN.

WAN – Wide Area Network. This wo
geographic area, with shared owners
telecommunications company might
Internet is the largest example of a W

Networks can be either **wired** or **wireless**:

Wired	
	
+ More secure, as a physical connec ed, so a hacker would need to uilding + Less prone to int	+ Much easier to ac + No requirement t

Wireless	adio waves
Wired	**Optical fibre** can be used for very fast connections, or if lots of single connection. **Copper** cabling is cheaper and slower, although it is quick enou single computer would perform online.

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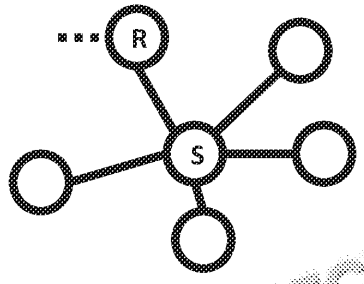
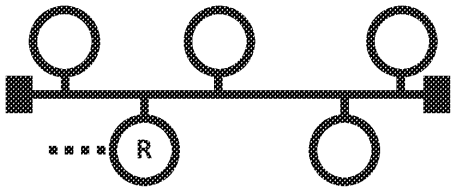
Topologies

Network topology – the pattern in which the hardware on a network connections. Common topologies include star and bus.

Topology	Explanat
 R = router (connection to another network) S = switch	**Star** Every device is connected to a switch communication travels via this switch + Very few data collisions, since each the switch + Strong, centralised security - Lots of cabling needed - If the switch has no spare ports, ad be difficult
	**Bus** A central cable, called the **backbone**, **terminators** (black rectangles), conne + Uses relatively little cable, making + Additional devices can be easily ad - Collisions can occur, as multiple tra the shared backbone - If a large number of devices are co can be slow (due to collisions) - If the backbone is cut, no signals ca network is no longer fully connecte

Network Protocols

Protocol – a set of rules that governs how a computer communicates many protocols, each necessary for a different purpose (email, access etc.). Without protocols, communication between computers would

- **Ethernet** - (a family of protocols rather than a single protocol). This is a set formatted for transmission across a local area network.
- **Wi-Fi** - these letters actually aren't short for anything but are a brand name transmitted on a wireless local area network (WLAN).
- **TCP/IP** - These are two protocols that often work together – *Transfer Contro* Their collective role is to break up data into packets, each of which is a chun been sent from and where it is to be delivered to.
- **UDP** – *User Datagram Protocol*. This protocol transmits data packets very q see whether it has arrived, so it is not always reliable.
- **HTTP** - *HyperText Transfer Protocol*. This is the set of rules governing how h worldwide web) is moved around the Internet, from device to device.
- **HTTPS** - *HTTP Secure*. This protocol encrypts data that is sent across the Int read if intercepted, so is favoured when sending passwords or credit card n
- **FTP** - *File Transfer Protocol*. This is how files are moved from one computer This protocol is heavily relied upon in building websites, moving files from t server, from where they can be accessed publicly.
- **SMTP** - *Simple Mail Transfer Protocol*. This is used to forward emails from c
- **IMAP** - *Internet Message Access Protocol*. This email protocol is used to allo tablets, phones, etc.) to access the same email account.

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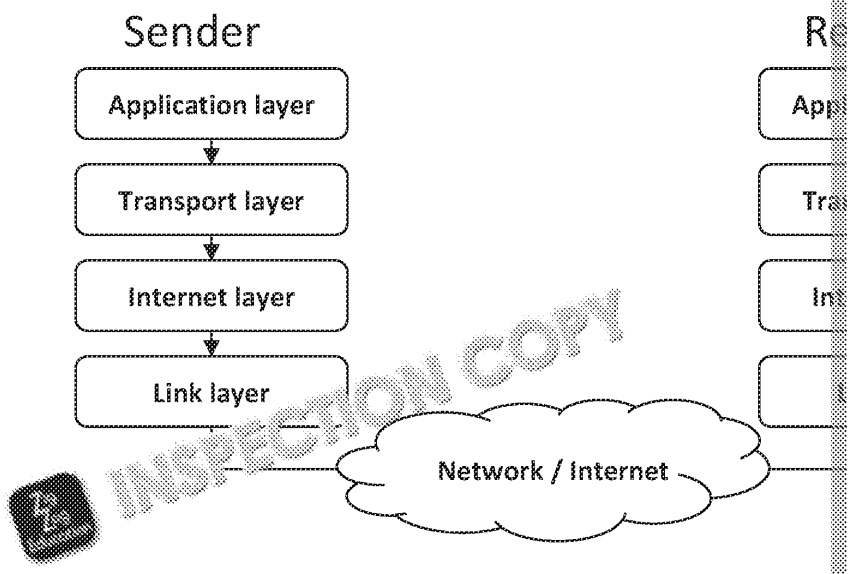
Network Security

With more data being shared, more data is falling into the wrong hands. Organis
professionals to keep data secure, as data breaches can damage an organisation
Even an individual can lose out financially if their credit card details are stolen.

Authentication	Measures to make sure that a person trying to acces This can take place by way of: • Usernames and passwords • Memorable information, such as their mother's m • Checking that they are using a recognised IP add
Encryption	Scrambling data using a k[illegible]en[illegible]ure that it makes n intercepts it. Whe[illegible] is received, the recipient also h decrypt the data, returning it to its readable form.
Fi[illegible]	[illegible] can be either hardware, software or both. A fi certain traffic (such as all emails or any traffic from a allow certain traffic (such as from a single, trusted de
MAC address filtering	Each computer has a MAC (media access control) ad address, cannot be changed. Based on this unique id either permitted onto, or blocked from, a network.

TCP/IP stack – a series of protocols. When they work together, they
computer, through any number of pieces of network hardware, to an
stack is a *concept*, not a physical thing.

This stack has four layers, each containing a number of protocols. When data is
down and repackage the data into smaller units, before passing the data to the l
received, those units are reassembled as they move up the stack.



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Layer	Description
Application layer	Where network applications, including browsers and e applications, operate.
Transport layer	Establishes communication between the sender and th recipient, agreeing on how communication will take pla
Internet layer	Packages data for transmission, by breaking it into unit **packets**, which are sent across the network.
Link layer	The physical components of the computer, such as the network interface card, operate at this level.

Note that some resources, particularly if they are not AQA-specific, might use sli layers. In an AQA exam, you should use the terms in the table above.

There are benefits to developing systems using this model:

- Different developers can be assigned to different aspects of a system
- Part of a system can be removed and altered without affecting the rest of

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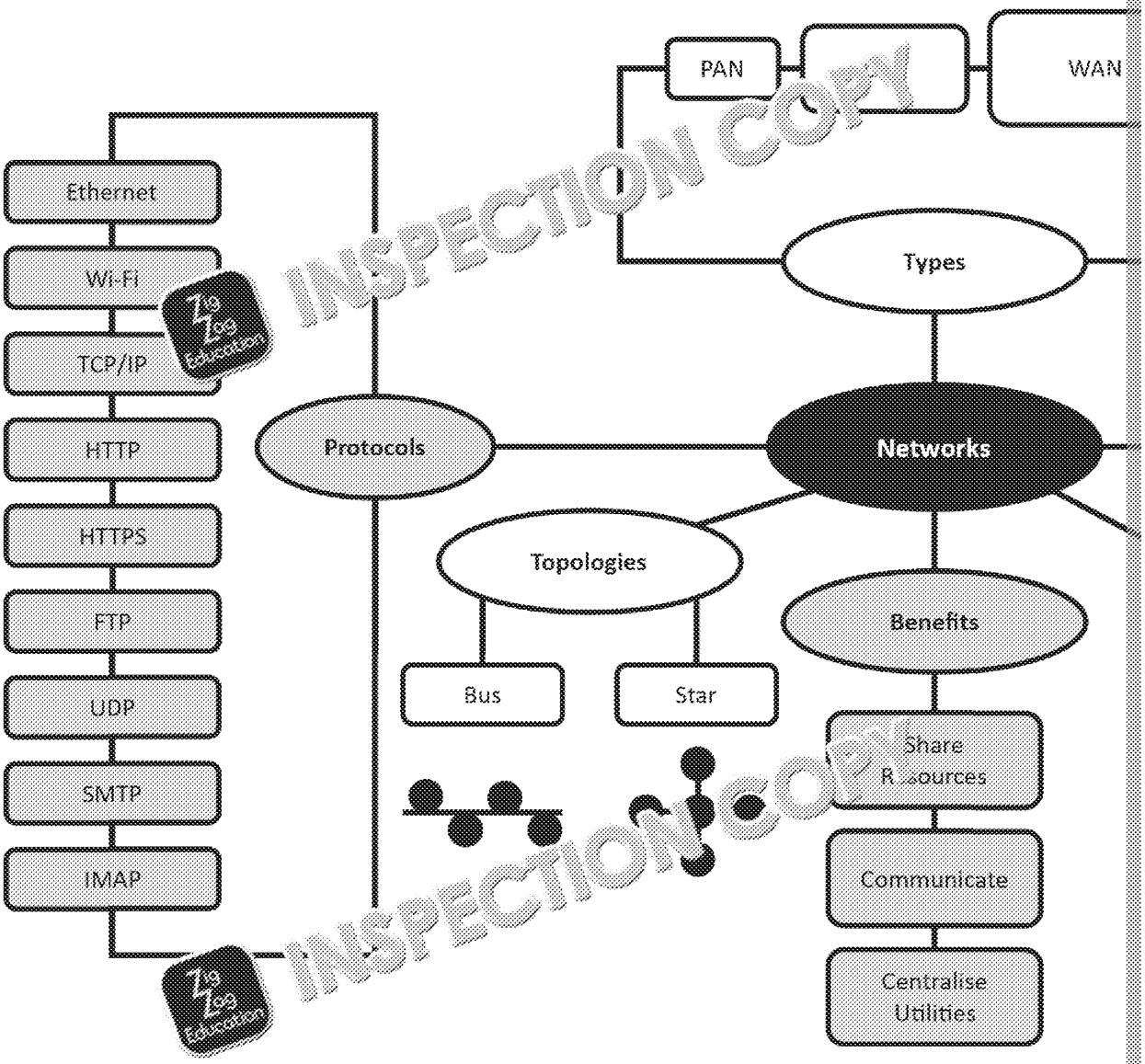
Fundamentals of Computer Networks Mind Map



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15. a. Define the term **protocol**.

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b. Describe **two** different protocols that govern the functioning of email.

1. .....

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2. .....

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.....

16. Describe **three** advantages of a networked computer over a standalone com

1. .....

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2. .....

.....

3. .....

.....

17. Place **one tick in each column** to indicate a pr[illegible]at operates at each la

	[illegible]otocol	File Transfer Protocol
Applicat[illegible] L[illegible]	[ ]	[ ]
Trans[illegible]yer	[ ]	[ ]
Internet Layer	[ ]	[ ]
Link Layer	[ ]	[ ]

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3.6. Cyber Security

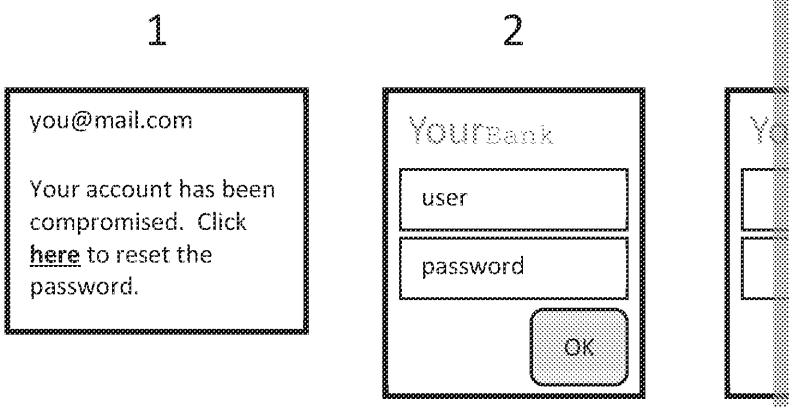
3.6.1. Fundamentals of Cyber Security

Cyber security – a series of processes, practices and technologies tha
software and data from attack, damage, or unauthorised access.

3.6.2. Cyber Security Threats

Social engineering – forms of cyberattack that focus on people, rathe
the weak point in any system. There are different ways to manipulate
confidential information.

- **Pretexting** involves fabricating a scenario in order to gain unaut
A perso pretend to be from IT support in order to persuade an empl
their password
- **Shoulder surfing** or **shouldering** is simply watching, over someone's should
or PIN
- **Phishing** uses emails or SMS messaging to lure people to convincing but fake
logging in, but they're really transmitting their login details to an unknown pe



1. The victim receives an email with a hyperlink. The email tells the user
hyperlink, often saying that their security has been compromised in or
2. They will be taken to a screen that asks them to enter personal informa
identical to a screen with which they are famili
3. When they have entered the informatio , they are usually forwarded t
meantime, the information the entered has been forwarded to a hack

Malicious software (malware) – any program that works against the inte
. Trojans, adware and spyware are types of malware, although

- **Computer viruses** are self-replicating pieces of code that can damage data
spread via email attachments or removable media such as USB flash drives.
- **Trojans** or **Trojan horses** are legitimate programs developed with the intent
within. Since they are largely legitimate, they are often not recognised as m
- **Spyware** covertly obtains sensitive data, such as credit card numbers and pa
to a hacker across the Internet.

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Weak passwords – passwords that are easy to guess. $tR0nG p@S$v
upper-case and lower-case letters as well as numbers and symbols. S
longer than weak passwords. Similarly, **default passwords** can be a p
might not change the password from 'admin' or 'password' when the
network vulnerable.

Pharming – redirecting users to an unsafe site. They might type in th
bank, and be taken to a website that looks very much like their bank's
then collect the user's login credentials.

Misconfigured access rights – access right[illegible]s that tell a compu
have access to which files and other resources. If these access rights
employees and other users could access data that they should not be

[illegible]at [illegible]media – any storage device that is highly portable can ea
introduce malware onto a system.

Unpatched software – when a security risk is identified in a program,
patch, which is an add-on program that fixes the security risk. If a use
their computer is not secure.

Threats will often exist in combination. A username acquired via phishing could
weak, easy-to-guess password to introduce a virus that specifically seeks out unp

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3.6.3. Methods to Detect and Prevent Cyber Security Thr

Biometric measures	Using some part of a person's biology to access a system inste • Mobile phones and tablets that unlock on scanning a • Doors that unlock when a person's iris or retina is sca • Voice recognition • Face recognition
Password systems	Automated procedures that ensure that sound password p • $tR0ng p@s$worD$ that include many different chara minimum number of characters • Passwords that must be ch d on a regular basis Users that try not to a re to the policies are simply not a they do.
CAPT	B e is presented to the reader, which is easy for a hu computer. This technology is used to ensure that a human i computer program trying to guess a password at a rate of m
Email confirmation	Often, when a password is changed, a user must verify this c to a registered email address. This can prevent third parties
Automatic software updates	When a new version of software is released, which might h a computer can be configured to automatically download t
Penetration Testing	Someone tries to hack into a system, but as an employee o owner. Their aim is not to steal or corrupt data, but to ide can be resolved.

If a person is conducting penetration without the consent or knowledge of the system, that person is more likely to be a threat than a defence.

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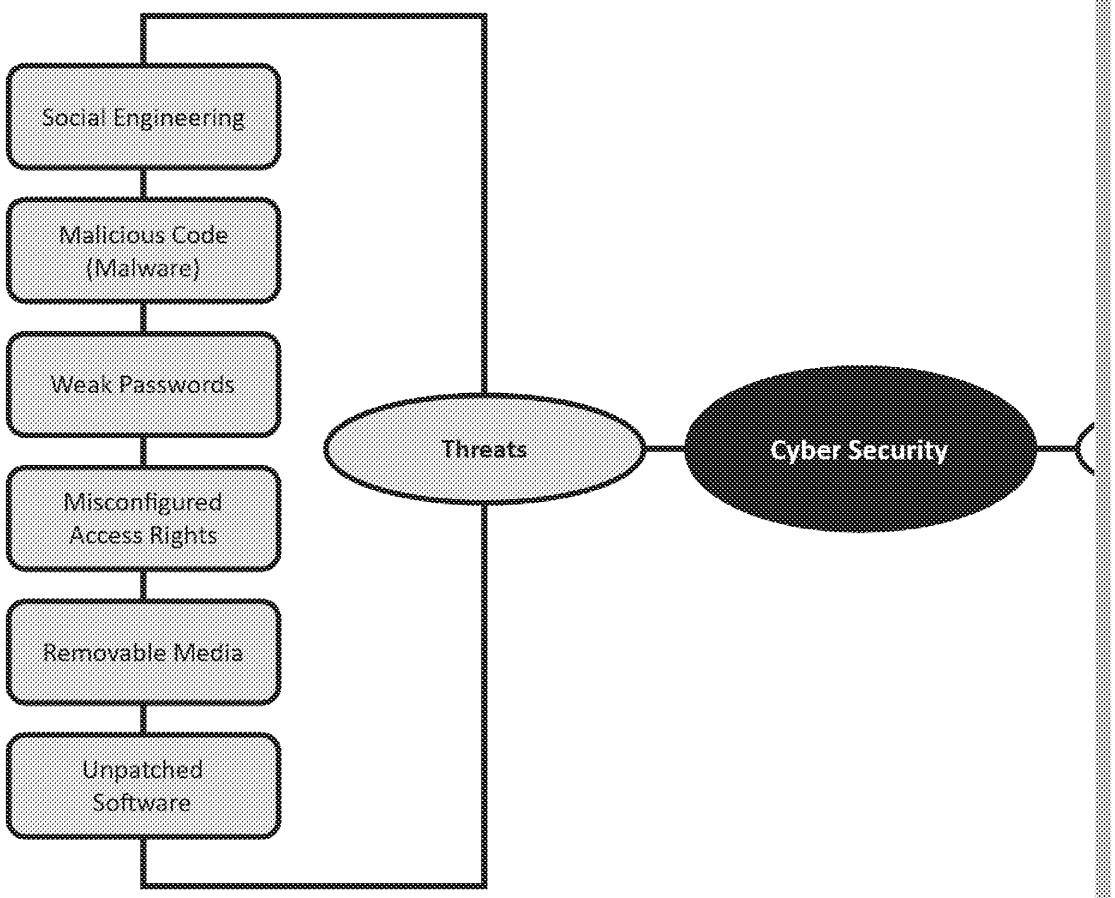
Cyber Security Mind Map



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18. The NHS stores a large amount of confidential data about patients. This dat
healthcare facilities across the country, so it is available online. Security is i
to enter a password in order to view any of the data.

State three cyber security threats that could apply to this data, and describe
measure to counter **each** threat.

Threat and countermeasure 1

.....

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.....

Threat and countermeasure 2

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Threat and countermeasure 3

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19. a. Define the term **social engineering**.

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b. State **two** examples of social engineering.

i. .....

ii. .....

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3.7. Relational Databases an

3.7.1. Relational Databases

Database – a collection of related data items stored systematically in
of several key elements, some of which are described below.

The **table** below stores data relating to video games.

Stock No	Title	No in Stock	Supplier No
A00123	Frostpunk	17	X01
A00124	Stardew Valley	12	X02
A00125	XCOM 2	1	X03
A00126	W[illegible]ine	7	X04

Within this table there are four **records**. A record is one instance of something.
games, each record consists of everything we know about **one** video game. Ever
(its stock number, title, number in stock and supplier number) is one record. Eve
Valley is another record.

There are also four **fields**, namely *Stock No*, *Title*, *No in Stock*, and *Supplier No*. A
piece of information about each record. Each field has a **data type**, which corres
programming. Data can be numeric, text-based, or date/time, among others.

One field, *Stock No*, is the **primary key**. This is the field that uniquely identifies e
identified by the stock number A00124. Since this is the primary key, no other re
same stock number.

Relational database – database in which data is organised into multip
an entity, which could be anything about which we need to store data
Links between these tables, called **relationships**, allow for quick retrie
data. Relational databases allow for the elimination of **data inconsist**
other data) and **data redundancy** (the same data stored more than o

Tables can also contain one or more **foreign keys**. A foreign key is a field. It is a
which is used to create relationships. In our table, *Supplier No* is a foreign key, a
primary key in some other table:

Supplier No	Supplier Name	Supplier Phone
X01	11 Bit Studios	(1111)
X02	Concer[illegible]e	(2222)
X03	[illegible] Games	(3333)

As this would be a relational database, we could extract data from both tables to
have a total of 24 games in stock, or that we should call (3333) to order more co

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3.7.2. Structured Query Language (SQL)

SQL – Structure Query Language is used to view and manipulate the c
well as to create and remove tables.

All SQL commands in this chapter relate to the following database table, which is

StudentID	LastName	MathsScore
S123	Evans	87
T456	Green	62

The fields *StudentID* and *LastName* are c a format, while *MathsScore* and *E*
does not distinguish between i ger and real numbers, and treats them in the

SQL statement	
`SELECT * FROM student`	Reads everything from the unchanged. The * symbo is the name of the table.
`SELECT * FROM student ORDER BY LastName ASC`	This would read everythin results in ascending alpha *LastName*. If we were to would still work, as this is
`SELECT * FROM student ORDER BY MathsScore DESC`	This would read everythin order based on *MathsSco*
`SELECT MathsScore FROM student`	Reads the named field, *M* ignoring other fields. This average score, where othe
`SELECT LastName FROM student WHERE MathsScore > 80`	Reads the last names from have a score above 80.
`SELECT MathsScore FROM student WHERE StudentID = "T456"`	Reads the *MathsScore* of 'T456'. Notice how text (T marks but numbers (80, in
`INSERT INTO student (StudentID, LastName, MathsScore) VALUES ("U789", "Jones", 50)`	Create a new record. The the fields, and the second da be entered into th N that this would leave new record.
`UPDATE student SET MathsScore = 88, EnglishScore = 75 WHERE StudentID = "S123"`	Edit one or more existing *StudentID* or S123 will hav and their *EnglishScore* set
`DELETE from student WHERE StudentID = "T456"`	Delete any records with a that's just one student. In delete no records, one rec
`DELETE from student`	Without the WHERE claus from the table, but the ta

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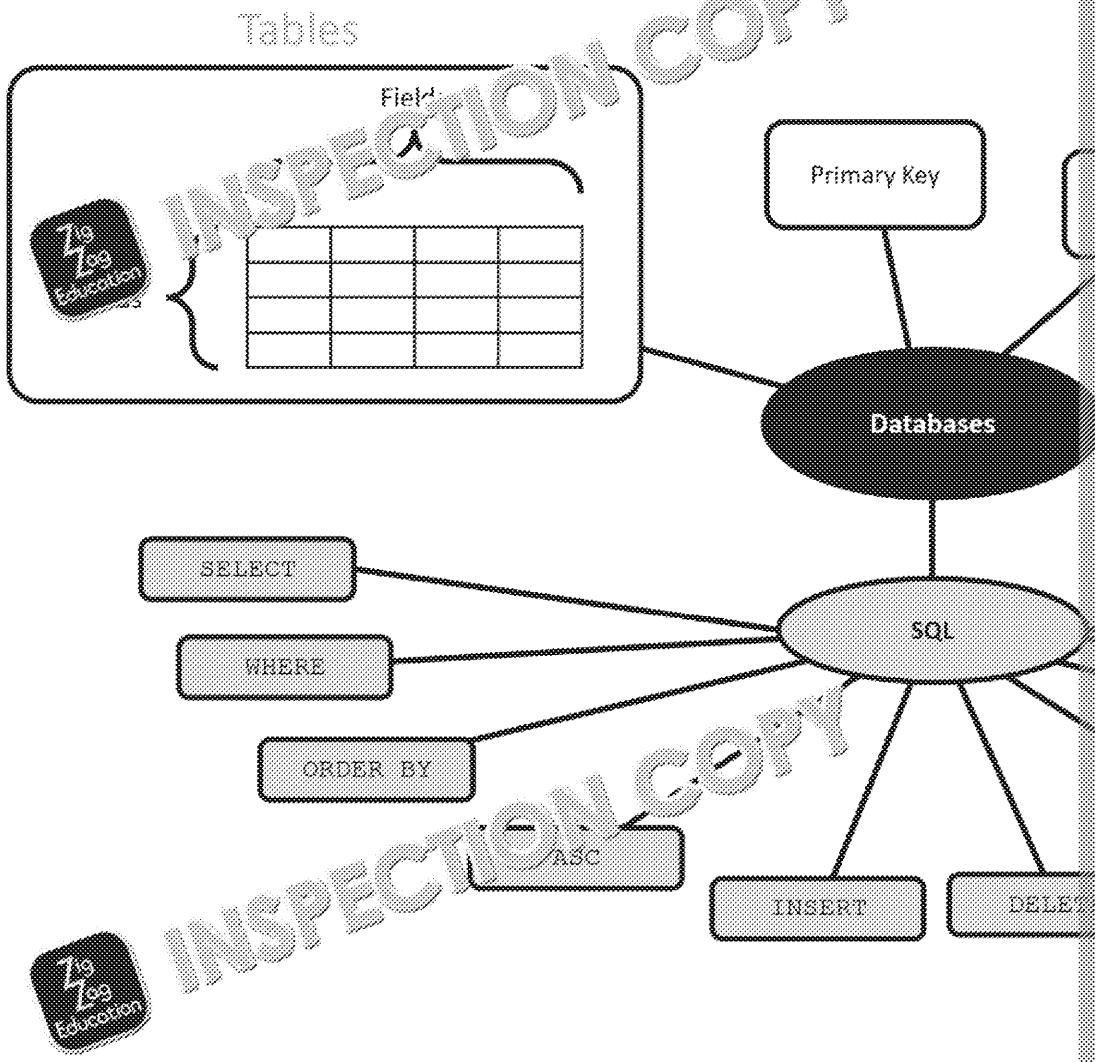
Databases Mind Map



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20. A database is used to monitor the attendance and punctuality figure of stud
records of the **performance** table are displayed below:

Student_ID	Last_Name	First_Name	Gender	Attend
P1	Adams	Megan	F	
P2	Ali	Raza	M	
P3	Jones	Timothy	M	
P4	Smith	Sam		
P5	Williams		F	

Write SQL comma[illegible] carry out the following operations:

a. Re[illegible]the student ID and attendance for all students

.....

b. Remove student *P3* from the database completely

.....

c. Adjust student *P1*'s punctuality value from *96* to *95*

.....

d. Create a new record with Student_ID of *P6*, Last_Name of *Smith*, and a

.....

e. Retrieve all student data for students with attendance below *90*

.....

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3.8. Ethical, Legal and Environmen

Ethics – this term refers to what is right and what is wrong, although straightforward that they have a single 'right' answer. Often what is for society as a whole, and vice-versa.

Topics	Issues
Privacy	• People expect to go online and find out everything abo expression), but they might prefer to keep some eleme lives (expectation of privacy), especially from the gover the other hand, argues that needs access to personal terrorist th • On ... ing is shared online, particularly in the wo ... ossible to delete it completely • Through social media, people unwittingly share details attended by their children, where they go in the evenin
Inclusion	• Among some groups, especially those of school age, th around not having the latest technology • Not everyone in the country has access to the Internet, access to information, to job listings or to a society that • Government could commit money to solving this inequ would be spending money unequally. This is an instanc 'right' answer.
Professionalism	• There is increasingly an expectation of people to be ava outside of working hours; this is a direct impact of tech • Although you can apply for jobs internationally, employ making the process far more competitive • Social media can be seen by anyone, including prospect between private and professional life.
Artificial Intelligence	• Driverless cars are now a real possibility, but it might be occupant or its programmer would be to blame in the e • Computers can read CVs to filter out certain types of jo might be people from particular postcode areas or ethn unscrupulous developer decides upon this

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Legal – this term refers to what is lawful and what is not. Laws are w
the normal functioning of a society, but it can be difficult to write a la
that either doesn't exist yet, or is constantly changing. Applicable law

Copyright, Designs and Patents Act (1988)

This law protects **intellectual property**, meaning it is a criminal offence to copy
permission of the owner of the **intellectual property rights**. Different types of

- Copyright applies to anything that can be written (such as web pages, boo
well as images. Once something has been written, copyright exists immed
apply for it.
- A registered design (applicable to computer [illegible] would apply to logos
suggests, such images need to be [illegible] and they need to have been
- Patents can be used to protect [illegible]ions. This would apply to a piece of
new method of p[illegible]g, but not to program code.

Computer Misuse Act (1990)

This law makes hacking a criminal offence. The following activities are recognis

- Accessing material on a computer that you are not authorised to access (f
system using someone else's credentials)
- Modifying material on a computer that you are not authorised to modify.
you are allowed to access the data

Data Protection Act (2018)

This law applies to personal data of living individuals. If an organisation stores
individuals, that data must be...

- processed fairly and lawfully
- adequate, relevant and not excessive
- not kept for longer than necessary
- held for specified
- kept up to date,
- kept secure

A **data subject** (a person about whom data is stored) has rights under this law:

- They should be informed about how their data is used
- They should be able to access their own personal data
- They have the right to have inaccurate data corrected
- They can have data erased, and processing stopped or restricted

Freedom of Information Act (2000)

This law gives members of the public the right to access information under the

- The information must relate to either a public body (l[illegible]al council, governm
or an organisation that provides a service to a public body
- Providing the data would not caus[illegible]he law (probably the Data Protec

You are n[illegible]ir[illegible] have knowledge of specific laws. It is much more impo
the legal p[illegible]s than the laws themselves.

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Environment – a broad term with several meanings relating to the ph
Global air pollution is an environmental issue, but so is the distance b
where you work.

Health Issues	
+ Proliferation of health-tracking apps allow people to monitor exercise and calorie intake – people are better informed	- An increase in co increase in seden
+ Medical technology is continually advancing in predicting and diagnosing illness	- Some people are media, and they c
+ Sharing of health-related data across the Int et helps research.	- Technology mean from work, increa

Energy Use	
+ Comp ec can be used to reduce cons of fossil fuels; they can turn off lights mpty offices and cause cars to run more fuel economically	- Computers, table all consume elect
+ Smart meters allow people to track and control their use of electricity and gas at home and at work	- The manufacture requires electricit
+ People can work from home more, so they commute less.	- Many devices tha unseen, including cloud storage and

Resources	
+ In theory at least, less paper needs to be used, so fewer trees should be cut down	- In reality, people may not really be
+ Some products, such as books and music, can be delivered electronically, with no physical transport needed	- Computers requi production, such supply and have t
+ One delivery driver, delivering ten Internet-ordered products on a single delivery run, requires less fuel than ten people each driving to a shop for one item.	- Not all obsolete t of it ends its life,

All of the bullet points in this chapter are just the beginnings of arguments. Be
two conflicting ideas against each other to see which ar ries the most weig

Exam questions on this are require you to draw together an understandin
ethical, **legal** and en al impacts in a single answer. While you are exp
understan f t areas mentioned in the table below, you are also expecte
particular relevant. You might be asked about, say, wireless networking
expected to recognise that unauthorised access or invasion of privacy are relev
these bullet points are starting points – not whole answers.

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Cyber security	• A government cyber security policy may actually w grants them access to personal data • A company may be held liable if they do not prote access; they can be sued for a data breach • The issue of cyber security overlaps with many oth mobile technologies, wireless networking and clou
Mobile technologies	• The amount that your phone knows about you, in etc. might already be a breach of privacy • Constant replacement of mobile phones, and their impact on the environment • Illegal copies of mp3s are co[illegible]only found on peo
Wireless networking	• Easier access for unauthorised users than in a wire • Wireless networking is better in terms of the environ cables and network hardware is concerned • Privacy can be breached as others might access pe
Cloud storage	• Other people may gain access to your data when s • Providers must adhere to the Data Protection Act • Fewer, more centralised data stores are better for reduce transport costs associated with distribution
Hacking	• Unauthorised access potentially breaches people's • It's possible that data obtained as a result of hacki interest. Is breaking this law for 'the greater good • Hacking often results in additional crimes, such as
Wearable technologies / Computer based implants	• Wearable technologies carry the same ethical, lega mobile technologies (see above) • Implants carry the additional complication of repla straightforward as simply buying a new one • Looking to the future, an implant may be a potent could contain biometric data, information about il device could be dangerous
Autonomous vehicles	• In the event of a collision, who bears legal respons wouldn't be one in a truly autonomous vehicle), th or the programmer who wrote the code? • Split-second decisions can be deliberated on slowl into code. Who should make the decision as to wh control, should safeguard the lives of its occupants • An advantage of autonomous vehicles is that they another, thus plan their acceleration and braking potentially reduce carbon emissions.

These issues are not straightforward, and there are often multiple viewpoints, a You'll get more credit for exploring the issue in detail than arriving at a clear an possible t[illegible]'ll be able to do both).

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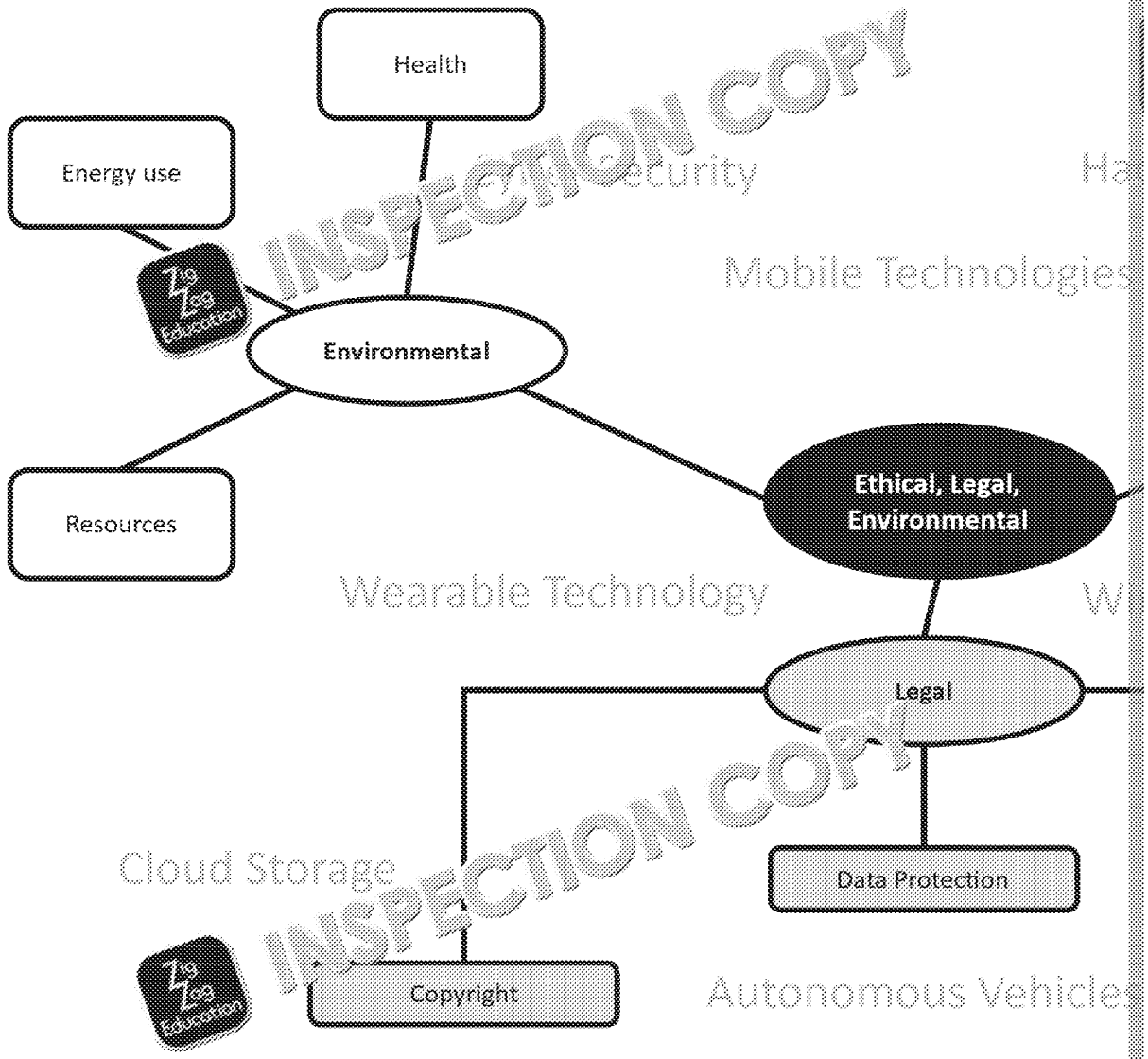
Ethical, Legal and Environmental Mind Map



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Security
Mobile Technologies
Wearable Technology
Cloud Storage
Autonomous Vehicle

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21. In recent years, there has been a dramatic increase in the number of people
Discuss the benefits and drawbacks of the widespread use of mobile phone

In your answer, you should consider any legal, ethical and environmental iss
widespread use of mobile phone technology.

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Sample Answers

3.1. Fundamentals of Algorithms

1. An algorithm is a series of instructions that describes how to solve a specific

> As you've seen by this point, this guide is full of definitions. It is highly like definitions will be required in the exam, although it's impossible to determine w assuming you have revised well, are the easiest marks available. One way to flash cards, with the word on one side and its definition on the other. Making t own, and it's easy for others to help you to study by testing you on the definitio

2. Terminator Process Decision

3. Pairs of numbers are co ed (first with second, second with third, third w being switched if they are not in order. Once all pairs have been compared, passes occu until either n-1 passes have occurred, or an entire pass occ being s d.

> This explanation is fairly complex. In circumstances like this, you might find written answer with a diagram. While it probably wouldn't be worth any mar clarify any points that you haven't worded as well as you would have liked.

3.2. Programming

4. a. i. total
   ii. keeps a running total
   iii. +
   iv. >
   v. WHILE

   b. They would need to input a value of '-1' or less.

> The best way to prepare for questions like this one is to write code – lots a program, you should make an effort to understand every part of every line simply having a program that works; make sure you can understand *why* it wor any lines of code that you don't understand.

5.

Data	Integer	Real	B
Money in account		✓	
Account holder's name			
Number of whole years the account has been active	✓		
Account holder's pos			
Whet n overdraft is permitted			
A sing r code that identifies the account type			

6.
```
highCount = 0
for x in data:
  if x > 5:
    highCount += 1
print(highCount)
```

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3.3. Fundamentals of Data Representation

7. a. 128 + 16 + 8 + 2 + 1 = **155**
   b. 1001 = 9; 1011 = B; **9B**

> **i** You will probably be asked to convert between binary, denary and hexa
> the end of the exam, if you have time, a good way to check your answers is to
> reverse. Did you convert a binary number to hexadecimal? Convert it back to
> result of this conversion matches the question.

8. a. 01100000
   b. Number is multiplied by four.
   c. Overflow would occur. There are not enough bits in this number to sto

9. a. A collection of every possible letter, number, symbol, etc. available to a
   b. 77

10. a. i. The number of different colours possible within a particular image
    ii.

    b. 640 * 480 = 307,200 bytes
    307,200 / 1,000 = **307.2 kilobytes**

> **i** When you try exam questions that require calculations, make sure you sho
> only is it a comprehensive attempt at every single mark, it increases the likeliho
> marks, even if your calculations contain an error.

3.4. Computer Systems

11. a. AND
    b.

Q	P	Output
0	0	0
0	1	0
1	0	0
1	1	1

12. An embedded system is a computer that forms part of a larger electrical or
    include microwaves and petrol pumps.

13.

Component	Description
Optical	'1's and '0's are represented by pits being burned locations on a disc
Magnetic	'1's and '0's are represented by magnetising indiv which can be either North-aligned or South-align
State	Transistors can either hold a charge or not hold a either a '1' or a '0'

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14. One role is the management of hardware. The operating system is respons
and output devices, which it can only do if the correct drivers are installed.
processes. When lots of tasks require the processor's attention, it is the job
prioritise and decide the order in which they should be executed. A third ro
An operating system allows the user to add, delete or edit files, and also de
where each file is to be stored.

Questions that begin with the term 'describe in detail' need to be address
questions. With these questions, the mark schemes usually give the examiners s
which points are worth a mark. The alternative, listing every possible answer c
impractical. This counts in your favour, but it doesn't do any harm to aim for m
Where there's a 6-mark 'describe-in-detail' question, aim for 9 marks.

3.5. Fundamentals of Computer Networks

15. a. A protocol is a set of rules governing how one device communicates wi

b. S[illegible]imple Mail Transfer Protocol. This is used to forward emails f
– [illegible]t Message Access Protocol. This allows email messages to be
accessing the same email account.

16. Networked computers can share resources such as printers
Networked computers can communicate with one another using email or in
Networked computers can centralise backing up, making data loss access m

This was a 3-mark question, so three pieces of information are required.
each mark is coming from, you should address each mark separately. Since the
three distinct points, three distinct sentences are the best way to present your a

17.

	Internet Protocol	File Transfer Protocol
Application Layer		✓
Transport Layer		
Internet Layer	✓	
Link Layer		

3.6. Cyber Security

18. People can read staff members' passwords over their shoulders. This can b
passwords, using a range of different charact[illegible]p[illegible]which are more diffic

Data can be intercepted as it [illegible]s[illegible]ted between devices. Encryption ca
scrambling data so t[illegible]n[illegible]akes sense when accessed on the intended

Malwa[illegible]t be installed on a system, which could steal or corrupt patien
malware software is installed and kept up-to-date is a means of countering

Again, the origin of each mark is easy to identify. Each paragraph is an
paragraph needs to make two distinct points. Within each paragraph, the firs
problem (first mark) and the second sentence describes the solution (second ma

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19. a. Social engineering is the act of manipulating people in order to extract
    b. One example is phishing, another is shouldering.

The keyword 'state' means only minimal information is required. In 'state' phrase will be enough to get you the mark.

3.7. Relational Databases and Structured Query Language (SQ

20. a. `SELECT Student_ID, Attendance FROM performance`
    b. `DELETE FROM performance WHERE Student_ID = 'P3'`
    c. `UPDATE performance SET punctuality = 95 WHERE Stu`
    d. `INSERT INTO performance (Student_ID, Last_Name) V`
    e. `SELECT * FROM performance WHERE Attendance < 90`

3.8. Ethical, Legal and Environmental Impacts

21. The main benefit is that more people are now able to communicate with social [illegible] communication is possible between countries, and people hav inform[illegible] the Internet wherever they go. There are also benefits to sa be for a person who is in danger to seek help. While some may question the new and improved mobile phones, whenever someone gets a new phone, s their old phone from them. This increases the number of people who have safety benefits.

    However, there are some negative points. Mobile phones make it much eas privacy at risk, since photos and personal information shared on social medi completely remove from the Internet. There is also an ethical issue of equa advanced mobile phones become, the more people who do not have access environment also takes a hit, since the materials needed to construct mobil when they are no longer needed, require mining.

There will probably be one question like this, which will be worth a large which depend on good-quality written communication. The question is most like environmental issues.

There are some guidelines you can follow for such questions:

- Plan your answer, rather than jumping straight in. The model answer above for each side of the discussion, and each paragraph makes several points.
- Know your subject – it is unlikely that you will score highly on a topic you ha written your answer is.
- Read/watch the news – this question is likely to be quite current, and being developments might give you more to write about.
- Provide examples to support any points you ma[illegible] a[illegible]ples above include satellite navigation).
- Proofread your finished answer. A s[illegible]spelling error (or even a hurriedly clearly be made out) could cost a mark, and that mark could put you on the grade boundary.

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Glossary

Term	Definition
Abstraction	The practice of hiding layers of complexity within a problem specific aspect.
Algorithm	A series of instructions to solve a problem.
Analogue	Signals that are continuously variable, i.e. the midpoint between how close together, can be represented.
Application software	Programs launched by the operating system to allow the user
Arithmetic Logic Unit	A component of the CPU that performs calculations and comparisons
Arithmetic operation	Performs a numeric operation, such as addition or multiplication
Array	A data type in which multiple data items of the same type are
Artificial intelligence	The branch of computing where technology attempts to perform tasks that normally require human intelligence.
ASCII	A character set consisting of 128 characters.
Assignment	The practice of providing a value to a variable.
Authentication	The process of ensuring that a user of a system is who they say they are.
Binary	A number system comprising two symbols: 0, 1.
Binary search	A search algorithm that begins in the middle of a sorted data set, comparing the data items with each item that it examines.
Binary shift	Moving the digits of a binary number to the left (to multiply) or right (to divide by two).
Biometric	Any piece of data obtained from a person's physiology, such as a fingerprint or retina scan.
Bit	The smallest unit of binary data – a binary digit – which can be 0 or 1.
Boolean	A data type that can store one of two values – true or false.
Boolean logic	Determining whether an output is true or false, based on Boolean operators such as AND, OR, NOT.
Boolean operator	Used upon Boolean values (true or false) to produce other Boolean values. Include AND, OR, NOT.
Boundary data	Test data that represents the highest or lowest permissible values.
Bubble sort	A sorting algorithm that works by repeatedly comparing pairs of items and swapping positions as necessary.
Bus	A connection between computer components, along which data is transmitted.
Byte	A sequence of eight bits.
Cache	Memory with shorter response times than RAM, so used to store frequently or recently used data or instructions.
Calling	The process of telling a subprogram to take place from elsewhere in the program.

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Term	Definition
CAPTCHA	An image of distorted text, readable to humans, but difficu intended to ensure that a human being is using an applicat
Casting	The process of converting data of one type to be stored in
Central Processing Unit (CPU)	A computer component that performs calculations and cor interpreting and executing instructions.
Character	Either a single letter (upper or lower case), a single numera invisible character (such as a tab or space). Most keyboard
Character set	All of the characters available w a particular system, e individual code.
Clock	A compone of the CPU that synchronises activities.
Cloud storage	that takes place remotely, on some managed comp
Colour	The number of distinct colours available (though not neces
Comment	A plain English line (or multiple lines) added to program co computer but is useful to other programmers.
Compiler	A translator that translates an entire program before runni
Compression	The process by which a file is made smaller in order to be s more efficiently.
Computer Misuse Act	A law that makes unauthorised access of a computer syste
Condition-controlled iteration	A program structure in which a section of code repeats unt
Constant	A named location in memory capable of storing a single da change during program execution.
Control Unit	A component of the CPU that coordinates the activity of ot
Copyright, Designs and Patents Act	A law that provides protection for intellectual property, su
Core	A processing unit with a control unit, arithmetic logic unit, of multiple cores.
Count-controlled iteration	A program structure in which a section of code repeats a c
Data Protection Act	A la erms how personal information is stored and
Datab	A collection of related data items stored systematically in a
Decimal	A number system comprising 10 symbols: 0, 1, 2, 3, 4, 5, 6,
Decomposition	The practice of taking a larger problem and dividing it into smaller problems.
Defragmentation	Reordering the contents of a disk so that a file is stored, as location, rather than in pieces across the disk.
Digital	Signals that are comprised of only 1s and 0s, with nothing i

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Term	Definition
Efficiency	In the context of algorithm design, a measure of the amou algorithm uses. If algorithm A is more time efficient than a less time to accomplish the same objective.
Embedded system	A computer that forms part of a larger electrical or mechan
Encryption	The process of converting data into a code, thereby preven
Erroneous data	Test data that should not be accepted by a system – it is ty messages appear as and when they are supposed to appea
Ethics	The practice of determining righ[illegible] wrong, often in com
Fetch-execute cycle	The process by whi[illegible] rams are run by a computer; inst memory[illegible] and executed (carried out), in a cyc
Firew[illegible]	[illegible]re or software technology that filters network traff network or an individual computer.
Flowchart	A diagrammatic means of representing algorithms, using sh
Foreign key	The primary key from another table, used in order to creat
Gigabyte	One billion bytes or one thousand megabytes.
Global variable	A variable declared outside of any subroutines, so is visible variables continue to exist until the program terminates.
Hardware	The physical components of a computer system.
Hexadecimal	A number system comprising 16 symbols: 0, 1, 2, 3, 4, 5, 6,
High-level programming language	A programming language in which one instruction can tran instructions. Examples include Python, Java and Visual Bas
Hosting	Storing a website, and related items, in such a way that it c the Internet.
Huffman encoding	A form of compression that represents commonly used cha sequences than other characters, thus reducing the file size
Input	The process of introducing data into a computer system, su
Integer	A data type comprising whole numbers, including positive,
Interface	Completely distinct from 'user interface', this describes hov communicated with by other su[illegible]s.
Internet	A network that spans [illegible]gl[illegible], connecting together a hug
Internet Protocol (IP) address	A series [illegible]um[illegible]s that uniquely identifies each device th [illegible]n[illegible]ime.
Interp[illegible]	A translator that translates and executes line by line.
Iteration	A program structure in which a section of code might be ex typically due to a FOR, WHILE or UNTIL statement.
Kilobyte	One thousand bytes.
Linear search	A search algorithm that begins at one end of a data structu
Local Area Network (LAN)	A series of interconnected devices over a small geographic or a campus.

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Term	Definition
Local variable	A variable declared within a subroutine, which is only acces It ceases to exist when the subroutine ends.
Logic error	An error in which code runs but produces the wrong outpu arithmetic operator is used.
Low-level programming language	A programming language in which one instruction translate Assembly and machine code are low-level languages.
MAC address filtering	Blocking traffic onto a network based on the MAC address particular computer) from which it originated.
Magnetic	A category of storage in which data is stored in the form of
Malware	Any piece of software that causes harm to a computer syst
Megabyte	One million bytes or one thousand kilobytes.
Memory	Any means by which a computer stores data for immediate Memory, cache and registers.
Merge sort	A sorting algorithm that divides a data structure into individ the data into pairs, then groups of four, groups of eight, etc.
Misuse	Any attempt to use a system in some way other than how i
Modularisation	The process of breaking a program into smaller parts called
Monochrome	Describes an image where only varying tones of one colour
Nesting	Placing one program structure, such as a loop or selection s
Number base	The number of unique digits available in a given numbering is also known as base-10, because there are 10 distinct sym
One-dimensional array	An array in which each element is identified by a sequentia
Operating system	The software that manages the hardware, from which appl be launched.
Operator	A symbol used to represent an operation performed on on
Optical	A category of storage in which data is read and written usin
Output	The process of communicating data beyond a computer sy
Parameter	A piece of data that can be passed into a subprogram.
Penetration testing	Simulation of a cyberattack on a computer system, in orde they are discovered by hackers.
Personal Area Network (PAN)	The interconnected devices around a single person, usually Bluetooth.
Pharming	Redirecting web traffic to an unsafe site, typically that clos
Phishing	Obtaining personal data or login credentials by presenting or service that people trust.
Pixel	The smallest unit within an image; can be considered a dot colour, and cannot be subdivided.
Post-check iteration	A looping structure with a Boolean condition at the end to the loop should execute again.

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Term	Definition
Pre-check iteration	A looping structure with a Boolean condition at the start to within the loop should execute.
Primary key	A field in a database table used to uniquely identify each re
Protocol	A set of rules governing how data is transmitted across a n
Pseudocode	A cross between English and a programming language, use
Random	A random number has been selected from a range of numb range had an equal chance of being selected
Random Access Memory (RAM)	Also known as primary storage, ... data and application
Read-only memory	Any memory that can be read from but not written to.
Real	... type comprising numbers that can include fractions; t
Record	A data structure in which multiple data items of different t
Register	A low-capacity data store – typically 32 or 64 bits – that for
Relational operator	Used to compare two values to see which is larger, or whet
Resolution	In the context of computer images, the number of pixels th described in terms of height and width.
Return	The last instruction that executes within a function, which that function.
Run length encoding	A form of encryption that maps a data item to the number that item.
Sample resolution	The number of bits that make up each sample of a sound.
Sampling rate	The number of times per second a sound is sampled by a d
Scope	The visibility of a variable, typically global or local.
Search	An algorithm used to determine whether a particular data structure, and often its position within that data structure.
Secondary storage	Non-volatile storage (i.e. storage that does not require con applications that are not currently in use.
Selection	A program structure in which ... two or more paths can typically determined by the ... luation of an IF statement.
Sequence	A program structure in which each instruction occurs once, is ... en.
Social engineering	Exploiting people as the weakness in any computer system
Software	The programs that run on a computer system.
Solid state	A category of storage that stores data electronically, with n
Sort	An algorithm used to place data items into some kind of or or numeric.
Spyware	Software that covertly obtains sensitive data.

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Term	Definition
String	A data type consisting of a sequence of characters.
Structure Query Language (SQL)	A language for reading and altering the contents of a datab
Subroutine	A named out-of-line set of instructions that forms part of a
Syntax error	An error that comes from failing to follow the rules of gram programming language.
System software	Programs that are needed for effective communication wit launching application software.
TCP/IP model	A layered set of common co[illegible]tion protocols.
Terabyte	One trillion by[illegible] thousand gigabytes.
Topology	Th[illegible] physical layout of a network – where compon another.
Trace t[illegible]	A table used to track the values of variables as an algorithn
Translator	A piece of software that converts source code (written by a (executable by the computer).
Trojan	A legitimate program designed to conceal malicious code w
Truth table	Maps all possible combinations of Boolean inputs to the co given function.
Two-dimensional array	An array in which each element is identified by a pair of ind point on a Cartesian plane can be identified using X and Y c
Typical data	Test data that represents normal use of a system.
Unicode	A character set that includes ASCII, as well as many other c other alphabets.
Unpatched software	A program that has a security vulnerability that has not bee 'patch' (which is an update, typically written by the softwar
User interface	The means by which a human and a computer interact with
Utility	An application that maintains a computer in some way, suc
Validation	The process of ensuring that data entered into a system is
Variable	A named location in memory capable of storing a single da
Virus	Self-replicating code that causes da[illegible]g to a computer sy
Von Neumann architecture	A means of organisi[illegible]on[illegible]ter system in which both da the same m[illegible], and data and instructions use a co
Wide area network	A [illegible] interconnected devices over a large geographic [illegible] multiple countries.
Wire	A means of connection on a network that uses wires, such
Wireless	A means of connection on a network that does not use wir

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