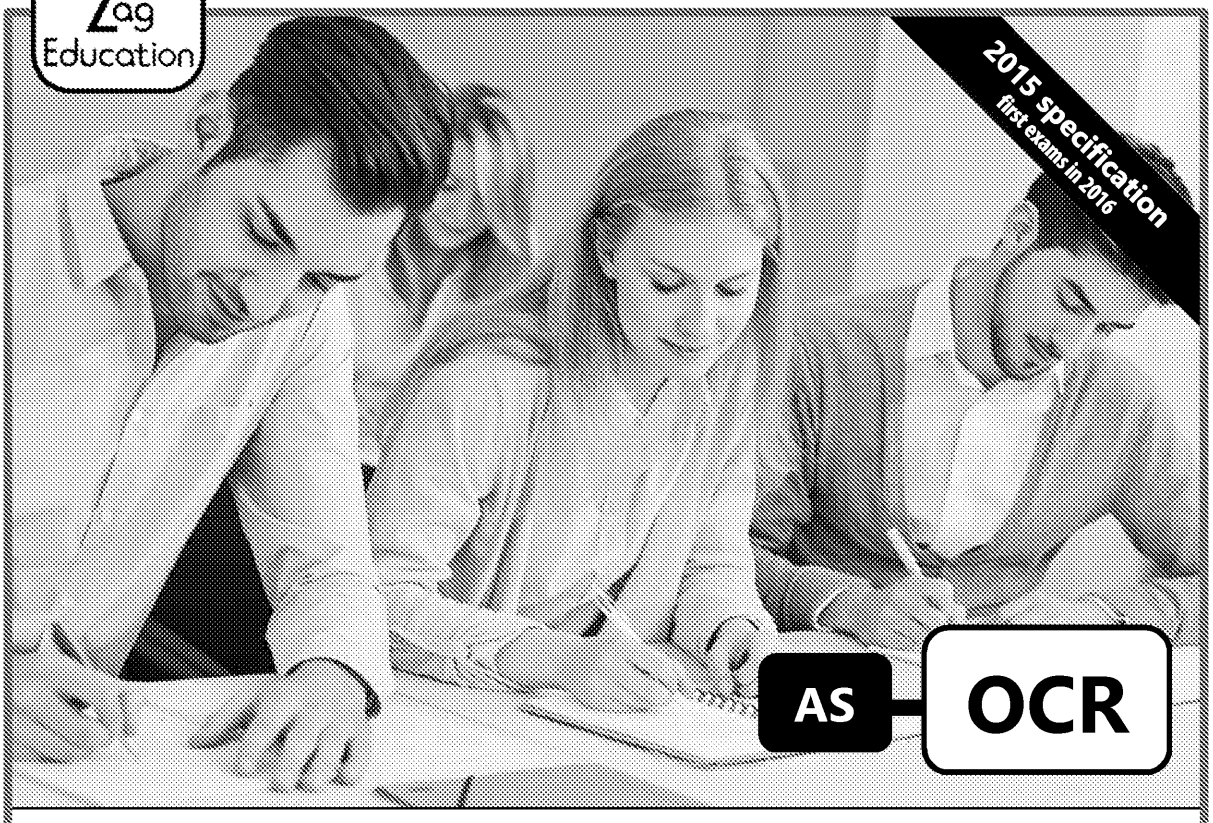
Zig Zag Education

Computer Science

AS | OCR | H046



Topic Tests

for AS OCR Computer Science

Component 1

zigzageducation.co.uk

POD 6298

Contents

Teacher's Introduction

This resource is designed to support teaching and learning of the AS OCR specification (for first teaching in September 2015; first exams from June 2016).

These end-of-topic tests are designed as factual tests to check your students' understanding as they complete each topic*. Their primary focus is not to provide exam-style practice, but instead to test the knowledge, skills and understanding required by the OCR specification in a variety of styles and complexities – ranging from simple short-answer questions through to longer essay-style questions.

**The tests could also be used for homework or revision, but their best use is as summative assessments.*

The tests cover the prescribed specification content for *Component 1* of the AS OCR specification – each provided in worksheet format (with answer lines) and a more photocopy-friendly format (without answer lines), to give you flexibility of use.

Each test is worth between 20–40 marks, and can be completed comfortably within a single one-hour lesson. Example answers are provided for every test. *Note that credit should also be given for any valid responses that are not explicitly included in this resource.*

1.1.1 Processors

1. Briefly explain the functional role of a processor in a computer system.

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2. Fill in the missing details in the following table:

Name	Role
Data bus	
	Carries processor commands to devices and returns sig
Address bus	

3. A processor consists of multiple components, including the arithmetic an control unit and registers.

   a) Circle the three operations that the ALU typically perform:

ADD	**BRANCH**	**STORE**
MULTIPLY	**LOAD**	**SHIFT**

   b) Briefly explain the function of each of the following registers.

      i. Program Counter (PC)

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      ii. Accumulator (ACC)

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      iii. Current Instruction Register (CIR)

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c) Describe the process of *storing* data to main memory. Identify the re

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4. a) Describe in detail each stage of the Fetch-Decode-Execute cycle.

i. Fetch

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ii. Decode

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iii. Execute

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b) Processor performance is dependent on a number of different factor

Give two examples of design techniques u[illegible] improve processor p
how they provide this improvemen[illegible]

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5. Explain the difference between a Von Neumann architecture and a Harva
For each architecture give an example of an application the architecture i

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1.1.2–3 Types of Processor, Input, Output and

1. Modern computer systems often contain a multicore processor.

   a) Complete the following table stating the resources that are shared by co

Resource	Shared between Cores (Yes/No)
Arithmetic and Logic Unit (ALU)	
Random-access Memory (RAM)	
Network Card	
Program Counter (PC) register	

   b) Give one advantage and one disadvantage of rewriting a single-threa
   advantage multiple processor cores.

   Advantage: .....

   .....

   .....

   Disadvantage: .....

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2. Consider the following assembly instruction:

ADDSTA Ra, Rb, Rc	Add the value in Ra to Rb and store the result at th

   a) Is the processor with this instruction a CISC or a RISC processor? Exp

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   b) Give **two** reasons why RISC processors are often used in portable de

   1 .....

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   2 .....

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3. When a processor is powered on it immediately loads a boot program fr
The boot program instructs the processor to load an operating system fr
magnetic hard disk, into RAM (random-access memory).

a) Explain why the boot program is stored in a ROM rather than in RAM

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b) Instead of being stored using an internal disk, an operating system ca
Name two examples of removable media and one advantage and dis
each to store an operating system

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4. A school is considering changing from using paper registers to storing all

a) Name two input devices that could be used to put the data into the
advantage of using each one.

1.....

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b) The school is considering using a virtual storage system to store the
Describe **two** advantages of using a virtual storage system rather tha
network-attached storage to store register

1.....

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2.....

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1.2.1 Systems Software

1. Operating systems provide computer systems with a wide range of functi

   a) Circle the three tasks that are performed by an operating system:

COMPILATION	I/O DEVICE COMMUNICATION	INTERRU
PROCESS SCHEDULING	WEB PAGE RENDERING	WEB PA

   b) Briefly explain what a real-time operating syste[illegible].

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   .....

   c) Briefly explain what a distributed operating system is.

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2. When a process is started it is allocated some memory by the operating s addressed directly by the process; instead a technique called *virtual mem*

   a) Explain what virtual memory is.

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   b) Explain how the use of virtual memory helps to improve the security

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   c) Virt[illegible]me[illegible]ables paging to a secondary storage device such a St[illegible]e advantage and one disadvantage of using paging.

   1.....

   .....

   2.....

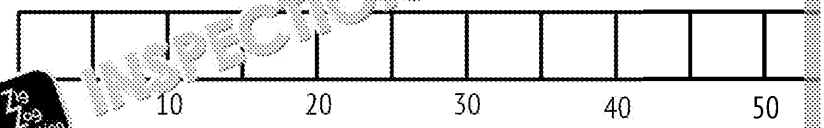
   .....

3. A system is running three processes. The processes have the IDs A, B and execution time for each process is listed in the table below:

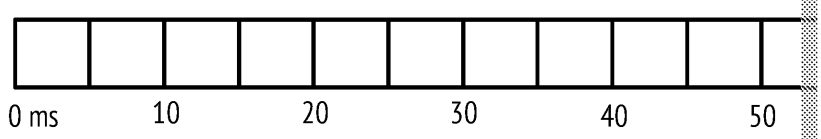
Process ID	Start time	Total execution time
A	10 ms	10 ms
B	0 ms	20 ms
C	5 ms	30 ms

a) Assume that processes can be scheduled in 5 ms time slots. For each algorithms write the ID of the process that will be running in each tim

i. First come, first served



ii. Round robin



c) Process C is an operating system response to a key press. The operat requires that process C needs to be completed as soon as possible.

i. Use your answers to questions (a) and (b) to identify whether *ro served* scheduling best meets this requirement.

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ii. Now assume that the start and execution times can change. Wil you gave as an answer to question (i) always be the best? Explai

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iii. Give an example of a scheduling algorithm that can prioritise op as process C. Explain how this scheduling algorithm works.

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4. Video games designed to run on obsolete game consoles can often be p
using an *emulator*. Emulators are *virtual machines*.

a) Explain the term *virtual machine*.

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b) Games run in an emulator can execute more slowly than the same ga
game console. This can happen even when new hardware that is muc
hardware is used. Explain why this slowdown occurs.

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c) State two other uses for virtual machines.

1.....

2.....

5. Some computer systems allow processes to put themselves to sleep for a
can use this functionality to add a delay between function calls. For exam
"..." every 60 seconds:

```
0 | while true
1 |     sleep(60)
2 |     print("...")
3 | endwhile
```

Explain in detail how interrupts could be used to implement this `sleep (`
Assume that the processor contains a programmable circuit that can raise
period of time has expired. Ensure that your system can cope with scenar
an interrupt earlier than expected.

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1.2.2 Applications Generation

1. a) Briefly explain the difference between system software and applicatio

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b) Complete the following table stating whether each piece of software is a

Software Name	Type (Application/System)	Software Name
Operating System		Calculator
Word Processor		Sound Card Driver

2. a) A c...piler is one type of translator program. Name the other two typ

1..... 2.....

b) Explain the differences between the three different types of translato

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3. Open-source programs are heavily used th...ut the computer indust

a) Explain the difference bet...e a ...osed-source program and an ope

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b) Give one example of a closed-source program and one example of a

Open-source:.....

Closed-source:.....

c) Describe one advantage and one disadvantage to a company of dist
in open-source form.

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1.2.3 Introduction to Programming

1. Procedural programming languages are very popular and are used to cre

   a) Describe what is meant by a procedural programming language.

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   b) Variables of routines declared in a procedural program may be acces
   but not in another.

      i. Give the term used to describe the part of the program a variab

      .....

      ii. Describe two major benefits of restricting the accessibility of var
      programming language.

      1.....

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      2.....

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2. a) Explain, using examples, the difference between a constant and a var

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   b) Explain the difference between a procedure and a function.

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3. a) Perform the following operations:

      i. 23 MOD 4

      .....

      ii. 23 DIV 4

      .....

   b) Describe, using an example, the concept of concatenation.

   .....

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3. Consider the following assembly program written for a Little Man compu
positive numbers together:

```
        INP
        STA   A
        INP
        STA   B
LOOP    LDA   A
        BRZ   QUIT
        SUB   ONE
        STA   A
        LDA   RESULT
        ADD   B
        STA   RESULT
        BRA   LOOP
QUIT    LDA   RESULT
        OUT
        HLT
ONE     DAT   1
A       DAT
B       DAT
RESUL
T       DAT   0
```

a) Describe the algorithm that this program implements.

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b) Suppose one of the inputs to this program is 0. Will the program pro
Explain your answer.

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c) What are LOOP, QUIT, ONE, A, B and RESULT examples of? Briefly ex
identifiers serve in an assembly program.

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d) Modify the assembly program given to produce the result of `A MOD B`

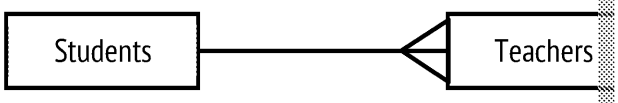
Assume that A and B are positive integers. Provide the pseudocode f

Pseudocode:

Assembly program:

1.3.1 Databases

1. Consider the following entity relationship diagram representing the relati
teachers at a school:



Each student has only one teacher, and there are usually about 30 studen

a) Identify the type of relationship described by the entity relationship d

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b) Identify and explain the mistake in the entity relationship diagram gi

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c) Each student and teacher attends a single school. Extend the entity r
include *Schools* and update all the relationships.

2. Describe what is meant by each of the following terms:

a) Pri key

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b) Secondary key

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c) Foreign key

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3. Consider the following entity description for a flat-file shop orders database

Order(OrderNum, CustNum,Title, FirstName, Surname, Address, PostCode, Price, Manufacturer, OrderDate, OrderTime, Dispatched)

a) i. Identify the primary keys

.....

ii. Identify the foreign keys and their location

.....

b) Draw an entity relationship diagram for your database

c) i. Assuming a three-table structure has been used to represent the
this question, what restriction does this place on the database th
day-to-day running of a shop?

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ii. Describe a possible solution for this problem.

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iii. Draw an Entity Relationship Diagram for your new structure.

1.3.2 Networks

1. A home user is trying to set up a local area network (LAN) that will be co
They have asked you to help them set it up.

   a) They have a printer with a network port. Suggest an appropriate stat
   assuming a subnet mask of 255.255.255.0.

   .....

   b) The network has been set up and the router has successfully obtaine
   ISP. Unfortunately the user isn't able to acce websites. You ask
   of a well-known web server into their browser and the website loads

   What is the name and purpose of the service that is not working cor

   .....

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2. The Transmission Control Protocol (TCP) is a common low-level networki

   a) TCP uses packets to send data across a link. Explain what a packet is
   information a packet contains.

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   b) A client is uploading a large amount of data to a server using the TC
   transfer one of the Internet service provider's network switches fails.
   through a different switch; however, several packets are lost. Explain
   detect and react to this packet loss.

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c) The Hypertext Transfer Protocol (HTTP) is the protocol most commo
HTTP is commonly implemented on top of TCP/IP.

Explain the advantages of implementing HTTP as a layer above TCP/
standalone protocol.

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3. A new company entering the voice over IP (VOIP) telephony market is deci
voice data between customers. They have two options: a client-server mod

Explain which model you would recommend the company use and why.
Provide advantages and disadvantages for both models.

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1.3.3 Web Technologies

1. A software developer is making a personal website that she wants to use she has worked on and some of the things that interest her. The website following snippet of HTML listing her favourite things:

```
<p>My favourite website is BBC News.</p>
<p>My favourite TV show is Downton Abbey.</p>
```

a) Rewrite the first paragraph to replace 'BBC News' with a link to *http:/* should still display the text 'BBC News'.

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.....

b) Th site author wants to add the heading 'About Me' above the Rec mmend an appropriate HTML tag to use for this purpose. Explai her to use this tag for the heading rather than using the <p> tag.

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c) The website author has decided to refactor her favourite things into written the following HTML:

```
<li>My favourite website is BBC News.</li>
<li>My favourite TV show is Downton Abbey.</li>
```

Unfortunately the website is not rendering the way she had intended with the HTML provided and rewrite the list so that it renders correct

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d) At the bottom of th ge the author wants to add a form to allow r form shou n two text boxes – one for the comment and one cu ting – and a submit button. Write the HTML for the form be

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2. Cascading style sheets (CSS) are commonly used to format a web page.

   a) Style information can be added to a HTML file in a few different ways external file.

      i. Write the mark-up required to import a CSS file called style.css i

      .....

      .....

      ii. Explain the advantages of using an external file to store style inf embedding style information into a static HTML file directly.

      .....

      .....

      .....

   b) Consider the following HTML snippet:

```
<p style="color:red;">Coursework is due on Tuesd
```

   The style has been written directly into the HTML element because th the deadline for the coursework without modifying the style of other

   The author now wants to move this style into an external CSS file and times in each page. Explain one way this could be achieved while kee Your answer should include the HTML and CSS required to implemen

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3. JavaScript can be embedded into HTML pages to provide dynamic behav

   a) Explain where JavaScript embedded into web pages is executed.

   .....

   .....

   b) Consider the following HTML:

```
<p id="name">Michael</p>
```

   Write a line of JavaScript that will change the contents of the paragra

   .....

c) You have been placed in charge of writing a website that requires us
website currently consists of a simple HTML file containing a form:

```
<!DOCTYPE html>
<html lang="en-GB">
<body>
    <form>
        <input id="pswd" type="password" name="p
    </form>
    <script>
        document.getElementById("pswd").onkeydow
    </script>
</body>
</html>
```

The password that the user enter should be at least eight characters
checkPassword will be called whenever a new character is added t
implementation of the `checkPassword` function that checks the len
makes the background colour of the input to be green if the passw
long, and red otherwise.

The contents of the password input can be retrieved using its **value** p
string can be retrieved using its **length** property. The background co
modified using its `style.backgroundColor` property.

```
function checkPassword() {
```

4. There are two categories of data compression: lossless and lossy.

a) Explain the difference between lossless and lossy data compression.

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b) Give an example of a type of data that is suitable for lossy data comp
Explain why this type of data is suitable for lossy data compression.

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c) It is possible to combine lossless and lossy compression techniques.
Explain why lossy techniques MUST be applied before lossless techni

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1.4.1 Data Types 1

1. a) Describe the representation of unsigned denary integers in binary fo

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.....

b) Complete the table for the binary and hexadecimal representations o numbers:

Denary	Bina	Hexadecima
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

2. Evaluate the following binary expressions. Show your working:

a) 0111 + 0010

b) 1011 - 0101

3. a) Convert the following unsigned binary numbers into denary.

i. 01100110

.....

ii. 10111001

.....

iii. 11000101

.....

b) Convert the following denary numbers into 8 bit unsigned binary.

i. 78

.....

ii.

.....

iii. 228

.....

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

i. 00101101

.....

ii. 10100111

.....

d) Convert the following unsigned binary fractions into denary decimal

i. 0100.1100

.....

ii. 1011.1001

.....

Questions continue on the following page

4. Convert the following values into each of the formats requested.

a) 204 (base 10)

i. Binary:

.....

ii. Hexadecimal:

.....

b) 11000111 (base 2)

i. Denary:

.....

ii. Hexadecimal:

.....

c) E7 (base 16)

i. Denary:

.....

ii. Binary:

.....

d) Represent -19 in binary as an 8-bit signed integer using the following

i. Sign and magnitude:

.....

ii. Two's complement:

.....

e) Represent $\frac{-3}{16}$ in binary as an 8-bit signed integer with four fractional

formats:

i. Sign and magnitude:

.....

ii. Two's complement:

.....

1.4.1 Data Types 2

1. ASCII is a widely used standard for encoding characters as binary values.

   a) Knowing that A is character 65 (base 10) in the ASCII table, give the A following letters.

      i. F .....

      ii. M .....

      iii. X .....

   b) How many ASCII characters ar[illegible] following phrase? You must ex answer.

      I love OCR Computer Science

      .....

      .....

   c) How many characters can 7-bit ASCII represent?

      .....

2. Unicode is a set of standards for encoding characters as multi-byte binary

   a) Explain the benefit of using Unicode instead of ASCII to encode char

      .....

   b) UTF-8 is a very popular type of Unicode encoding that uses a variabl each character. For example, the character A is encoded using one by be encoded using two bytes. Explain one advantage and one disadva number of bytes to represent each character.

      .....

      .....

      .....

   c) How many characters can a 16-bit [illegible] represent?

      .....

Questions continue on the following page

3. An IEEE754 floating-point number consists of three component parts: a m
a sign bit (S). The following diagram shows how these three parts are co
precision floating-point number:

S	E_4	E_3	E_2	E_1	E_0	M_9	M_8	M_7	M_6	M_5	M_4	M

a) The following equation can be used to calculate the value of a non-z

$$(1 - 2a)(1 + b)2^{c-15}$$

Write the component each variable in the equation represents below

a: .....

b: .....

c: .....

b) The number of bits allocated to the exponent and mantissa can be c
that is made when the number of bits used to represent the exponen
of bits used to represent the mantissa is reduced.

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4. Floating-point numbers can be represented as two two's complement int
exponent and one representing the mantissa. Use this floating-point form

a) Convert the following binary floating-point numbers into denary:

i.

0	1	0	1	0	1	0	1
Exponent			Mantissa				

.....

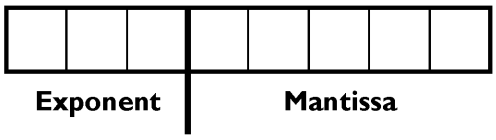
ii.

1	1	0	0	1	0	0	0
Exponent			Mantissa				

.....

b) Convert the following denary numbers into binary floating-point nur
a 5-bit mantissa:

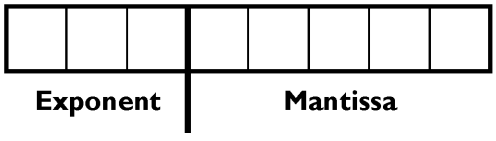
i. 0.75



ii. -7.5

c) Fi highest number that can be represented using a 3-bit expor

i. In floating-point binary:

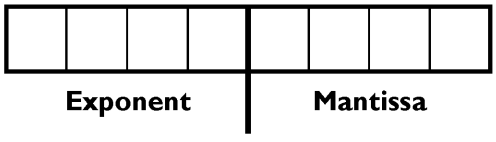


ii. In denary:

.....

d) Find the lowest number that can be represented using a 4-bit expon

i. In floating-point binary:

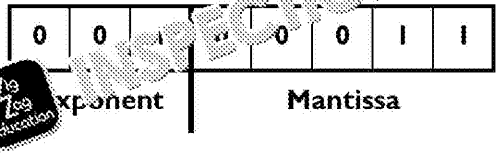


ii. In denary:

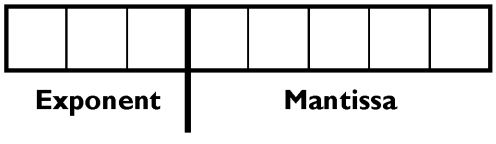
.....

e) Normalise the following floating point nu b

i.



Answer:



ii.

1	0	1	1	1	0	1	0
Exponent			Mantissa				

Answer:

Exponent			Mantissa				

f) Add the following two numbers and n rm li e the result. Show your

0	0	0	0	1	0	0	+	0	0	0	1	0
o nt			Mantissa					Exponent				

Answer:

Exponent			Mantissa				

g) Subtract the number on the right from the number on the left and n
Show your working.

1	1	1	1	1	0	0	0	-	0	0	0	0	1
Exponent				Mantissa					Exponent				

Answer:

Exponent				Mantissa			

5. Is it possible to represent 0.3 exactly in floating-point binary? Explain you

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1.4.2 Data Structures

1. Arrays are a very popular and commonly used data structure in programm
language of your choice on this question wherever required.

   a) Write the code that would create a one-dimensional array (named 'sp
   five sports that are played at a school: rugby, football, hockey, netba

   .....

   b) In the majority of languages, arrays are said to be 0-based. What doe

   .....

   .....

   c) W e ... hat would output the first and last element.

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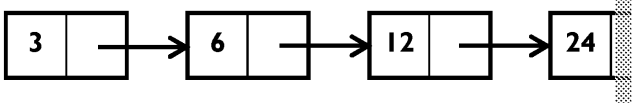
   d) It has been decided that football will no longer be played and they a
   Write the code that would update the array with this information.

   .....

2. Consider the following linked list:



   a) What do the arrows in the diagram above represent?

   .....

   b) Is the linked list above an example of a singly linked list or a doubly l
   answer.

   .....

   .....

   c) Does it take longer t... ook u... an item by index in a linked list or an a

   .....

   .....

   d) Give two advantages of using a linked list over an array.

   .....

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   .....

e) A student has written a procedure to remove an item to the list. Iden
You do not need to worry about memory allocation and deallocation

```
procedure remove(head, indexToRemove)
    if indexToRemove == 0
        head = head.next
        return head
    endif

    prev = head
    for i=0 to indexToRemove
        prev = prev.next
    endfor

    prev.next = prev.next.next
    return head
endprocedure
```


.....

.....

f) Write a procedure `append` which will add an item to the end of the q
take the `head` of the list and the `item` to add. You may assume that
encapsulated in a linked list node (i.e. `item` has the attributes `value`
list elements may be assumed to be equal to `nil`. The procedure sho

3. Take the following example of a stack that is currently stored in memory.

Memloc	Data	TopOfStac
6		
5		
4		
3	Fish	←
2	Cat	
1	D	

a) Complete the table after the following commands:

Push 'Mouse', Pop, Pop

Memloc	Data	TopOfStac
6		
5		
4		
3		
2		
1		

b) Complete the table after the following further commands:

Pop, Pop, Push 'Rabbit'

Memloc	Data	TopOfStac
6		
5		
4		
3		
2		
1		

4. Queues are a particular way of representing data within a computer.

a) Explain the difference between a queue and a stack.

.....

.....

.....

.....

b) Describe how a circular queue works.

.....

.....

.....

.....

c) Complete the following table showing the state of the queue at each
the queue at each state. You must complete the state of the queue a
NextFree values at each stage.

State 1	State 2	State 3	S
start state	joins queue	Item served from queue	J joi
1 2 3 4 5 A B C	1 2 3 4 5 A B C	1 2 3 4 5	1 2
FrontPtr = 1 NextFree = 4	FrontPtr = NextFree =	FrontPtr = NextFree =	FrontP NextF

1.4.3 Boolean Algebra

1. a) Explain the function of applying the following logical operators to a c

   i. NOT

   .....

   .....

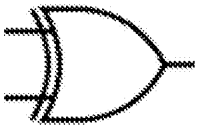
   ii. OR

   .....

   .....

   b) W e t functions of the following logic gates?

   i.  .....

   ii.  .....

2. Complete the following truth table:

A	B	A NAND B	A OR B	A XOR B
FALSE	FALSE			
FALSE	TRUE			
TRUE	FALSE			
TRUE	TRUE			

3. Calculate the results of the following logic expressions:

   a) $0 \vee 1 \ldots 1 \vee$

   .....

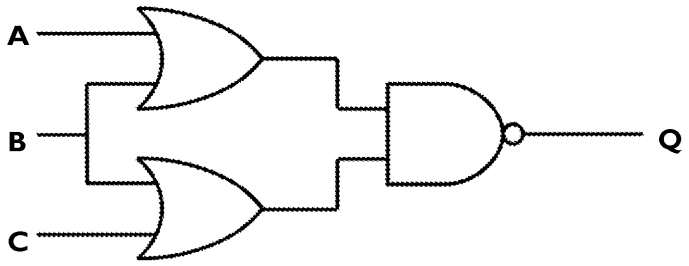
   b) $1 \wedge 0$

   .....

   c) $(0 \vee 0 \vee 0) \vee (0 \vee (1 \wedge 1))$

   .....

4. Consider the following logic diagram:



Write the logic equation for Q.

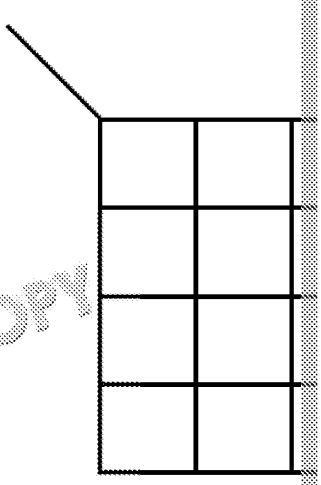
.....

5. Draw the logic diagram for this expression.

¬ ((A C)

6. a) Complete the Karnaugh map using the truth table below.

A	B	C	D	Q
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1



b) Use the Karnaugh map to produce a simplified equation for Q.

.....

1.5.1 Computing-related Legislation

1. The Computer Misuse Act 1990 introduced three new criminal offences.

   a) State the three new criminal offences introduced in the act.

   1 .....

   2 .....

   3 .....

   b) Explain the concept of phishing and gi[illegible]mple of a way a crim[illegible] gain access to a computer sys[illegible]

   .....

   .....

   .....

2. The Data Protection Act 1998 sets out the laws that govern the way perso[illegible]

   a) Explain what is meant by personal data according to the act.

   .....

   .....

   .....

   b) The act contains eight principles that should be followed by organisa[illegible] data. State three of these principles.

   1.....

   2.....

   3.....

   c) Does the UK government have to abide by the principles laid out in t[illegible]

   .....

   d) A marketing company w[illegible]ect data about potential custome[illegible] information such [illegible]erson's name, date of birth and contact det[illegible] and [illegible]rin[illegible] database. Does the Data Protection Act forbid this[illegible]

   .....

   .....

   .....

   .....

   .....

3. The Copyright, Designs and Patterns Act 1988 sets out some of the laws t
content owners.

a) Give one example of a type of work that can be protected by each of

i. Patents

.....

ii. Copyright

.....

iii. Designs

.....

iv. Trademarks

.....

b) In most cases it is illegal for a programmer to copy code that someo
her company's code without the owner's permission.

i. What type of protection applies to computer code?

.....

ii. The computer code does not contain a notice displaying the na
protected?

.....

c) Explain the concept of *fair dealing*.

.....

.....

.....

d) A company is developing a new software product that includes a nev
company. They are unsure how they should protect their new softwa
Discuss the advantages and disadvantages of the protections they co

.....

.....

.....

.....

.....

.....

.....

4. The Regulation of Investigatory Powers Act 2000 governs surveillance and
and postal communication.

a) Encrypted communications are useless when they are intercepted un
Explain the provisions the act contains to mitigate this problem.

.....

.....

.....

b) The act has been widely criticised by privacy campaigners. Explain wh
and compare the benefits of the act with its effect on civil liberties.

.....

.....

.....

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.....

.....

.....

1.5.2 Moral and Ethical Issues

1. a) Peer-to-peer networks are frequently used to share large files on the

   i. Explain what a peer-to-peer network is.

   .....

   .....

   ii. Give two reasons why peer-to-peer networks are more popular networks for distributing pirated videos.

   .....

   .....

   .....

   .....

   b) Explain what Digital Rights Management (DRM) is.

   .....

   .....

   c) Give four ways DRM might restrict the way a video file can be used.

   .....

   .....

   .....

   .....

2. Give two advantages and two disadvantages of utilising robots for work i

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

3. There has been a huge push in recent years into the development of com
software by companies such as Google, Facebook and Apple.

If a human is shown two pictures, they will be able to identify if the same
an accuracy of 97.53% on average. Facebook has developed an algorithm

Discuss the uses of this technology and any ethical issues surrounding its
You may wish to consider what the technology would be used for, privac
information and the impact of wearable technology.

Questions continue on the following page

4. 'According to a well written and thorough article in the *Virginia Journal* s
we've been saying for over three years has been determined to be true: W

In September 2004, this statement was written by Marius Milner. Marius w
NetStumbler, which is a tool used to map Wi-Fi networks using a Wi-Fi ca
known as 'WarDriving'.

Marius Milner also worked for Google and his code for gathering this info
the street-view cars which were used to gather data on mapping network
from open networks as street-view information was being gathered.

Discuss the ethics and legality of WarDriving. You may wish to consider h
WarDriving yourself – what information could be gathered, what the end
such information, what happens to the information later, and where it is s

1.1.1 Processors

1. Briefly explain the functional role of a processor in a computer system.

2. Copy the following table and complete the missing details:

Name	Role
Data bus	
	Carries processor commands to devices and returns sig
Address bus	

3. A processor consists of multiple components, including the arithmetic an control unit and registers.

   a) Complete the three operations that the ALU typically perform:

ADD	**BRANCH**	**STORE**
MULTIPLY	**LOAD**	**SHIFT**

   b) Briefly explain the function of each of the following registers.

      i. Program Counter (PC)
      ii. Accumulator (ACC)
      iii. Current Instruction Register (CIR)

   c) Describe the process of *storing* data to main memory. Identify the re

4. a) Describe in detail each stage of the Fetch-Decode-Execute cycle.

      i. Fetch
      ii. Decode
      iii. Execute

   b) Processor performance is dependent on a number of different factor

      Give two examples of design techniques used to improve processor p explain how they provide this improvement.

5. Explain the difference between a Von Neumann architecture and a Harva For each architecture give an example of an application the architecture i

1.1.2–3 Types of Processor, Input, Output and

1. Modern computer systems often contain a multicore processor.

   a) Copy and complete the following table stating the resources that are sh
   processor:

Resource	Shared between Cores (Yes/No)
Arithmetic and Logic Unit (ALU)	
Random-access Memory (RAM)	
Network Card	
Program Counter (PC) re[illegible]	

   b) Gi[illegible]e a[illegible]ntage and one disadvantage of rewriting a single-thre
   ad[illegible]e of multiple processor cores.

2. Consider the following assembly instruction:

ADDSTA Ra, Rb, Rc	Add the value in Ra to Rb and store the result at th

   a) Is the processor with this instruction a CISC or a RISC processor? Exp

   b) Give **two** reasons why RISC processors are often used in portable de

3. When a processor is powered on it immediately loads a boot program fr
   The boot program instructs the processor to load an operating system fr
   magnetic hard disk, into RAM (random-access memory).

   a) Explain why the boot program is stored in a ROM rather than in RAM

   b) Instead of being stored using an internal disk, an operating system ca
   Name two examples of removable media and one advantage and dis
   each to store an operating system.

4. A school is considering changing from using paper registers to storing all

   a) Name two input devices that could be used to put the data into the
   advantage of using each one.

   b) The school is considering using a virtu[illegible]st[illegible]ge system to store the
   Describe **two** advantages [illegible]sing a virtual storage system rather tha
   storage to store r[illegible]r data.

1.2.1 Systems Software

1. Operating systems provide computer systems with a wide range of functi

   a) Circle the three tasks that are performed by an operating system:

COMPILATION	I/O DEVICE COMMUNICATION	INTERRU
PROCESS SCHEDULING	WEB PAGE RENDERING	WEB PA

   b) Briefly explain what a real-time operating syste[illegible].

   c) Briefly explain what a distributed oper[illegible]stem is.

2. When a process is start[illegible] is a[illegible]cated some memory by the operating s addressed direc[illegible]e process; instead a technique called *virtual mem*

   a) Ex[illegible]hat virtual memory is.

   b) Explain how the use of virtual memory helps to improve the security

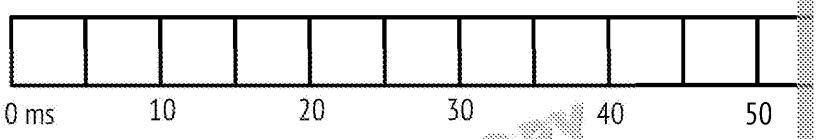
   c) Virtual memory enables paging to a secondary storage device such a State one advantage and one disadvantage of using paging.

3. A system is running three processes. The processes have the IDs A, B and execution time for each process is listed in the table below:

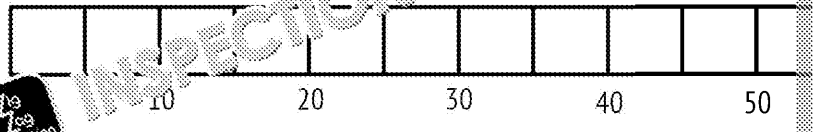
Process ID	Start time	Total execution time
A	10 ms	10 ms
B	0 ms	20 ms
C	5 ms	30 ms

   a) Assume that processes can be scheduled in 5 ms time slots. For each algorithms write the ID of the process that will be running in each tir

      i. First come, first served



      ii. Round robin



   c) Process C is an operating system response to a key press. The operat requires that process C needs to be completed as soon as possible.

      i. Use your answers to questions (a) and (b) to identify whether *ro served* scheduling best meets this requirement.
      ii. Now assume that the start and execution times can change. Wil you gave as an answer to question (i) always be the best? Explai
      iii. Give an example of a scheduling algorithm that can prioritise op such as process C. Explain how this scheduling algorithm works.

4. Video games designed to run on obsolete game consoles can often be p
using an *emulator*. Emulators are *virtual machines*.

   a) Explain the term *virtual machine*.

   b) Games run in an emulator can execute more slowly than the same ga
game console. This can happen even when new hardware that is muc
hardware is used. Explain why this slowdown occurs.

   c) State two other uses for virtual machines.

5. Some computer systems allow processes to put themselves to sleep for a
can use this functionality to add a delay between function calls. For exam
"..." every 60 seconds:

```
0 while true
1     sleep(
2     print("...")
  endwhile
```

Explain in detail how interrupts could be used to implement this `sleep (`
Assume that the processor contains a programmable circuit that can raise
period of time has expired. Ensure that your system can cope with scenar
an interrupt earlier than expected.

1.2.2 Applications Generation

1. a) Briefly explain the difference between system software and applicatio

   b) Copy and complete the following table, stating whether each piece of s software:

Software Name	Type (Application/System)	Software Name
Operating System		Calculator
Word Processor		Sound Card Driver

2. a) A compiler is one type of translation program. Name the other two ty

   b) Explain the difference between the three different types of translato

3. Open-source programs are heavily used throughout the computer indust

   a) Explain the difference between a closed-source program and an ope

   b) Give one example of a closed-source program and one example of a

   c) Describe one advantage and one disadvantage to a company of dist in open-source form.

1.2.3 Introduction to Programming

1. Procedural programming languages are very popular and are used to cre

   a) Describe what is meant by a procedural programming language.

   b) Variables or routines declared in a procedural program may be acces program but not in another.

      i. Give the term used to describe the part of the program a variab

      ii. Describe two major benefits of restricting the accessibility of var programming language.

2. a) Explain, using examples, the difference be. ve. a constant and a var

   b) Explain the difference bet. a procedure and a function.

3. a) Perform th. ng operations:

      i. MOD 4

      ii. 23 DIV 4

   b) Describe, using an example, the concept of concatenation.

4. Consider the following assembly program written for a Little Man compu positive numbers together:

```
         INP
         STA   A
         INP
         STA   B
LOOP     LDA   A
         BRZ   QUIT
         SUB   ONE
         STA   A
         LDA   RESULT
         ADD   B
         STA   RESULT
         BRA   LOOP
QUIT     LDA   RESULT
         OUT
         HLT
ONE      DAT   1
A        DAT
B        DAT
RESUL
T        DAT   0
```

   a) D. the algorithm that this program implements.

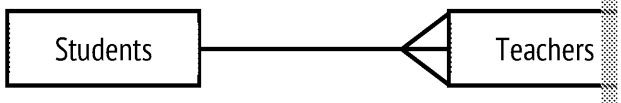
   b) Suppose one of the inputs to this program is 0. Will the program pro Explain your answer.

   c) What are LOOP, QUIT, ONE, A, B and RESULT examples of? Briefly ex identifiers serve in an assembly program.

   d) Modify the assembly program given to produce the result of `A MOD B` Assume that A and B are positive integers. Provide the pseudocode f

1.3.1 Databases

1. Consider the following entity relationship diagram representing the relati
teachers at a school:



Each student has only one teacher, and there are usually about 30 studen

a) Identify the type of relationship described by the entity relationship d

b) Identify and explain the mistake in the entity relationship diagram gi

c) Each student and teacher atte[illegible] single school. Extend the entity r
include *Schools* and [illegible] relationships.

2. Define each of the following terms:

a) Primary key

b) Secondary key

c) Foreign key

3. Consider the following entity description for a flat-file shop orders databa

**Order(OrderNum, CustNum,Title, FirstName, Surname, Address, PostCod
Manufacturer, OrderDate, OrderTime, Dispatched)**

a) i. Identify the primary keys

ii. Identify the foreign keys and their location

b) Draw an entity relationship diagram for your database

c) i. Assuming a three-table structure has been used to represent the
this question, what restriction does this place on the database t
day-to-day running of a shop?

ii. Describe a possible solution for this problem.

iii. Draw an Entity Relationship Diagram for your new structure.

1.3.2 Networks

1. A home user is trying to set up a local area network (LAN) that will be con
They have asked you to help them set it up.

   a) They have a printer with a network port. Suggest an appropriate stat
   assuming a subnet mask of 255.255.255.0.

   b) The network has been set up and the router has successfully obtaine
   ISP. Unfortunately the user isn't able to access any websites. You ask
   of a well-known web server into their browser and the website loads

   What is the name and purpose of the service th[illegible]s not working cor

2. The Transmission Control Protocol (TCP) is a common low-level networki

   a) TCP uses packets to send data across a link. Explain what a packet is
   informatio[illegible]et contains.

   b) A [illegible]s uploading a large amount of data to a server using the TC
   transfer one of the Internet service provider's network switches fails.
   through a different switch; however, several packets are lost.

   Explain how the client and server detect and react to this packet loss

   c) The Hypertext Transfer Protocol (HTTP) is the protocol most commo
   HTTP is commonly implemented on top of TCP/IP.

   Explain the advantages of implementing HTTP as a layer above TCP/
   standalone protocol.

3. A new company entering the voice over IP (VOIP) telephony market is de
to move voice data between customers. They have two options: a client-s
peer-to-peer model.

   Explain which model you would recommend the company use and why. P
   and disadvantages for both models.

1.3.3 Web Technologies

1. A software developer is making a personal website that she wants to use she has worked on and some of the things that interest her. The website following snippet of HTML listing her favourite things:

```
<p>My favourite website is BBC News.</p>
<p>My favourite TV show is Downton Abbey.</p>
```

   a) Rewrite the first paragraph to replace 'BBC News' with a link to *http:/* The link should still display the text 'BBC News'.

   b) The website author wants to add the heading 'ut Me' above the Recommend an appropriate HTML tag to ... for this purpose. Explai her to use this tag for the h... ther than using the <p> tag.

   c) The website auth... ided to refactor her favourite things into writ... th... g HTML:

```
<li>My favourite website is BBC News.</li>
<li>My favourite TV show is Downton Abbey.</li>
```

   Unfortunately the website is not rendering the way she had intended with the HTML provided and rewrite the list so that it renders correct

   d) At the bottom of the page the author wants to add a form to allow r form should contain two text boxes – one for the comment and one commenting – and a submit button. Write the HTML for the form be

2. Cascading style sheets (CSS) are commonly used to format a web page.

   a) Style information can be added to a HTML file in a few different ways external file.

      i. Write the mark-up required to import a CSS file called style.css i
      ii. Explain the advantages of using an external file to store style inf embedding style information into a static HTML file directly.

   b) Consider the following HTML snippet:

```
<p style="color:red;">Coursework is due on Tuesd
```

   The style has been written directly into the HTML element because tl the deadline for the coursework without modifying the style of other

   The author now wants to move this style into an external CSS file and times in each page. Explain one way this could be achieved while kee Your answer should include the HTML and CSS required to implemen

3. JavaScript can be embedded into HTML pages to provide dynamic behav

   a) Ex... wi... JavaScript embedded into web pages is executed.

   b) Co... the following HTML:

```
<p id="name">Michael</p>
```

   Write a line of JavaScript that will change the contents of the paragra

c) You have been placed in charge of writing a website that requires us
The website currently consists of a simple HTML file containing a for

```
<!DOCTYPE html>
<html lang="en-GB">
<body>
    <form>
        <input id="pswd" type="password" name="p
    </form>
    <script>
        document.getElementById("pswd").onkeydow
    </script>
</body>
</html>
```

The password that the [illegible] should be at least eight characters
`checkPassw[illegible]` called whenever a new character is added t
im[illegible]en [illegible] the `checkPassword` function that checks the len
m[illegible] the background colour of the input to be green if the passw
long, and red otherwise.

The contents of the password input can be retrieved using its **value** p
string can be retrieved using its **length** property. The background co
modified using its `style.backgroundColor` property.

4. There are two categories of data compression: lossless and lossy.
   a) Explain the difference between lossless and lossy data compression.
   b) Give an example of a type of data that is suitable for lossy data comp
   Explain why this type of data is suitable for lossy data compression.
   c) It is possible to combine lossless and lossy compression techniques.
   Explain why lossy techniques MUST be applied before lossless techni

1.4.1 Data Types 1

1. a) Describe the representation of unsigned denary integers in binary fo
   b) Copy and complete the table below for the binary and hexadecimal r denary numbers 0–16:

Denary	Binary	Hexadecimal
0		
↓		
16		

2. Evaluate the following binary expressions. S[illegible] y[illegible] r working:
   a) 0111 + 0010
   b) 1011 - 0101

3. a) C[illegible] th[illegible]owing unsigned binary numbers into denary.
      i. [illegible]00110
      ii. 10111001
      iii. 11000101
   b) Convert the following denary numbers into 8-bit unsigned binary.
      i. 78
      ii. 123
      iii. 228
   c) Convert the following 8-bit two's complement binary into denary.
      i. 00101101
      ii. 10100111
   d) Convert the following unsigned binary fractions into denary decimal
      i. 0100.1100
      ii. 1011.1001

4. Convert the following values into each of the formats requested.
   a) 204 (base 10)
      i. Binary:
      ii. Hexadecimal:
   b) 11000111 (base 2)
      i. Denary
      ii. Hexadecimal
   c) E7 (base 16)
      i. Denary
      ii. [illegible]ar
   d) Re[illegible]t -19 in binary as an 8-bit signed integer using the following
      i. Sign and magnitude
      ii. Two's complement
   e) Represent $\frac{-3}{16}$ in binary as an 8-bit signed integer with four fractiona
      i. Sign and magnitude
      ii. Two's complement

1.4.1 Data Types 2

1. ASCII is a widely used standard for encoding characters as binary values.

   a) Knowing that A is character 65 (base 10) in the ASCII table, give the A
   letters F, M and X.

   b) How many ASCII characters are in the following phrase? You must ex
   your answer.

   I love OCR Computer Science

   c) How many characters can 7-bit ASCII represent?

2. Unicode is a set of standards for encoding characters as multi-byte binary

   a) Explain the benefit of using Unicode instead of ASCII to encode char

   b) UTF-8 is a variable-width type of Unicode encoding that uses a variabl
   encoding character. For example, the character A is encoded using one by
   be encoded using two bytes. Explain one advantage and one disadva
   number of bytes to represent each character.

   c) How many characters can a 16-bit number represent?

3. An IEEE754 floating-point number consists of three component parts: a m
   a sign bit (S). The following diagram shows how these three parts are co
   precision floating-point number:

S	E_4	E_3	E_2	E_1	E_0	M_9	M_8	M_7	M_6	M_5	M_4	M

   a) The following equation can be used to calculate the value of a non-z

   $$(1 - 2a)(1 + b)2^{c-15}$$

   Write the component each variable in the equation represents: *a, b,* c

   b) The number of bits allocated to the exponent and mantissa can be c
   that is made when the number of bits used to represent the exponen
   of bits used to represent the mantissa is reduced.

4. Floating-point numbers can be represented as two two's complement int
   exponent and one representing the mantissa. Use this floating-point form

   a) Convert the following binary floating-point numbers into denary:

   i.

0	1	0	1	0	1	0	1

   Exponent | Mantissa

   ii.

1	1	0	0	1	0	0	0

   Exponent | **Mantissa**

   b) Convert the following denary numbers into binary floating-point nu
   a 5-bit mantissa:

   i. 0.75
   ii. -7.5

c) Find the highest number that can be represented using a 3-bit expo

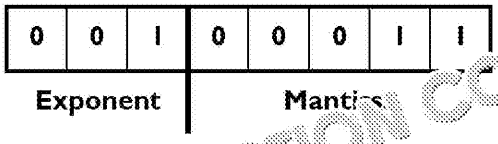
i. In floating-point binary
ii. In denary

d) Find the lowest number that can be represented using a 4-bit expon

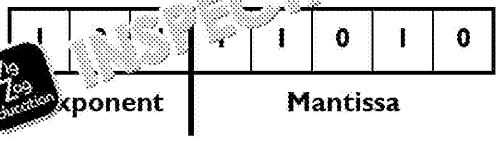
i. In floating-point binary
ii. In denary

e) Normalise the following floating point numbers:

i.

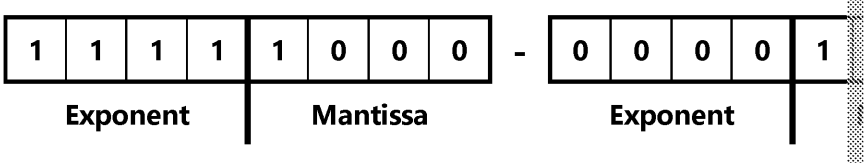


ii.



f) Add the following two numbers and normalise the result. Show your

g) Subtract the number on the right from the number on the left and n
Show your working.



5. Is it possible to represent 0.3 exactly in floating-point binary? Explain you

1.4.2 Data Structures

1. Arrays are a very popular and commonly used data structure in programm
language of your choice on this question wherever required.

   a) Write the code that would create a one-dimensional array (named 'sp
   five sports that are played at a school: rugby, football, hockey, netba

   b) In the majority of languages, arrays are said to be 0-based. What doe

   c) Write the code that would output the first and last element.

   d) It has been decided that football will no longer be played and they a
   Write the code that would update the arra[illegible]t is information.

2. Take the following example of [illegible] is currently stored in memory.

Memloc	Data	TopOfStac
6		
5		
4		
3	Fish	←
2	Cat	
1	Dog	

   a) Complete the table after the following commands:

   Push 'Mouse', Push 'Rat', Pop

   b) Complete the table after the following further commands:

   Pop, Pop, Push 'Rabbit'

3. Queues are a popular way of representing data within a computer.

   a) Explain the difference between a queue and a stack.

   b) Describe how a circular queue works.

   c) Complete the following table showing the state of the queue at each
   the queue at each state. You must complete the state of the queue a
   NextFree values at each stage.

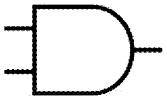
State 1	State 2	State 3	S
start state	H joins qu[illegible]	[illegible]erved from queue	J joi
1 2 3 4 5 C	1 2 3 4 5 A B C	1 2 3 4 5	1 2
FrontPtr = 1 NextFree = 4	FrontPtr = NextFree =	FrontPtr = NextFree =	FrontP NextF

1.4.3 Boolean Algebra

1. a) Explain the function of applying the following logical operators to a c

   i. NOT ii. OR

   b) What are the functions of the following logic gates?

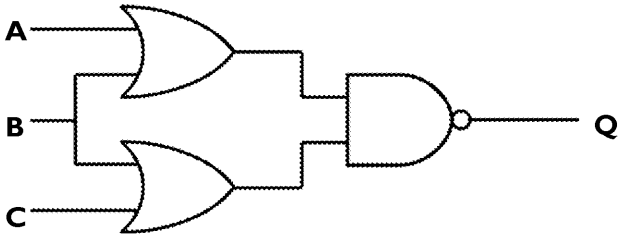
   i.  ii. 

2. Copy and complete the following truth table:

A	B	A NAND B	A OR B	A XOR B
FALSE	FALSE			
FALSE	TRUE			
TRUE	[illegible]			
[illegible]	TRUE			

3. Calculate the results of the following logic expressions:
   a) $0 \vee 1 \vee 1 \vee 0$
   b) $1 \wedge 0$
   c) $(0 \vee 0 \vee 0) \vee (0 \vee (1 \wedge 1))$

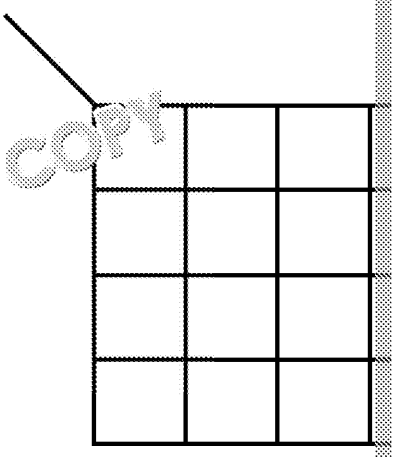
4. Consider the following logic diagram. Write the logic equation for Q.



5. Draw the logic diagram for this expression: ¬ ((A ^ B) ˅ C)

6. a) Draw a Karnaugh map using the truth table below.

A	B	C	D	Q
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1



   b) Use the Karnaugh map to produce a simplified equation for Q.

1.5.1 Computing-related Legislation

1. The Computer Misuse Act 1990 introduced three new criminal offences.
   a) State the three new criminal offences introduced in the act.
   b) Explain the concept of phishing and give an example of a way a crim gain access to a computer system.

2. The Data Protection Act 1998 sets out the laws that govern the way perso
   a) Explain what is meant by personal data according to the act.
   b) The act contains eight principles that should be followed by organisa data. State three of these princi
   c) Does the UK gover nt have to abide by the principles laid out in t
   d) A marketing company wants to collect data about potential custome information such as the person's name, date of birth and contact det and storing it in a database. Does the Data Protection Act forbid this

3. The Copyright, Designs and Patterns Act 1988 sets out some of the laws t content owners.
   a) Give one example of a type of work that can be protected by each of
      i. Patents
      ii. Copyright
      iii. Designs
      iv. Trademarks
   b) In most cases it is illegal for a programmer to copy code that someo her company's code without the owner's permission.
      i. What type of protection applies to computer code?
      ii. The computer code does not contain a notice displaying the nar protected?
   c) Explain the concept of *fair dealing*.
   d) A company is developing a new software product that includes a nev company. They are unsure how they should protect their new softwa Discuss the advantages and disadvantages of the protections they co

4. The Regulation of Investigatory Powers Act 200 e as surveillance and and postal communication.
   a) Encrypted communication is useless when they are intercepted un Explain the provision the act contains to mitigate this problem.
   b) T a has been widely criticised by privacy campaigners. Explain wh an pare the benefits of the act with its effect on civil liberties.

1.5.2 Moral and Ethical Issues

1. a) Peer-to-peer networks are frequently used to share large files on the

   i. Explain what a peer-to-peer network is.
   ii. Give two reasons why peer-to-peer networks are more popular networks for distributing pirated videos.

   b) Explain what Digital Rights Management (DRM) is.

   c) Give four ways DRM might restrict the way a video file can be used.

2. Give two advantages and two disadvantages of [illegible] robots for work i

3. There has been a huge push in [illegible] years into the development of com software by companies [illegible] Google, Facebook and Apple.

   If a hu[illegible] s[illegible] two pictures, they will be able to identify if the same an acc[illegible]f 97.53% on average. Facebook has developed an algorithm

   Discuss the uses of this technology and any ethical issues surrounding its You may wish to consider what the technology would be used for, privacy information and the impact of wearable technology.

4. 'According to a well written and thorough article in the ***Virginia Journal*** we've been saying for over three years has been determined to be true: W

   In September 2004, this statement was written by Marius Milner. Marius w NetStumbler, which is a tool used to map Wi-Fi networks using a Wi-Fi ca known as 'WarDriving'.

   Marius Milner also worked for Google and his code for gathering this info the street-view cars which were used to gather data on mapping network from open networks as street-view information was being gathered.

   Discuss the ethics and legality of WarDriving. You may wish to consider h WarDriving yourself – what information could be gathered, what the end such information, what happens to the information later, and where it is s

1.1.1 Processors

1. A processor is the chip/circuit in a computer that decodes and executes instr

2. *1 mark for each answer in **bold**:*

Name	Role
Data bus	**Carries binary data to and from devices.**
Control bus	Carries processor commands to devices and returns signals
Address bus	**Carries the address/location of data that needs to be sent retrieve data from.**

3. a) 1 mark for circling ADD, MULTIPLY and SHIFT

   b) *2 marks for a correct des... 1 mark if the description is less specific b*
   i. Program Co... Stores the memory address of the next instr... ...uction and can be overwritten to branch.
   ii. ...mulator (ACC): Stores the results of arithmetic and logic opera... ...erations.
   iii. Current Instruction Register (CIR): Instructions are loaded into this r... while the instruction is decoded and executed.

   c) *1 mark for each correct step and 1 mark for each correct register name. Ti... in any order:*
   Load the target memory address into the MAR (memory address registe...
   Load the data to store into the MDR (memory data register).

4. a) i. Fetch:
   Load the next instruction from the memory location given by the p... into the current instruction register (CIR) (1 mark). Increment the co...
   ii. Decode
   The processor separates the instruction in the CIR into the function... immediate values (1 mark) and registers to operate on or store resu...
   iii. Execute (up to 3 marks from the following)
   The instruction and its associated data are dispatched to the appro... ALU or LOAD/STORE unit) (1 mark). If the operation is a branch the... operation is a load or a store then the MAR is updated with the me... either read from or written to (1 mark). Arithmetic and logic instruc... alternative destination register (1 mark). If the operation is a HLT in... are loaded (1 mark).

   b) *1 mark for identifying a technique and 1 mark for a correct explanation:*
   - Clock speed: Increasing the clock spe... ...es the time the pr... each operation.
   - Cache size: Increasing ...ze ...e cache reduces the chance that ... need to trav... the way to the main memory, reducing the ave... an op...tion.
   - ...e ... instructions (also known as SIMD): Operations take place ... ...han needing to be executed one after another.
   - Multiple cores: Increasing the number of cores means that m... simultaneously rather than needing to be executed one after ...

5. *Give 2 marks for correctly identifying the difference between the two architectu... reasonable application of each.*

   Von Neumann: Instructions are stored in the same memory address space as ... purpose computers.
   Harvard: Instructions are stored in a separate memory address space to the d... embedded applications.

1.1.2–3 Types of Processor, Input, Output and Stora

1. a) *1 mark for each two correct answers:*

Resource	Shared between Cores (Y
ALU (arithmetic and logic unit)	No
RAM (random-access memory)	Yes
Network card	Yes
PC (program counter) register	No

b) *2 marks for each advantage and disadvantage, o identification and*

Advantages:

- Performance: Can do multiple tasks in parallel.
- Responsiveness: Tasks don't necessarily have to wait for other tas
- Clearer code: Tasks that are unrelated can be written in separate f
- Tasks rather than needing to be multiplexed into a single code

Disadvantages:

- Difficult: Writing and maintaining multi-threaded code is generall single-threaded code.
- Bugs: Rewriting the code may introduce bugs.
- Less clear code: Tasks that need to be split to balance the load on elegant.

2. a) The processor is a CISC processor (1 mark). The instruction performs mo

b) *1 mark for a reason and 1 mark for a correct explanation:*

- Low power: RISC processors require less complex circuitry and so
- Custom chips: RISC processors are simpler and, therefore, cheape less chip space. Therefore, they are easier/cheaper to combine wit single chip (known as a system-on-chip or SoC).
- Software availability: RISC processors are more common than CIS and, therefore, more mobile-centric software is available.
- Simpler assembly: Code written in RISC assembly uses a smaller n be easier to write and understand. This can be important if a mob to heavily hand-optimise parts of the software to improve perfor

3. a) 2 marks: RAM loses its data when it loses power; therefore, a ROM is use remains available after power has been lost.

1 mark: RAM can be overwritten so the boot pro might be lost. By to accidentally wipe the boot program.

b) *1 mark per advantage and dis va ge. Only one advantage and disadv*

- Flash me stick, SD card, etc.):
- dv can save operating system state, maximum capacity
- advantages: high cost relative to optical media, might be slow
- Optical disk (CD, DVD, Blu-Ray):
- Advantages: cheap, can save state if rewriteable
- Disadvantages: easily damaged, can degrade, slow, require optica
- External hard disk (HDD, SSD):
- Advantages: cheap per GB relative to flash memory, fast, can save
- Disadvantages: minimum cost is high, possibly fragile if HDD used

4. a) *2 marks each for two of the following:*
   - Mouse (to select classes, and then pupils who are absent) – cheap
   - Keyboard – cheap and shortcut commands can be used
   - Optical Mark Reader – very quick and access to computer not nee
   - Bar Code Reader – easy to use and could later be used (by pupils) from printed sheet by teacher
   - Electronic Whiteboard – often installed in modern classrooms and see the class
   - RFID – can be used wirelessly for convenience
   - Smart Card – can contain a relatively large amount of information other alternatives so can be used for various functions
   - Biometrics – much more secure than other methods as only a per enter data into the computer

   b) *1 mark for a correct advantage and 1 mark for a good explanation for two*
   - Appears as a single storage device: users don't have to manage m
   - Cheap: commodity hardware can be used to implement storage s
   - Expert advice as expensive dedicated network storage devices
   - Expandable: adding extra servers can expand storage capacity; vir limits a single piece of hardware such as a NAS has
   - High availability: virtual storage can be designed with redundancy ensure maximum uptime

1.2.1 Systems Software

1. a) 1 mark for circling I/O DEVICE COMMUNICATION, PROCESS SCHEDULIN

   b) A real-time operating system provides processes with guarantees about will be scheduled to run. This means that processes can be designed to within a certain time frame. Real-time operating systems are typically op rather than throughput as a standard operating system is.

   c) A distributed operating system combines multiple computers connected virtual system.

2. a) Virtual memory is a mapping, usually implemented with hardware suppo management unit), from a processes address space to a physical addres that processes do not use physical memory addresses directly.

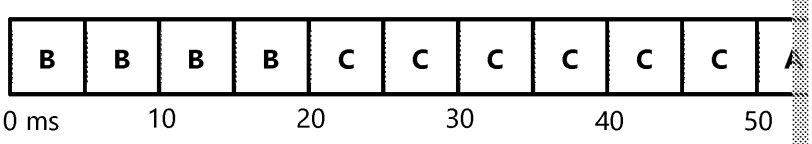
   b) Since each process can only see the address space it has been allocated are not in its address space. Therefore, it cannot overwrite or read memo system or other processes.

   c) *1 mark for one of the following advantages:*
   - Allows system to keep functioning even if it runs out of main mem
   - Infrequently used data can be moved from main memory to ma data and cach

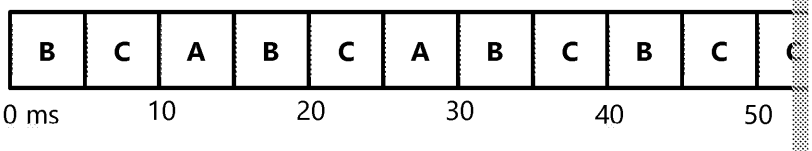
   1 mark for one of the following disadvantages:
   - System performance may be reduced if data contained in second
   - Memory may be moved to secondary storage unnecessarily.
   - Memory access times become more variable (important in system performance/responsiveness is required).

3. a) *Full marks for the correct answer. 1 mark if the processes are scheduled in times are incorrect.*

   i. First come, first served



ii. Round robin



c) i. First come, first served (C ends after 50 ms rather than 60 ms).

ii. No (1 mark), if A and B were longer-running processes and started first they have to wait until the long-running processes completed before getting processor time. In a round-robin approach they would get processor time earlier, and so complete in a first come first served system (2 marks).

iii. Multi-level feedback queues could be used (1 mark). In this scheduling system C is classed in a higher priority queue than A or B. The scheduler prefers to run higher priority queues so C would be run in preference to A or B until it

4. a) A virtual machine is a piece of software that executes instructions designed for a machine itself or for a hardware platform that the virtual machine is emulating.

b) *1 mark each for up to two of the following:*

- Executing an instruction in software incurs overhead (the cost of running in place for example) that executing an instruction in hardware does not.
- Hardware may contain specialised circuits to perform certain operations.
- The instruction set of the machine being emulated may not be a good fit for the machine the emulator is run on, so the virtual machine may have to carefully map the instructions to the real underlying hardware.

c) *1 mark for each of:*

- Interpreting an intermediate instruction set generated by a compiler.
- Running one or more operating systems within another.

5. *1 mark for each of the following steps. Full marks should also be given if an alternative but correct method is described.*

- Provide an interrupt service routine (ISR) that will add the process back to the scheduler.
- Register the ISR so that it will be called when the given time period has elapsed.
- Remove the process from the operating system's scheduler.
- Yield the process to stop executing.
- When the process resumes, check to see if the given time period has elapsed and repeat the process subtracting the time elapsed from the delay required.

1.2.2 Applications Generation

1. a) 1 mark each for correct descriptions of system software and application software. Application software is used for a specific task. System software controls and manages the system and provides a platform for applications.

b) *1 mark for each two correct answers.*

Software Name	Type (Application or System)
Operating System	System
Word Processor	Application
Calculator	Application
Sound Card Driver	System

2. a) Assembler, interpreter

b) *2 marks for each correct description:*
Compilers convert code written in a high-level language into an executa
Assemblers convert code written in a low-level assembly language into a
machine code.
Interpreters execute code directly without necessarily first converting int

3. a) Closed-source programs are programs where the source code is kept se
code for open-source programs is made available to the recipient and th
redistribute it (1 mark).

b) *1 mark for a correct example of each. Examples:*
Open-source: Linux, Open/LibreOffice, GCC, Mozilla Firefox, Chromiu
Closed-source: Windows, Office, Internet Explorer, Safari, PowerDVD,

c) *Up to 2 marks each for one advantage and one disadvantage, with good e*

Advantages:
- Community involvement and support: members of the software d
develop and support the software.
- Maintaining community relations: open-sourcing software can he
relations with the community and encourage similar ventures by c
- Increased adoption: the software might be adopted more widely a
commercial activities such as advertising, hardware sales and prop

Disadvantages:
- Exposure of proprietary information: the software might expose in
would rather keep secret.
- Difficult to sell open-source software: it can be more difficult to m
than proprietary software.

1.2.3 Introduction to Programming

1. a) Procedural programming languages are imperative (consist of a sequen
executed one after the other) (1 mark) and have subroutines/procedures
isolate and group a particular sequence of statements to provide some s

b) i. Scope
ii. *1 mark for each of the following points up to a maximum of 2 marks*
- Makes it more difficult to accidentally change the value of a v
program can see.
- Reduces the possibility of procedures having side effects tha
understand and work with the code.
- Allows access to variables to be restricted to the executing th
accessed by any thread (possibly in an unsafe manner).

2. a) *2 marks for describing the term, plus an additional mark for giving e*
Variables are declared to store data that may change while the program
For example, the product number of an item on an e-commerce website
Constants are used where data that is used in a computer program is pr
For example, assigning Pi (π) the value of 3.145 (3dp).

b) A procedure is a routine called by the program which performs a set of a
A function is a routine called within an expression which returns a result

3. a) i. 23 MOD 4 = 3
ii. 23 DIV 4 = 5

b) Concatenation is used to join two strings together where the combined
Example (1 mark), 'OCR' + 'Computer Science'; returns 'OCR Computer S

4. a) The program adds B to the result (1 mark) A times (1 mark).

   b) It will produce the correct answer (1 mark). If A is 0, the loop will not exe
   and if B is 0, then 0 will be added to the result A times, again resulting ir

   c) Labels (1 mark). They allow instructions to be addressed without hardco
   might change as the program is edited (1 mark).

   d) Pseudocode:

```
RESULT = A
while (B - RESULT) < 0
    RESULT = RESULT - B
endwhile
```

   Assembly Program:

```
        INP
        STA
        STA     B
LO      LDA     B
        SUB     RESULT
        BRP     QUIT
        LDA     RESULT
        SUB     B
        STA     RESULT
        BRA     LOOP
QUIT    LDA     RESULT
        OUT
        HLT
ONE     DAT     1
B       DAT
RESULT  DAT
```

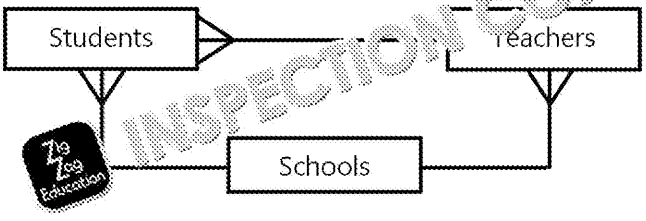
   Max 3 marks for a correct pseudocode algorithm (does not have to mat
   Max 4 marks for fully correct assembly program (reduce accordingly if th

1.3.1 Databases

1. a) One-to-many

   b) The relationship between students and teachers is the wrong way round
   students to one teacher.

   c)



2. a) A primary key is an attribute which uniquely defines a tuple/row.

   b) A secondary key is an attribute which uniquely defines a tuple/row but t
   the primary key.

   c) A foreign key is an attribute that is found in multiple tables. It must be th
   tables.

3. a) Table names can vary from the below suggestions but should be sensibl

1 mark for each of the three tables with an extra mark for correctly having in the Order table for the relationships.

Order(OrderNum, CustNum, StockNum, OrderDate, OrderTime, Dispatch
Customers(CustNum, Title, FirstName, Surname, Address, PostCode)
Stock(StockNum, StockName, Price, Manufacturer)

b) i. *All primary keys must be present to get the mark and must match th Don't penalise twice for mistakes in part a.*
OrderNum, CustNum, StockNum

iii. *Both foreign keys must be present to get the mark and must match t Don't penalise twice for mistakes in part*
CustNum and StockNum in the Orders Table

c) *1 mark for all tables being present*

1 mark for the correct labelling and connections between them
1 mark for showing the 1-many relationships
Tables may differ from below but must match pupil's answer for part a.

d) For each table:

1 mark for all fields being defined.
1 mark for a sensible Data Type and Format for each field.
1 mark for sensible Validation Rules/Input Masks/Default Values used.
1 mark for correct identification of keys.

The items below are suggestions only – any logical answers can gain cred Tables must match the pupil's earlier database format.

Customer Table *(4 marks)*

Field	Data Type	Format	Validation Rule/Inpu
CustNum	AutoNumber		"CUST
Title	Text	Length = 4	
FirstName	Text	Length = 15	
Surname	Text	Length = 15	
Address	Text	Length = 30	
PostCode	Text	Length =	>LL

Stock Table *(4 mar*

Field	Data Type	Format	Validation Rule/Inpu
StockNum	AutoNumber		"STCK
StockName	Text	Length = 25	
Price	Currency	£0.00	Defa Validat
Manufacturer	Text	Length = 25	

Order Table *(4 marks)*

Field	Data Type	Format	Validation Rule/Inpu
OrderNum	AutoNumber		"ORDR
CustNum	Number	Long Integer	
StockNum	Number	Long Integer	
OrderDate	Date/Time	Short Date	Defaul Validation
OrderTime	Date/Time	Short Time	Defaul Validation
Dispatched	Yes/No		

1.3.2 N...o...

1. a) i. ...serial connection is one where only one bit can be sent at a time.
   ii. A parallel connection is one where multiple bits are sent simultaneo

   b) Serial would be a better choice because in a long-distance parallel cable the signal meaning that data transmission has to be slowed right down in a parallel cable also means that it costs significantly more (1 mark).

   c) $transmission\ time = \frac{amount\ of\ data}{bandwidth} + delay$

   $transmission\ time = \frac{1}{100} + 0.01 = 0.02\ s = 20\ ms$

2. a) i. A gateway is a device which converts between two different types o In this example, it is required in order to convert between the ADSL and the Ethernet system used in the local network (1 mark).
   ii. A person does not need physical access to their building/network i (1 mark) so communication should be password-protected/encrypt WPA2 (1 mark).

   b) Any IP address in the range 192.168.1.2–192.168.1.254 such as 192.168.1

   c) Firewalls block network traffic based on a set of rules (1 mark). They mak attackers to probe computers to discover vulnerable services, for examp

   d) DNS (domain name service) (1 mark). DNS is responsible for translating addresses (1 mark).

3. a) A packet consists of data and a head... m...). The header contains inf the packet, the destination ...et, the sequence number of the si checksum of the pac... for ...mple (2 marks for at least two).

   b) Eve... me... ...r receives a packet it sends an acknowledgement to re... (1 ...ark). If the client does not receive the acknowledgement w (1 ...) then it resends the packet (1 mark). The sequence number is en be received out of order (1 mark). So the client would simply resend the acknowledged.

   c) *1 mark for an advantage and 1 mark for a good description.*
   - Allows HTTP to operate over TCP/IP networks: no special hardwa
   - Can take advantage of TCP/IP features such as error handling: so
   - Simplicity: reduces the complexity of the HTTP standard.
   - Reliability: TCP/IP implementations may already be very reliable.
   - Flexibility: HTTP could use other transport systems as required.

4. *2 marks for each advantage/disadvantage up to a maximum of 6 marks.*

Advantages of peer-to-peer:
- Cheaper – no need to buy bandwidth / expensive servers
- Can be faster – transmission does not need to travel to a server and or
- Privacy – the transmission is not sent to a server

Advantages of client-server:
- Less complex client code (important if, for example, the client is impler
- Server can be upgraded to fix security problems – client is controlled b as frequently
- Servers can provide more features

1.3.3 Web Technologies

1. a) *1 mark for using <a> ... an... mark for using it correctly.*

```
<p>M... fa... ... website is <a href="http://www.bbc.co
N...  ...> ... p>
```

b) She should use the h1 (or, less likely, h2–6) tag (1 mark). It is important t styled appropriately by a web browser (1 mark) / interpreted properly by reader (1 mark).

c) Each item should be contained in <ul> tags, with an <li> tag around the

```
<li>
    <ul>My favourite website is BBC News.</ul>
    <ul>My favourite TV show is Downton Abbey.</ul>
</li>
```

d) *1 mark for each of the following elements: form, text input, submit input, l*

```
<form>
    <label>Name</label>
    <input type="text">
    <label>Comment</label>
    <input type="text">
    <input type="submit">
</form>
```

2. a) i. *1 mark for using a link tag, 1 mark for any other correct element up*

```
<link rel="stylesheet" type="text/css" href="styl
```

ii. *1 mark per advantage up to a maximum of 2 marks.*
- Can be used in multiple HTML files
- Can be cached by a browser
- Can be swapped out to give the site diff... ent looks

b) *1 mark for identifying that a class is requ... ed. 1 ...ark for adding the class selector and 1 mark for the corr... ...yntax.*

The author should ... a class. Example code:

HT...
```
<p ... s="deadline">...</p>
```

CSS:
```
.deadline {
    .color: red;
}
```

3. a) JavaScript is executed by the web browser on the client's computer.

   b) `document.getElementByID("name").innerHTML = "Emily";`

   c) *5 marks for a correct function that fulfils the specification. Accept minor e*

```
function checkPassword() {
    var pswd = document.getElementById("pswd");
    if (pswd.value.length < 8) {
        pswd.style.backgroundColor = "red";
    } else {
        pswd.style.backgroundColor = "green";
    }
}
```

4. a) Lossless compression is reversible: the origi[illegible]a can be recreated ex
   Lossy compression is not reversible: some data is lost (e.g. the quality m

   b) Examples: Music, Video, Ima[illegible]

   Reason: Hum[illegible]an still understand/enjoy the result when certain in

   c) L[illegible]cc[illegible]ression techniques require all the information in the comp
   or[illegible] the original file to be recreated (1 mark). Lossy compression w
   information, preventing the original file being recreated (1 mark). Lossle
   applied to lossy compressed files as the lossy compressed file will be rec

1.4.1 Data Types 1

1. a) Denary numbers are each represented by a pattern of bits which are inc
   example, 0000, 0001, 0010, 0011.

   b) *1 mark for five correct answers and 2 marks for a complete set of correct a*

Denary	Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F
16	10000	10

2. a)

```
  0011
+ 0010
  1001
```

   b)

```
  1011
- 0101
  0110
```

3. a) i. 102
   ii. 185
   iii. 197

   b) i. 01001110
   ii. 01111011
   iii. 11100100

   c) i. 45
   ii. -89

   d) i. 4.75
   ii. 11.5625

4. a) i. 11001100
   ii. CC

   b) i. 199
   ii. C7

   c) i.
   ii. 1100111

   d) i. 10010011
   ii. 11101101

   e) i. 1000.0011
   ii. 1111.1101

1.4.1 Data Types 2

1. a) i. F: 70
   ii. M: 77
   iii. X: 88

   b) *1 mark for the correct answer and 1 mark for the explanation mentioning* 28 – 4 spaces, 1!, and 23 letters. You may accept 29 if the student menti end of the line in the explanation.

   c) 128

2. a) Unicode can represent a much larger number of characters than ASCII.

   b) *1 mark for an advantage and 1 mark for a disadvantage:*

   Advantages:
   - Common characters can use fewer bytes
   - Can be made backwards compatible with ASCII

   Disadvantages:
   - More difficult to process
   - If a string does not use many one-byte characters then the encod

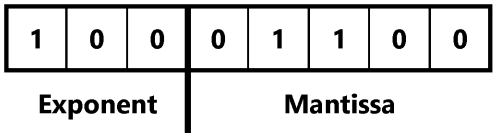
   c) 2^{16} = 65,536

3. a) a: sign
   b: mantissa
   c: exponent

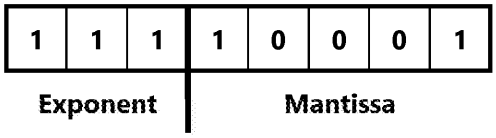
   b) Increasing the number of exponent bits increases the range of the numb precision of the number (1 mark)

4. a) i. $-11 * 2^2 = -44$
   ii. $8 * 2^{-2} = 2$

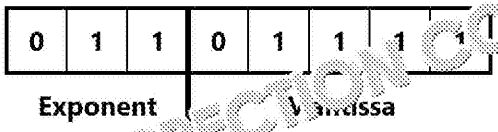
b) i. 0.75



ii. –7.5

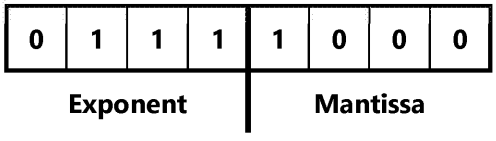


c) i.



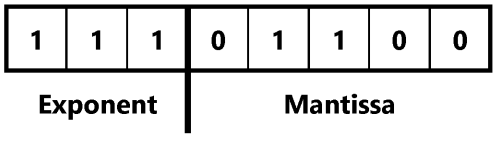
ii. 2

d) i.

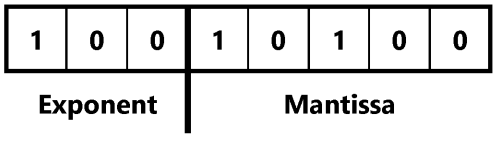


ii. $-8 * 2^7 = -1024$

e) i.



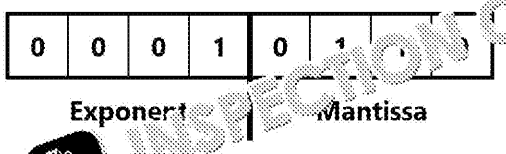
ii.



f) Equalise the exponents:
00000100 = 00010010

Add the mantissas:
0100 + 0010 = 0110

Answer:



g) Equalise the exponents:
11111000 = 00001100

Subtract the mantissas:
1100 – 1010 = 0010

Normalise the result:
00000010 = 11110100

Answer:

1	1	1	1	0	1	0	0
Exponent				Mantissa			

5. No (1 mark). 0.3 is not representable as a fraction with a denominator that is

1.4.2 Data Structures

1. a) *1 mark for the correct declaration of an array string and 1 mark for the sp*

```
C:
const char *sports[] = {"rugby", "football", "hockey"

VB:
Dim sports() As String = {"rugby", "football", "hocke
"cricket"}

JS:
var sports = ["rugby", "football", "hockey", "ne
```

b) The first element of the array has the index 0 which means the last elem of number of elements –1.

c)
```
C:
printf("%s\n", sports[0]);
printf("%s\n", sports[4]);

VB:
console.writeline(sports(0))
console.writeline(sports(4)) OR console.writeline(spo

JavaScript:
console.log(sports[0]);
console.log(sports[4]); OR console.log(sports[sports.
```

d) `C/JavaScript: sports[1] = "gymnastics";`
`VB: sports(1) = "gymnastics"`

2. a) Accept 1 mark each for Mouse and Rat being added in the correct order being at MemLoc 4.

Memloc	Data	TopOfStack
6		
5	Rat	
4	Mouse	←
3	Fish	
2	Cat	
1	Dog	

b) Accept 1 mark for TopOfStack being in MemLoc 3 and 1 mark for the Rabbit (Do not advise for a mistake in part a if their answers suit their r

Memloc	Data	TopOfStack
6		
5	Rat	
4	Mouse	
3	Rabbit	←
2	Cat	
1	Dog	

3. a) A queue is a first-in, first-out (FIFO) data structure (1 mark) whereas a st
data structure (1 mark). This means that items are retrieved from a queu
inserted, whereas items are retrieved from a stack in the reverse of the c

b) A circular queue consists of a fixed length array with pointers to the star
of the queue. The pointers wrap around to 0 when they reach the end o

c) *1 mark for the state of the queue and 1 mark for the pointer values being*

State 1	State 2	State 3	S
Start state	H joins queue	Item served from queue	J joi
1 2 3 4 5 A B C	1 2 3 4 5 A B C H	1 2 4 5 A C H	1 2 A B
FrontPtr = 1 NextFree = 4	Front = 1 Next = 5	FrontPtr = 2 NextFree = 5	Fro Nex

1.4.3 B an Algebra

1. a) i. NOT – This gives the negation (or opposite response)
ii. OR – This shows whether either of the two conditions is true includin

b) i. AND
ii. XOR

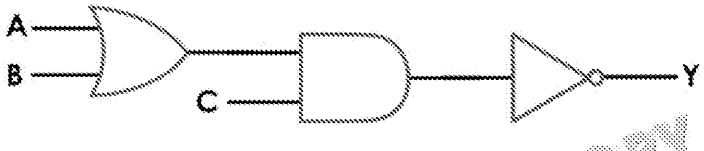
2. *1 mark for each correct column.*

A	B	A NAND B	A OR B	A XOR B
FALSE	FALSE	TRUE	FALSE	FALSE
FALSE	TRUE	TRUE	TRUE	TRUE
TRUE	FALSE	TRUE	TRUE	TRUE
TRUE	TRUE	FALSE	TRUE	FALSE

3. a) 1 b) 0 c) 1

4. $Q = \neg((A \vee B) \wedge (B \vee C))$

5. *1 mark for each correctly placed symbol:*



6. a)

CD \ AB	00	01	11	10
00	0	1	0	0
01	0	1	1	1
11	0	1	1	1
10	0	1	0	0

b) $Q = (\neg A \wedge B) \vee (A \wedge D)$

1.5.1 Computing-related Legislation

1. a) *1 mark for each correct criminal offence*
   Accessing computer material without authorisation.
   Modifying computer material without authorisation.
   Accessing computer material without authorisation in order to commit a

   b) Phishing is the act of masquerading as a trusted institution or person (e.g
   into providing personal information (1 mark). Phishing can be used to ge
   and passwords in order to get access to a computer system (1 mark).

2. a) *Up to 2 marks from the following:*

   Personal data is data related to a living individual (1 mark) who can be id
   - from the data (1 mark)
   - from the data and other informati... ...ata controller has, or is
     of the data controller (1 ...)

   b) *1 mark each for up ... the following (may be reworded and simpli*

   - ...ers... ...ta shall be processed fairly and lawfully and, in particu
     - (a) at least one of the conditions in Schedule 2 is met, and
     - (b) in the case of sensitive personal data, at least one of the co
   - Personal data shall be obtained only for one or more specified an
     be further processed in any manner incompatible with that purpo
   - Personal data shall be adequate, relevant and not excessive in rela
     for which they are processed.
   - Personal data shall be accurate and, where necessary, kept up to d
   - Personal data processed for any purpose or purposes shall not be
     for that purpose or those purposes.
   - Personal data shall be processed in accordance with the rights of
   - Appropriate technical and organisational measures shall be taken ag
     processing of personal data and against accidental loss or destructio
   - Personal data shall not be transferred to a country or territory out
     unless that country or territory ensures an adequate level of prote
     of data subjects in relation to the processing of personal data.

   c) Yes, unless there is an exception for a particular purpose.

   d) Yes, it is forbidden (1 mark). In order to store identifiable data about an
   individual in question must give their consent (2 marks).

3. a) One example required for each.
   i. Inventions
   ii. Literature, art, music, code, film or any other copyrightable work
   iii. Product appearance, configuration, decoration or shape
   iv. Names, logos and phrases

   b) i. Copyright
   ii. Yes, copyright is automati...

   c) Fair dealing is the ... ...roduction of part of a copyrighted work (1 m
   resea...h/r... ...n news reporting (1 mark).

   d) *1 ... r each point up to a maximum of four.*

   They could use copyright or patents (1 mark). Copyright means that no c
   code / program (1 mark); however, it does not automatically stop somec
   algorithm and rewriting the code from scratch (1 mark). Patents might a
   algorithm (1 mark) although technically algorithms are not directly pate
   also force them to make their algorithm public (1 mark). Patents also
   expire much more quickly than copyright (1 mark).

4. a) The act allows the authorities to demand that a person either hand over the file. It is a criminal offence not to comply.

b) This is a banded question:

Level	Description
3	Provides a clear, structured and well-reasoned response. Identi points and provides examples related to the act.
2	Provides a clear, structured and well-reasoned response. Identi
1	Provides one or two points related to the act.

Example benefits of the act:

- Provides a legal framework for covert [illegible]ce and clarifies the institutions.
- Allows police to inter[illegible] communications relating to terrorism a
- Allows secret [illegible]ces to intercept communications for national se

Exa[illegible] civil liberties:

- [illegible]ows installation of equipment at ISPs enabling mass surveillanc
- [illegible]pen to many different parts of government (including local cour such a broad mandate for surveillance.
- Broad range of reasons that surveillance can be used.
- Limited oversight.
- No way to achieve redress.

1.5.2 Moral and Ethical Issues

1. a) i. A group of computers connected together with equal status that ca data.

ii. Any two of the following:

- Difficult to shut down (need to shut down all the peers rathe
- Lower cost as upload bandwidth is shared
- Harder to trace the original source of the files
- Faster as upload bandwidth is equal to the combined upload

b) DRM uses hardware or software and encryption to restrict the usage of a

c) *1 mark for each of the following (up to a maximum of 4):*

DRM might prevent a video file being:

- viewed on multiple computers
- copied to different computers
- viewed more than a set number of times
- played using anything other than [illegible]r proprietary program
- played on portable devic[illegible]
- played in an uns[illegible] country

2. *1 mark f[illegible]ch [illegible] of two advantages and two disadvantages:*

Advant[illegible]

- Robots can work in places that humans can't
- Robots can perform tedious tasks continuously and at speed
- Robots are cheaper to run than a labour force
- Robots are consistent in the quality of finished products

Disadvantages

- Robots are very expensive to set up
- Robots are unable to work well in changing environments
- Robots can be difficult to maintain without the relevant expertise

3.

Level	Description
4	A line of reasoning has been followed to produce a coherent, relevant, logically structured response. The response covers all four areas indicat guidance below and in at least three of these areas there is sufficient de the student has a good level of understanding of the technologies requ of understanding would be indicated by expanded points showing both arguments in each section. Answer uses an excellent range of technical vocabulary and there are n few spelling or grammar mistakes in the answer.
3	A line of reasoning has been followed to produce a coherent, relevant, s logically structured response but the response may only cover three of t in the guidance below, with two or three substantiated points being mad Answer uses a good range of technical vocabulary but there are more t or grammar mistakes in the answer.
2	A limited attempt has been made to follow a line of reasoning by cover topic areas in the guidance below. Overall, at least four valid points which can relate to any of the topic areas in the guidance. Answer uses some technical vocabulary and there are several spelling o mistakes in the answer.
1	A few relevant points have been made but there is no evidence that a li has been followed. The points may only relate to one or two of the four guidance or may be made in a superficial way with little substantiation. Answer contains very little if any technical vocabulary and the spelling / g

Indicative content –

What the technology would be used for

Facial unlock of devices

Security (e.g. the bouncer who knows you in a crowd of people before you g

Targeted advertising – Tesco announced plans for screens that identify your checkout and target you with specific advertising.

The more companies such as Facebook and Google know about you, the bet advertising, etc. Facial recognition allows them to create a kind of diary of yo pictures on the Internet to create a personal history.

TVs are being made that can measure your engagement with a program/adv companies directly.

Benefits include targeted adverts that you may actually find relevant and sign

Privacy concerns

When is the data being collected?

Always-on technologies

Do the brands have the right to know anything and everything about their cu have such information?

Who can this data then be shared with? (SceneTap is a company in America w It allows users to identify in real-time information on gender ratios and average wish to see where to go on a night out. The company have since filed a p identifi ple with their social networking profiles. This would then be us status, intelligence, education and income' – is this information then going to

Most information that is currently data mined by companies is anonymous – designed to be exactly the opposite.

Plans for use in public places means people don't get the choice to 'opt in' – is it

Who holds the information?

Who has given permission for the data to be taken in the first place?

Who can the data be passed/sold to?

What country is the data stored in? Implications of the Data Protection Act.

The impact of wearable technology
Google Glass and other such technologies herald an age where someone cou
identify you on the street without ever meeting you.
As soon as Google Glass was announced, an app called NameTag was create
you are able to start a conversation with a stranger; it would take a picture ar
Internet to find out who it is. Google Glass said they wouldn't use facial recog
matter of time before someone else does – would Google then change their

*The specific use of Google Glass is not required – even though the project is discon
to call upon and has only been discontinued so that Google can develop the next*

4.

Level	Description
4	A line of reasoning has been followed to produce a coherent, relevant, s logically structured respon[illegible] response covers all four areas indicate guidance below a[illegible] at least three of these areas there is sufficient de the studen[illegible] good level of understanding of the technologies requ [illegible]ding would be indicated by expanded points showing both [illegible]nents in each section.
3	A line of reasoning has been followed to produce a coherent, relevant, subst logically structured response but the response may only cover three of the a the guidance below, with two or three substantiated points being made per
2	A limited attempt has been made to follow a line of reasoning by coveri the topic areas in the guidance below. Overall, at least four valid points made which can relate to any of the topic areas in the guidance.
1	A few relevant points have been made but there is no evidence that a lin has been followed. The points may only relate to one or two of the four a guidance or may be made in a superficial way with little substantiation.

Indicative content –

How easy it is nowadays to do WarDriving yourself?
The ability to map nearby Wi-Fi networks using GPS data is now a common f
many able to complete the task without a 3rd party app.
When using these inbuilt apps, who has control over that data thought?
Where is it going and why is it being used?

What information could be gathered?
At the most basic level a map would be created with an overlay of Wi-Fi cove
indication of the security level of each network so that open/public networks
As Google did during the Street View project though, other data can also be
then connected to and any information on the network that could be accesse
to the Google servers.
Google argued any information stored on an individual was only ever very m
the car driving past the house/b[illegible]

What may the end [illegible] gathering such information?
The ma[illegible]ur[illegible] WarDriving is to identify open networks for the conve
where [illegible]n go to get Wi-Fi access if required (e.g. in a café).
WarDriv[illegible] can be broken down into three groups:

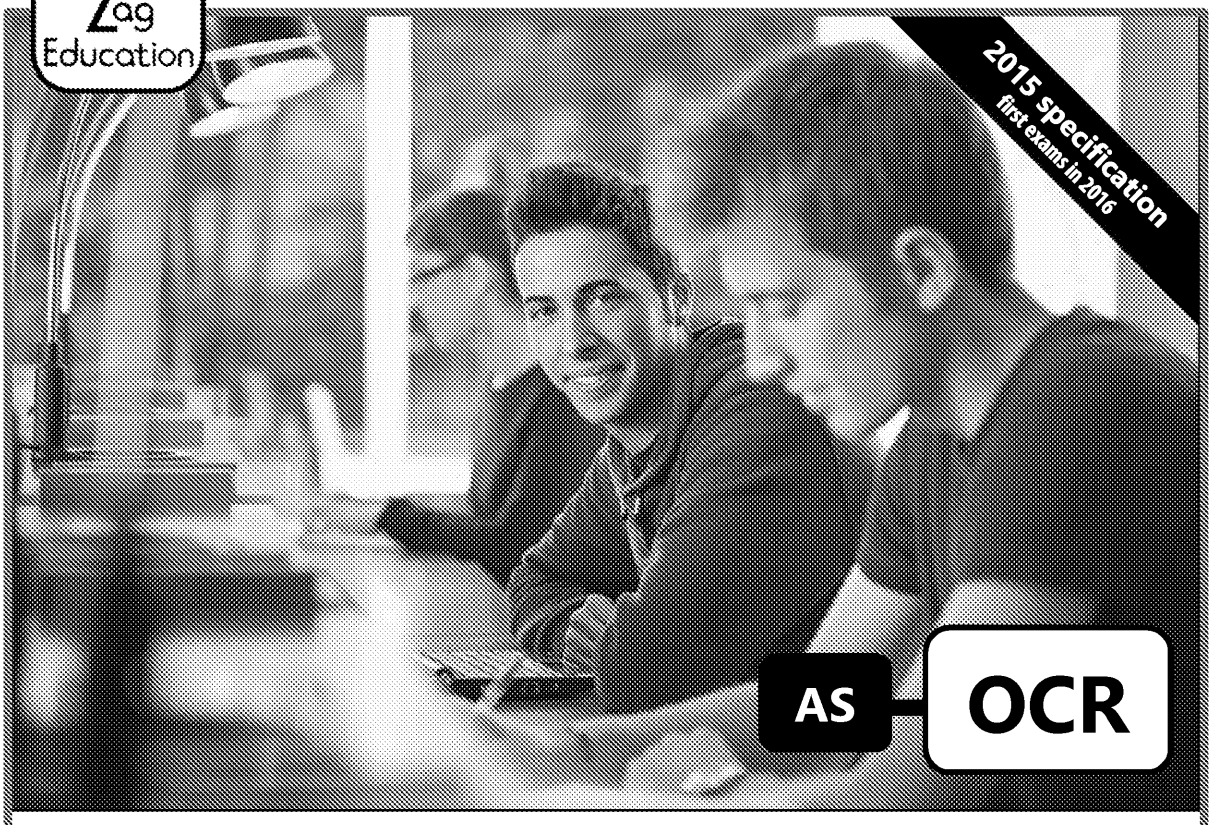
- 'They innocently wish to gain free wireless access in their neighbourhoo
- 'They have commercial motivations and hope to sell security services.'
- 'They have dishonest motives and hope to surreptitiously access netwo spam, or acquire illegal data.'

What happens to the information later, where is it stored?
Who has given permission for the data to be taken in the first place?
Who can the data be passed/sold to?
What country is the data stored in? Implications of the Data Protection Act.

Zig Zag Education

Computer Science

AS | OCR | H046



Topic Tests

for AS OCR Computer Science

Component 2

zigzageducation.co.uk

POD 6299

Contents

Teacher's Introduction

This resource is designed to support teaching and learning of the AS OCR specification (for first teaching in September 2015; first exams from June 2016).

These end-of-topic tests are designed as factual tests to check your students' understanding as they complete each topic*. Their primary focus is not to provide exam-style practice, but instead to test the knowledge, skills and understanding required by the OCR specification in a variety of styles and complexities – ranging from simple short-answer questions through to longer essay-style questions.

**The tests could also be used for homework or revision, but their best use is as summative assessments.*

The tests cover the prescribed specification content for *Component 2* of the AS OCR specification – each provided in worksheet format (with answer lines) and a more photocopy-friendly format (without answer lines), to give you flexibility of use.

Each test is worth between 20–40 marks, and can be completed comfortably within a single one-hour lesson. Example answers are provided for every test. *Note that credit should also be given for any valid responses that are not explicitly included in this resource.*

2.1.1–5 Computational Thinking 1

1. You have been tasked with developing a library that contains a single functio of floating-point values and returns a new array containing the same values

   a) Identify the information about the input array that `fsort` would req

   .....

   .....

   b) Explain the benefit of placing `fsort` into a library rather than directl

   .....

   .....

   .....

   c) A m that the library will be used on contains a processor with for sorting floating-point numbers. Give two ways you could make a instruction on this platform. Which method would you recommend a

   1.....

   .....

   .....

   2.....

   .....

   .....

2. A programmer has a problem. They want to log debug information to eit depending on an option the user has set. This has led to their code conta code repeatedly:

```
msg = "..."
if options.getPrintToScreen() then
   print(msg)
elseif options.getPrintToFile() then
   options.getFile().write(msg)
endif
```

   a) Propose a way of reduc[illegible] nount of repetition in their code.

   .....

   .....

   b) Explain how your proposal would make it easier to add new features adding a timestamp as a prefix to each message.

   .....

   .....

   .....

3. Consider the following design brief for a new contactless ticketing system

'The customer will walk up to the screen in the cinema that is showing the mo screen there will be a barrier, a touchscreen display, a receipt printer and a pa payment card on. The customer will use the touchscreen to select the number to buy. The customer will then tap their contactless card on the pad. If the pay asking them to go to reception. If the payment succeeds a message will be sen the screen telling it to let in the number of people tickets have just been boug

a) Identify all the inputs of the ticketing system described.

.....

.....

b) Identify all the outputs of the ticketing system described.

.....

.....

c) Draw a flow chart representing the process described.

d) Convert the process shown in the flow chart into pseudocode.

2.1.1–5 Computational Thinking 2

1. Imagine you have been put in charge of developing an application that w
room in the event of a fire.

   a) A model is an example of an abstraction. Explain what abstraction is anc

   .....

   .....

   .....

   b) Identify four inputs that your mode[illegible] would need in order to calculate
   could be evacuated.

   .....

   .....

   .....

   .....

   .....

   .....

   c) Explain why the speed of a real evacuation might differ from the speed

   .....

   .....

   .....

   .....

2. While reading ASCII-encoded text from a network you run into the proble
wrong order. The order of every group of four bytes is reversed. So, for e

   ```
   TRANSMITTED OVER THE NETWORK
   ```

   would be read as:

   ```
   NARTTIMS DETREVOEHT [illegible]
   ```

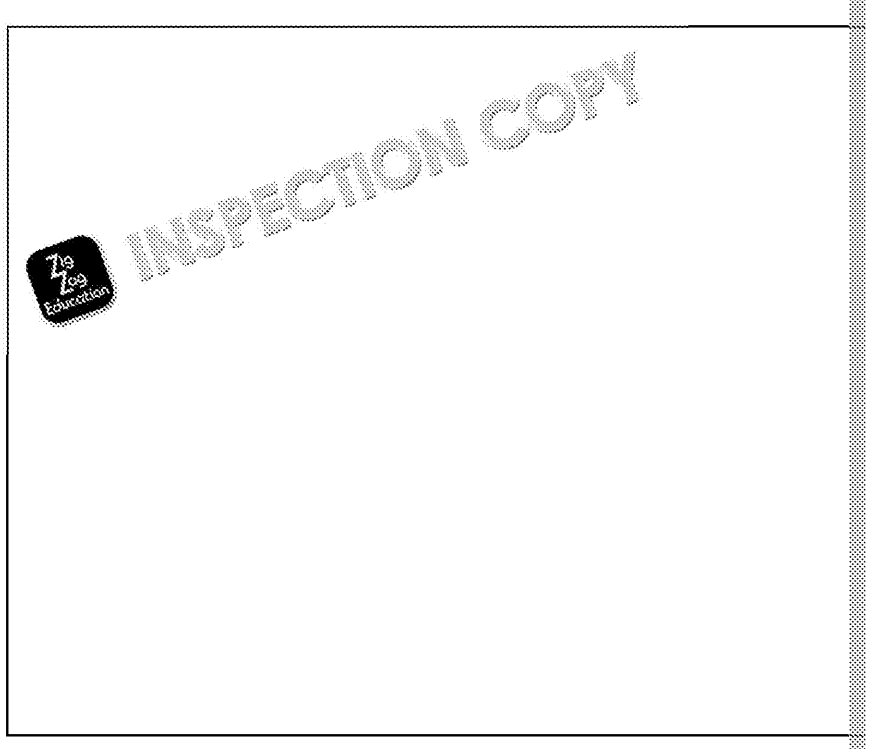
   a) Use pseudo[illegible] write a procedure that unscrambles a complete m
   A[illegible] that the message length is a multiple of four bytes.

b) There are a number of different applications that need to receive dat
you could share the procedure you have written between them.

.....

.....

c) Data that is sent over the network can be compressed. The bytes are co
Use the procedure you wrote in part (a) to write a procedure that unscr
message. You may use the procedure `decompress` to decompress the



3. People who have difficulty reading text on a website can make use of spe
selected words on the screen aloud to them.

a) Identify the inputs and outputs of screen-reading software.

.....

.....

b) It can be difficult for people who have difficulty seeing things on scre
website that they are interested in to be read aloud. Describe an appro
to overcome this problem.

.....

.....

.....

.....

.....

.....

2.2.1 Programming Techniques

1. Consider the following pseudocode:

```
var noOfTurns = input("Enter the number of turns: ")
if noOfTurns < 1 then          B
   print("Error - must be at least 1")
else
   for x=1 to noOfTurns        C
      print(x)
      ...
   next x
endif
```

Here is a list of statement types that can be used in programming langua

- Variable declaration
- Constant declaration
- Assignment
- Iteration

Identify the statement that best suits parts A, B and C of the pseudocode

A .....

B .....

C .....

2. a) Explain the difference between a constant and a variable.

.....

.....

b) Explain the difference between a global variable and a local variable.

.....

.....

.....

c) Explain how parameters can be used to avoid the use of global varia

.....

.....

.....

d) A colleague has decided that when they are programming they are g in the order they are used, i.e. x1, x2, x3, x4... and so on. What is the p would you recommend they do instead?

.....

.....

3. Programmers often use IDEs to improve their productivity.

   a) What does IDE stand for?

   .....

   b) IDEs often contain an auto-completion feature. Explain what an auto
   how it can improve the productivity of a programmer.

   .....

   .....

   .....

   c) A debugger can help a pro[illegible]mer debug their project.

   i. Explain the use of a breakpoint in a debugger.

   .....

   .....

   .....

   ii. Explain why compiler optimisations might have to be disabled t

   .....

   .....

   .....

4. The factorial of a number ($n!$) is defined as:

$$n! = \begin{cases} 1 & if\ n = 0 \\ n \times (n-1)! & if\ n > 0 \end{cases}$$

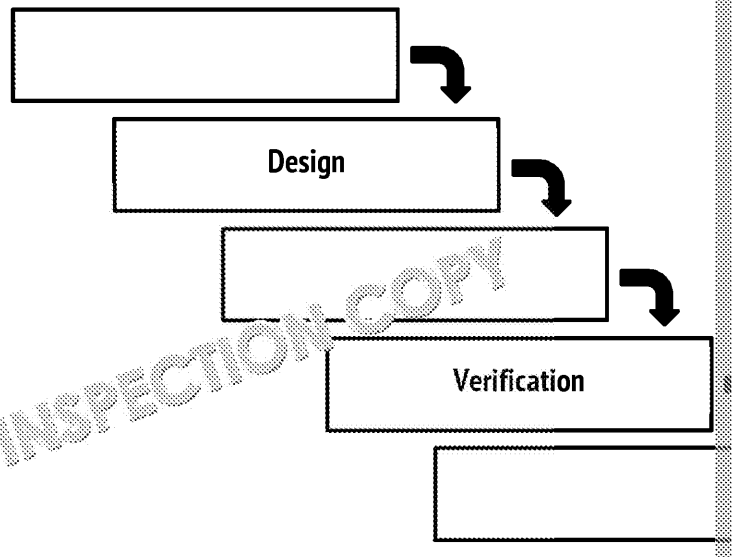
For example:

$$6! = 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 720$$

   a) Write an iterative function called *factorial* that calculates the factorial
   returns the answer.

2.2.2 Software Development

1. a) Fill in the missing stages in the waterfall software development mode



b) Explain the purpose of the Design phase in the waterfall model.

.....

.....

.....

c) Some software development methodologies, such as rapid applicatio
less emphasis on producing a detailed design than the waterfall mod
Explain how the use of RAD reduces the need for a detailed specifica

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d) Describe the strengths and weaknesses of the waterfall development

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2. a) For each of the following pairs of words circle the word that is given software development methodology:

COMMUNICATION	OR	**MANAGEMENT**
SOFTWARE	OR	**DOCUMENTATION**
NEGOTIATION	OR	**COLLABORATION**
PLANNING	OR	**RESPONSIVENESS**

b) Describe the agile approach to ensuring customer requirements are

.....

.....

.....

3. a) Explain the concept of Pair Programming and the advantages of using

.....

.....

.....

.....

.....

b) A key phase in an extreme programming project is the Planning Game. Explain what the goals of the Planning Game are and how it works.

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4. Continuous integration testing is utilised extensively in projects following programming methodologies.

a) Explain what a unit test is and how it relates to continuous integration

.....

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b) Explain how well-designed unit tests can help software developers w

.....

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c) Explain how continuous integration testing helps to enable the rapid in the agile and extreme programming methodologies.

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5. Modern development processes attempt to reduce the level of risk in a p the measures taken to reduce risk in the waterfall methodology, the extre methodology and the spiral model of software development.

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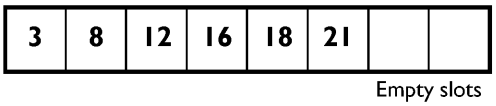
2.3.1 Algorithms

1. Consider the following array of sorted values:



a) Describe how the value 17 would be inserted into this array using ins

.....

.....

.....

.....

b) Explain why the insertion sort is more suited for sorting small data se

.....

.....

.....

2. Consider the following bubble sort algorithm:

```
procedure Sort( A : list of sortable items )
  do
    swapped = false
    for each i in 1 to length(A) - 1 inclusive do
      if A[i-1] > A[i] then
        Temp = A[i-1]
        A[i-1] = A[i]
        A[i] = Temp
        swapped = true
      end if
    end for
  while swapped
end procedure
```

a) Describe using words how this sorting technique works.

.....

.....

.....

b) Explain a disadvantage of using the bubble sort approach.

.....

.....

.....

c) Using the following data, complete a trace table for this sort algorith

height	
1	90
2	7
3	99
4	63

Swapped	Count	Length(A)	Temp	
				1
False		4	null	90

d) Answer: .....

3. Consider the following array:

Index	1	2	3	4	5	6	7
Data	14	18	19	22	23	25	24

a) Why can't a binary search be performed on this array in its current st

.....

b) Fix the array so that a binary search can be pe ed. Perform a bin
24. Explain each step of the algorithm.

Index	1	2	3	4	5	6	7
Data							

c) Describe one advantage and one disadvantage of the binary search t

.....

.....

.....

d) Explain why a binary search is more efficient than a linear search.

.....

.....

.....

4. a) Describe the difference between a stack and a queue.

.....

.....

.....

b) Imagine a stack containing the following numbers:

89, 45, 22, 90 (90 is the top of the stack)

Rewrite the stack after the following operations have been performe

```
Pop()
Pop()
Push(77)
Push(56)
```

c) Write a function in pseudocode that will add up all the items in a sta

d) A queue contains the values 7, 6, 9 where 7 is the first value stored a

Rewrite the queue after the following operations have been perform

```
Pop()
Pop()
Push(12)
Push (16)
Pop()
Push(11)
```

2.1.1–5 Computational Thinking 1

1. You have been tasked with developing a library that contains a single functio
of floating-point values and returns a new array containing the same values s

   a) Identify the information about the input array that `fsort` would req

   b) Explain the benefits of placing `fsort` into a library rather than direct

   c) A platform that the library will be used on contains a processor with a
   for sorting floating-point numbers. Give two ways you could make a
   instruction on this platform. Which method would you recommend a

2. A programmer has a problem. They w[illegible] debug information to eit
depending on an option the user has set. This has led to their code conta
code repeatedly:

```
msg [illegible].
if op[illegible].getPrintToScreen() then
   print(msg)
elseif options.getPrintToFile() then
   options.getFile().write(msg)
endif
```

   a) Propose a way of reducing the amount of repetition in their code.

   b) Explain how your proposal would make it easier to add new features
   adding a timestamp as a prefix to each message.

3. Consider the following design brief for a new contactless ticketing system

   *'The customer will walk up to the screen in the cinema that is showing the mo
   screen there will be a barrier, a touchscreen display, a receipt printer and a pa
   payment card on. The customer will use the touchscreen to select the number
   to buy. The customer will then tap their contactless card on the pad. If the pay
   asking them to go to reception. If the payment succeeds a message will be ser
   the screen telling it to let in the number of people tickets have just been boug*

   a) Identify all the inputs of the ticketing system described.

   b) Identify all the outputs of the ticketing system described.

   c) Draw a flow chart representing the process de[illegible]ed.

   d) Convert the process shown in the flow chart into pseudocode.

2.1.1–5 Computational Thinking 2

1. Imagine you have been put in charge of developing an application that w
room in the event of a fire.

   a) A model is an example of an abstraction. Explain what abstraction is anc

   b) Identify four inputs that your model would need in order to calculate
   could be evacuated.

   c) Explain why the speed of a real evacuation might differ from the speed

2. While reading ASCII-encoded text from a netwo[illegible] un into the proble
wrong order. The order of every group of f[illegible]ur [illegible]es is reversed. So, for e

   `TRANSMITTED OVER THE NETWORK`

   would be read as:

   `NART[illegible]DE REVOEHT TEN KROW`

   a) Use pseudocode to write a procedure that unscrambles a complete m
   Assume that the message length is a multiple of four bytes.

   b) There are a number of different applications that need to receive dat
   you could share the procedure you have written between them.

   c) Data that is sent over the network can be compressed. The bytes are co
   Use the procedure you wrote in part (a) to write a procedure that unscr
   message. You may use the procedure `decompress` to decompress the

3. People who have difficulty reading text on a website can make use of spe
selected words on the screen aloud to them.

   a) Identify the inputs and outputs of screen-reading software.

   b) It can be difficult for people who have difficulty seeing things on scre
   website that they are interested in to be read out. Describe an appro
   to overcome this problem.

2.2.1 Programming Techniques

1. Consider the following pseudocode:

```
var noOfTurns = input("Enter the number of turns: ")
if noOfTurns < 1 then                                  B
   print("Error - must be at least 1")
else
   for x=1 to noOfTurns                                C
      print(x)
      ...
   next x
endif
```

Here is a list of statement types that can be used in programming langua

- [illegible] declaration
- Assignment
- Constant declaration
- Iteration

Identify the statement that best suits parts A, B and C of the pseudocode

2. a) Explain the difference between a constant and a variable.

   b) Explain the difference between a global variable and a local variable.

   c) Explain how parameters can be used to avoid the use of global varia

   d) A colleague has decided that when they are programming they are g in the order they are used, i.e. x1, x2, x3, x4... and so on. What is the would you recommend they do instead?

3. Programmers often use IDEs to improve their productivity.

   a) What does IDE stand for?

   b) IDEs often contain an auto-completion feature. Explain what an auto how it can improve the productivity of a programmer.

   c) A debugger can help a programmer debug their project.

      i. Explain the role of a breakpoint in a debugger.
      ii. Explain why compiler optimisations might have to be disabled t

4. The factorial of a number ($n!$) is defined as:

$$n! = \begin{cases} 1 & if\ n = 0 \\ n \times (n-1)! & if\ n > 0 \end{cases}$$

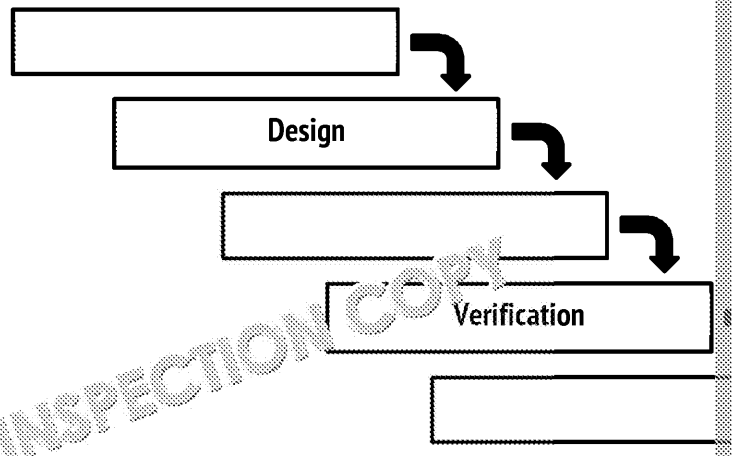
For example:

$$6! = 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 720$$

Write an iterative function called *factorial* that calculates the factorial of t returns the answer.

2.2.2 Software Development

1. a) Copy the waterfall software development model below and fill in the



   b) Ex[plain] the purpose of the Design phase in the waterfall model.

   c) Some software development methodologies, such as rapid applicatio[n] less emphasis on producing a detailed design than the waterfall mod[el]. Explain how the use of RAD reduces the need for a detailed specifica[tion].

   d) Describe the strengths and weaknesses of the waterfall development

2. a) For each of the following pairs of words circle the word that is given [to] software development methodology:

COMMUNICATION	OR	**MANAGEMENT**
SOFTWARE	OR	**DOCUMENTATION**
NEGOTIATION	OR	**COLLABORATION**
PLANNING	OR	**RESPONSIVENESS**

   b) Describe the agile approach to ensuring customer requirements are

3. a) Explain the concept of Pair Programming and the advantages of usin[g]

   b) A key phase in an extreme programming project is the Planning Gam[e]. Explain what the goals of the Planning Game are and how it works.

4. Continuous integration testing is utilis[ed] ex[tensively] in projects following programming methodologi[es].

   a) Explain wh[at] t[est] is and how it relates to continuous integratio[n]

   b) Ex[plain] how well-designed unit tests can help software developers w[ork]

   c) Explain how continuous integration testing helps to enable the rapid in the agile and extreme programming methodologies.

5. Modern development processes attempt to reduce the level of risk in a p[roject]. the measures taken to reduce risk in the waterfall methodology, the extre[me] methodology and the spiral model of software development.

2.3.1 Algorithms

1. Consider the following array of sorted values:

3	8	12	16	18	21		
						Empty slots	

a) Describe how the value 17 would be inserted into this array using ins

b) Explain why the insertion sort is more suited for sorting small data se

2. Consider the following bubble sort algorithm:

```
procedure Sort( A : 1D array of sortable items )
  do
    swapped = false
    for each i in 1 to length(A) - 1 inclusive do
      if A[i-1] > A[i] then
        Temp = A[i-1]
        A[i-1] = A[i]
        A[i] = Temp
        swapped = true
      end if
    end for
  while swapped
end procedure
```

a) Describe using words how this sort technique works.

b) Explain a disadvantage of using the bubble sort approach.

c) Using the following data, complete a trace table for this sort algorith

height	
1	90
2	7
3	99
4	63

Construct the table in the following format:

Swapped	Count	Length(A)	Temp	hei	
				1	2
		4	null	90	7

d) Answer:

3. Consider the following array:

Index	1	2	3	4	5	6	7
Data	14	18	19	22	23	25	24

a) Why can't a binary search be performed on this array in its current st

b) Fix the array so that a binary search can be performed. Perform a bin
the number 24. Explain each step of the algorithm.

c) Describe one advantage and one disadvantage of the binary search t

d) Explain why a binary search is more efficient th linear search.

4. a) Describe the difference bet en a stack and a queue.

b) Imagine a sta containing the following numbers:

8 2, 90 (90 is the top of the stack)

Rewrite the stack after the following operations have been performe

```
Pop()
Pop()
Push(77)
Push(56)
```

c) Write a function in pseudocode that will add up all the items in a sta

d) A queue contains the values 7, 6, 9 where 7 is the first value stored a

Rewrite the queue after the following operations have been perform

```
Pop()
Pop()
Push(12)
Push (16)
Pop()
Push(11)
```

2.1.1–5 Computational Thinking 1

1. a) Start pointer and length OR an object encapsulating this information.

   b) The function can be used in other programs (1 mark) without having to
   codebase (1 mark). This means that there is only one version of the func

   c) The two possible ways are:
   - Place fsort into a dynamic library (so that the correct version is lin
   - Use a conditional statement in the code to check the platform and (1 mark).

   Either can be recommended. Give 1 mark per valid point raised up to
   - Dynamic library:
     - + All machine code is specific to the target platform.
     - + Bugs can be fixed without updating the main binary.
     - + Can add more platform support without updating th
     - – Overhead for calling function pointer.
     - – Need to manage additional files.
     - – Can increase the complexity of compilation.
   - Conditional:
     - + Easy to compile.
     - + No extra files to manage.
     - – Overhead for calling conditional statements.
     - – Changes require the main binary to be updated.
     - – Code might be more complex (need to detect platform,

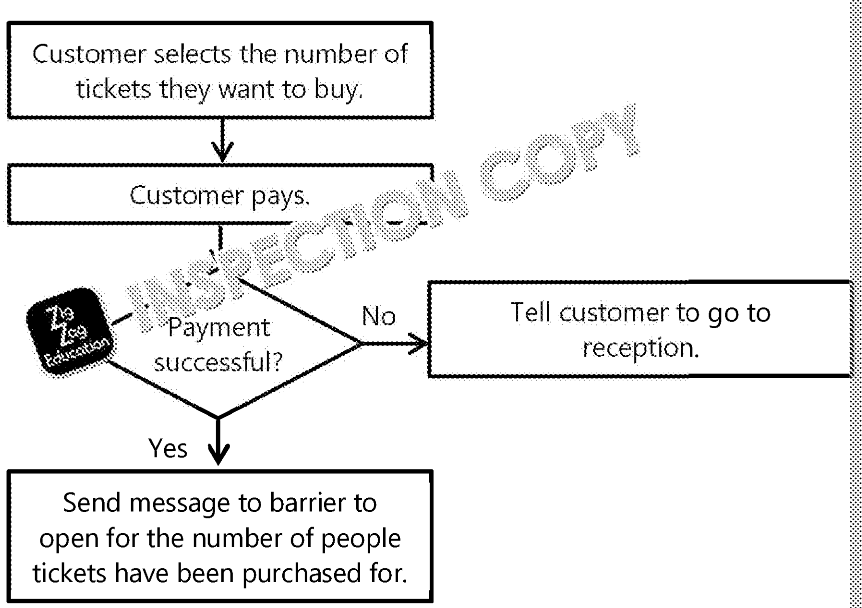
2. a) They could use a subroutine/procedure to encapsulate the repetitive fun

   b) They would add the code for the new feature in only one place: the subr
   code in one place it becomes easier to test and changes will be consiste
   program (1 mark).

3. a) Subtract 1 mark for each missing input.
   Touchscreen display and contactless card reader.

   b) Subtract 1 mark for each missing output to a minimum of 0.
   Barrier, receipt printer and touchscreen display.

   c) 1 mark for decision box, 1 mark for the input stage and 1 mark correct c
   Exact format of flowchart is not important.



d) Up to 3 marks for correct pseudocode. Example:

```
display("Please select number of tickets")
numTickets = input();
if charge(numTickets)
    printReceipt(numTickets)
    sendMessageToBarrier(numTickets)
else
    display("Payment unsuccessful. Please go to recep
endif
```

2.1.1–5 Computational Thinking 2

1. a) An abstraction hides or generalises details in order to simplify a problem makes it possible to quantify information about a potential evacuation w understand/quantify every aspect of the real situation (1 mark).

   b) 1 mark per input up to a maximum of 4 marks. Some possible inputs:
   - Location of exits
   - Layout of room
   - Size of room
   - Number of people in the room
   - Size of exits
   - Locations of obstacles
   - Details about people in room (age, mobility, etc.)
   - Location of fire
   - Speed fire spreads

   c) The model is an abstraction so there might be details/variables that have (1 mark), assumptions/variables may be incorrect (1 mark) and there are real evacuation that cannot be predicted (1 mark).

2. a) 5 marks for a complete correct procedure. 3–4 marks for a procedure th minor errors. 1–2 marks for a procedure that is somewhat correct but co

```
procedure unscramble(message[0..N-1])
    for i=0 to N/4 - 1
        for j=0 to 1
            tmp = message[i*4+j]
            message[i*4+j] = message[i*4+3-j]
            message[i*4+3-j] = tmp
        next j
    next i
endprocedure
```

   b) Place the procedure into a library.

   c) 1 mark for the order of the operations and 1 mark for returning the resu (decompression cannot be done in place as the result will be larger than

```
procedure unscramble_and_decompress(message[0..N-1])
    unscramble(message)
    return decompress(message)
endprocedure
```

4. a) The inputs of the system are a selection device (such as a mouse) and th provided directly by a program or parsed from the graphical output) (1 produced (1 mark).

   b) There are a number of possible approaches. Give up to 4 marks for an e

   Example: The screen reader could read the headings in the website alou assigned a key as it is read out. To read the subheadings/content under the appropriate key. They could use other predetermined keys to naviga move to the next section and so on.

2.2.1 Programming Techniques

1. A – Variable declaration (1 mark)
   B – Selection (1 mark)
   C – Iteration (1 mark)

2. a) The value of a constant cannot be changed during the course of a progr variable represents can be.

   b) A global variable is accessible to every subroutine/procedure/function ir whereas a local variable is limited to the scope in which it was declared (

   c) Parameters allow variables to be passed to and between functions/proce that global variables should not be needed as all the data required by fu through parameters (1 mark).

   d) It makes it very difficult to understand their code. They should use variab function they are performing.

3. a) Integrated Development Environment

   b) Auto-completion suggests ways that the text a programmer writes could not have to type an entire variable name, function name or other symbo programmers because they do not need to remember the exact name th harder to make a mistake (1 mark).

   c) i. A breakpoint allows the programmer to stop the execution of a prc source code (1 mark) so that the programmer can analyse the state stage in its execution (1 mark).
      ii. Compiler optimisations might remove variables that the programm or change the logic of the program (for example removing a loop), programmer to understand what is going on (1 mark).

4.
```
function factorial(n)
    result = 1
    for i = 2 to n
        result = result * i
    next i
    return result
endfunction
```

2.3.1 Algorithms

1. a) *Up to 3 marks for a valid description of the process, e.g.*

   - 17 would be placed in the first empty slot in the array.
   - It would then be compared with the value to the left of it (21) and sw smaller.
   - It would then be compared with the next value to the left of it (18) ar smaller again.
   - It would then be compared with the next value to the left of it (16) ar the than 16 so the array is now sorted.

   b) The insertion sort needs a large number of element shifts which is ineffic as the number of elements is increased the performance of the program

2. a) *Up to 2 marks for a valid description of the process, e.g.*

   - Bubble sort steps through the list comparing each pair of items in the
   - And swapping them if they are in the wrong order
   - The pass through the list is repeated until no swaps are needed

b) Main disadvantage is that it can take a maximum of (N-1) scans to fully s
the list that needs to be sorted (1 mark); this is because an out-of-positi
(or swapped) one position per scan (1 mark).

c) 1 mark for each of the three 'bubbles' (line 2, 4, 6) and 1 for overall accu

Swapped	Count	Length(A)	Temp	height			
				1	2	3	4
False		4	null	90	7	99	63
True	1		90	7	90		
	2						
True	3		99			63	99
False	1						
True	2		90			63	90	99
	3						
False							
	2						
	3						

d) 1: 7, 2: 63, 3: 90, 4: 99

3. a) It is not sorted

b) Array is sorted. 10/1 = 5.5 so midpoint is 5.

1	2	3	4	5	6	7	8	9
14	18	19	20	21	22	23	24	2
⇧				⇧				
Left				Mid				

21 is less than 24 so mid and everything left of it is discarded.

6	7	8	9	10
22	23	24	25	27
⇧		⇧		⇧
Left		Mid		Right

Mid is now 24 so we have found the answer in two steps. Also accept a
midpoint of 6, followed by 9 and then 8, solving the problem in three st

c) Advantage: more efficient than the linear search, as elements can be fou
(1 mark). Disadvantage: the data needs to be sorted (1 mark).

d) In a linear search, each element in the list is examined until the target va
considerable time for a large array (1 mark).
In a binary search the number of eler er s h g examined is halved for
program (1 mark).

4. a) A qu e is first out (FIFO) data structure. (1 mark) A stack is firs

b) 8 56

c) *3 marks for a valid working algorithm; deduct marks for errors accordingl*

```
FUNCTION add(stack) RETURNS INTEGER
  total = 0
  WHILE stack is not empty
    total = total + stack.pop()
  END WHILE
RETURN total
```

d) 89,45,77,56