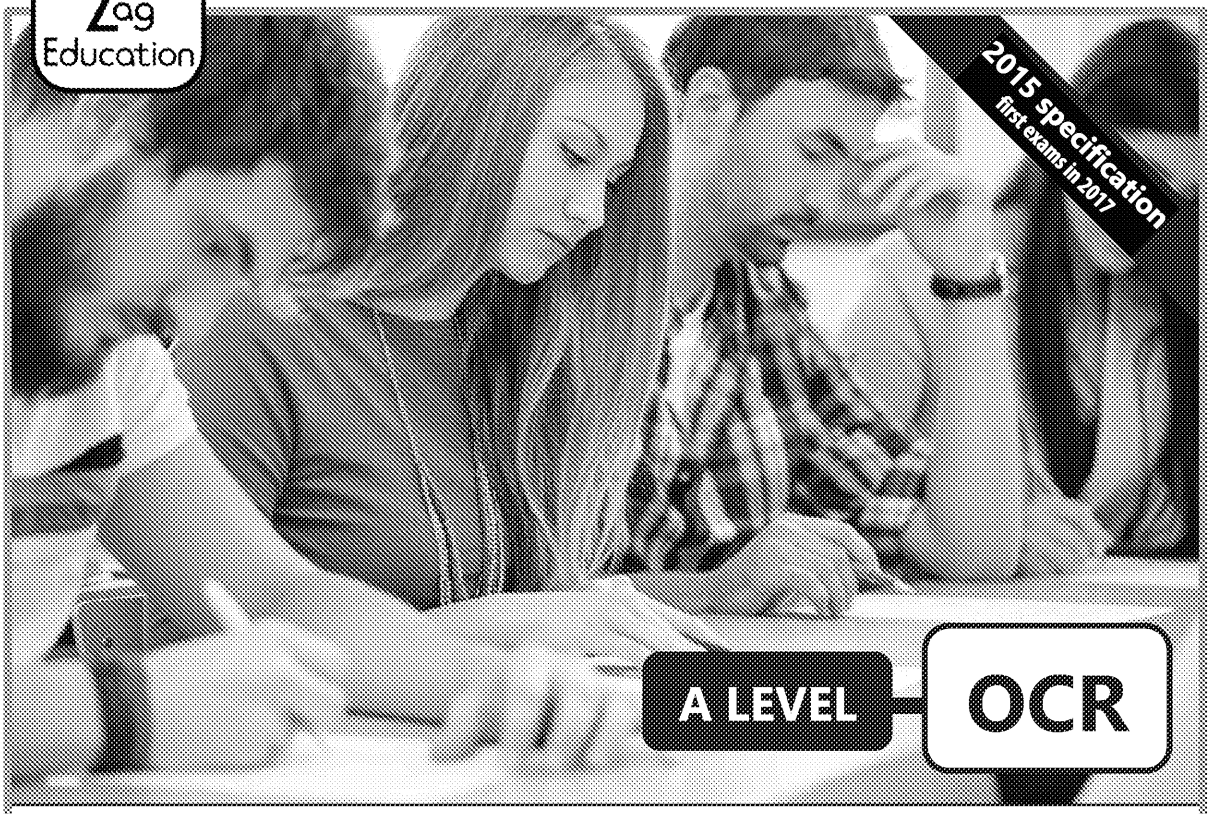
Zig Zag Education

Computer Science A Level | OCR | H446



Topic Tests

for A Level OCR Computer Science

Component 1

Update v1.1, January 2022

zigzageducation.co.uk

POD 6353

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Teacher's Introduction

This resource is designed to support teaching and learning of the A Level OCR specification (for first teaching in September 2015; first exams from June 2017).

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 A Level 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 tests is worth between 30-40 marks, so that it can be comfortably completed 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.*

Update v1.1, January 2022
Corrected use of <li> and <ul> tags in answer to question 1(c), Test 1.3.4, p 107.

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)

.....

.....

      ii. Accumulator (ACC)

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.....

      iii. Current Instruction Register (CIR)

.....

.....

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-Dec[illegible] 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

i. Explain how pipelining the Fetch-Decode-E[illegible]ute cycle improve

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ii. [illegible]e [illegible]er examples of design techniques used to improve p[illegible]ain how they provide this improvement.

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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 c

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

   b) Give one adv a and one disadvantage of rewriting a single-thre
   ad ge ultiple processor cores.

   Advantage: .....

   .....

   .....

   Disadvantage: .....

   .....

   .....

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 RIS processors are often used in portable de

   1. .....

   .....

   .....

   2. .....

   .....

   .....

3. When a processor is powered on it immediately loads a boot program fro
The boot program instructs the processor to load an operating system fro
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 can
Name two examples of removable media and one advantage and disa
each to store an operating syste

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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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.....

2.....

.....

.....

b) The school is considering using a virtual storage system to store the
Describe **two** advantages of using a virtual storage system rather tha
storage to store regular data.

1.....

.....

.....

2.....

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.....

5. Graphics Processor Units (GPUs) have been traditionally used to render in
or television screen. Nowadays they are also used for a wide variety of co
order to reduce their execution time.

a) Explain **two** ways a GPU differs from a Central Processor Unit (CPU).

1.....

.....

.....

2.....

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b) Gi example of a non-graphical application that is a suitable ta
GPU, and explain how running the application on a GPU will make it f

.....

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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

   .....

   .....

   .....

   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.

   .....

   .....

   .....

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

   .....

   .....

   .....

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

   1.....

   .....

   2.....

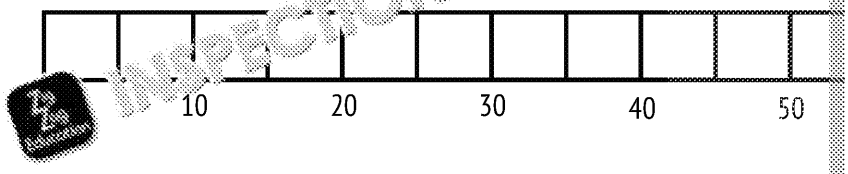
   .....

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

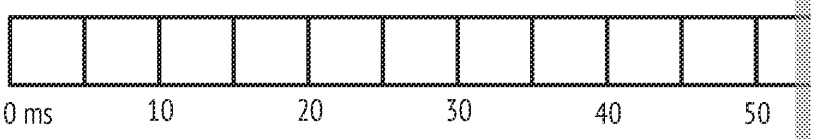
Process ID	Start time	Total execution time
A	10 ms	10 ms
B	0 ms	20 ms
C	5 ms	30 ms

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

i. First come, first served



ii. Round robin



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

i. Use your answers to questions (a) and (b) to identify whether *round robin* or *first come, first served* scheduling best meets this requirement.

.....

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

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iii. Give an example of a scheduling algorithm that can prioritise operations such 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 scenari
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 compiler is one type of translator program. Name the other two ty

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

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

.....

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.....

c) A compiler typically consists of four sta... Enter the missing inform...

Stage	Descript...
L... analysis	
	Uses the language grammar to transform into an intermediate form suitable for t...
Optimisation	
	Reproduces the program in a new form ... execution on the target system.

3. Libraries can provide programs with access to functionality that would ot
consuming for an application developer to write herself.

a) Libraries present the application developer with an application progr
Explain what an API is and the benefits that APIs give application dev

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b) Libraries can usually be provided in one of two forms: static or dynam

i. Explain the difference between these forms and how they are linke

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ii. Explain one benefit of using a dynamic library instead of a static

.....

.....

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

a) Explain the difference between a closed-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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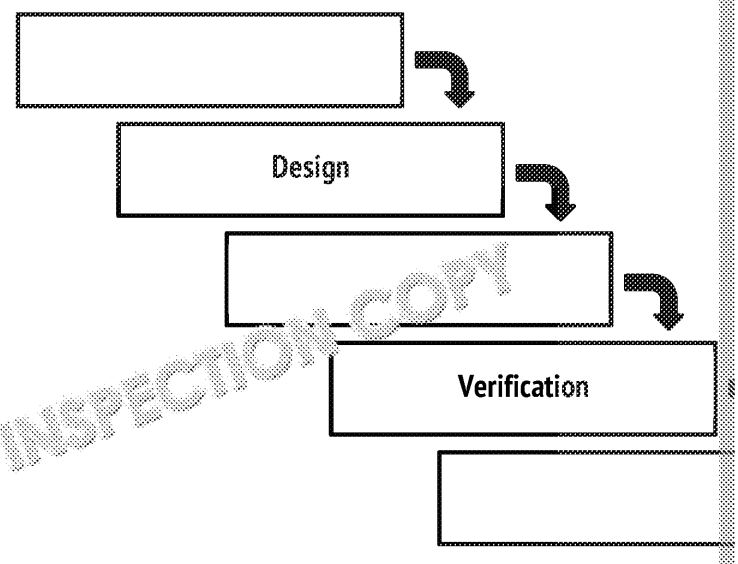
1.2.3 Software Development

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.

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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 ensuri[ng] cust[omer] requirements are

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

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

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4. Contin[uous] int[egration] testing is utilised extensively in projects following
progra[mming] methodologies.

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

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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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1.2.4 Types of Programming Language

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

   a) Describe the properties of a procedural programming language.

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   .....

   b) Variables declared in a procedural progr[illegible] be accessible in one another.

      i. Give the term us[illegible] to describe the part of the program a variabl

      .....

      ii. [illegible]cribe two major benefits of restricting the accessibility of var programming language.

      1 .....

      .....

      2 .....

      .....

   c) Describe two ways a *functional* programming language differs from a language.

   1.....

   .....

   2.....

   .....

2. The following object-oriented code defines a class called `FileReader` t from a file. Internally it calls two system functions: [illegible] which opens the handle to the file and `read` which reads a b[illegible] from the file referred to b

```
class FileReader
    private ha[illegible]e
    publ[illegible] procedure new(name)
        handle = open(name)
    endprocedure
    public procedure readByte()
        return read(handle)
    endprocedure
endclass
```

a) Identify one example of each of the following in the class `FileRead`

i. An attribute

.....

ii. A method

.....

iii. A constructor

.....

b) Explain the effect of the keywords `pub` and `private`.

.....

.....

c) Th`eReader` class is part of a library that cannot be modified. A library that takes a `FileReader` as an argument and you need to co from a file during this procedure. To do this a colleague has suggest `CountingFileReader` class that inherits from `FileReader`.

i. Explain the benefits of using inheritance to implement `Countin`

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ii. Write an implementation of the `CountingFileReader` class th `FileReader`.

3. a) Define each of the following addressing modes:

i. Immediate

.....

ii. `ct`

.....

iii. Relative

.....

b) Explain which of the addressing modes given in part (a) are most suit
might not always have the same memory addresses allocated to it at

.....

.....

.....

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

```
        INP
        STA   A
        INP
        STA   B
LOOP    LDA   B
        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.

.....

.....

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

.....

.....

c) Wh[illegible] QUIT, ONE, A, B and RESULT examples of? Briefly ex
id[illegible]s serve in an assembly program.

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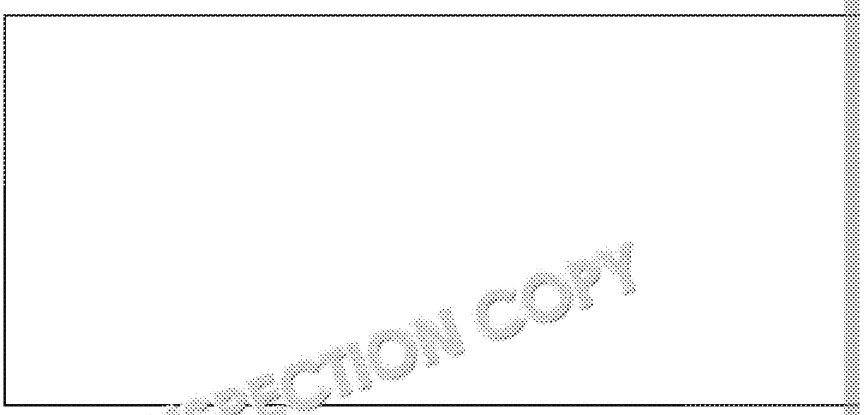
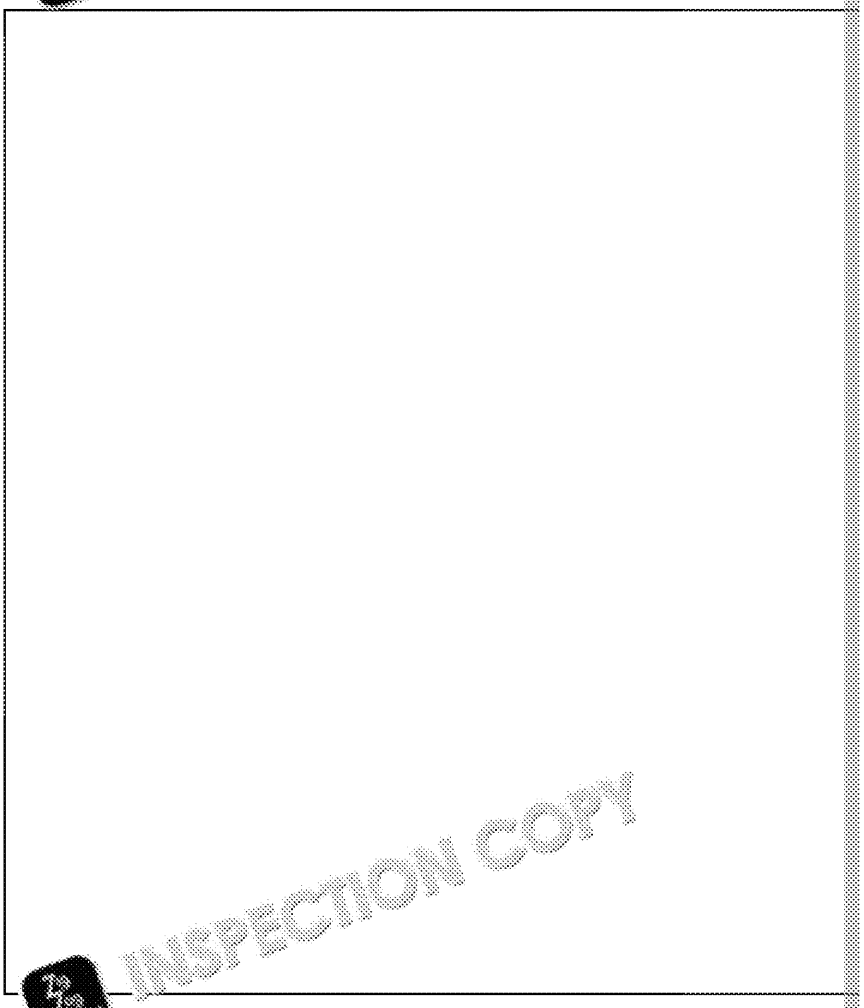
d) Modify the assembly program given to produce the result of `A MOD B`. You may assume that A and B are positive integers. Provide the pseudocode and assembly program:

Pseudocode:



Assembly program:



1.3.1 Compression, Encryption and Hashing

1. 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 compression. 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 techniques.

   .....

   .....

   .....

   .....

2. Run-length encoding is a form of lossless compression. A simple way of representing data is as a series of pairs of bytes, with the first byte in each pair representing a character and the second byte in each pair representing the number of times the character is repeated.

   Example: The ASCII string "HHHEEEELLLLOOOOOOOO" would be encoded as

   ```
   ['H', 3, 'E', 4, 'L', 4, 'O', 7].
   ```

   a) Encode the string "GGOOOOODDBBYYEEEE" using the format described above.

   b) Calculate the compression ratio achieved by your answer to question 2a. Ignore any data stored to maintain the array data structure itself (e.g. length).

   .....

c) Would using the described run-length encoding scheme on its own large amounts of English text? Explain your answer.

.....

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3. A web-hosting company keeps a hash table containing all of the domain customer types a domain name into their website to see if it is still availab value of the given domain name, checks for it in the hash table, and return name is not found in the table then **UNAVAILABLE** if the domain name is

For example:

Domain	Result
reallyobscureandlongdomainname.com	AVAILABLE
google.com	UNAVAILABLE

a) Explain how a lookup in a hash table works.

.....

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b) A hash algorithm is used to generate the hash values for the domain used by the company has a bug and only produces even hash values would affect the performance of the hash table.

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c) The company is launching a new download service for customers. The se have made sure a checksum is supplied for every file. Explain why it is useful for customers who are downloading files from the Int

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4. Dictionary coding compression schemes can use a variety of different tec
One simple technique to encode English ASCII words separated by space
the dictionary as it is encountered.

Use this text to answer the following questions:

I LOVE CHOCOLATE YOU LOVE CHOCOLATE WE ALL LOVE

a) Build a dictionary from the text using the technique described above

Index	Word

b) Encode the text using the dictionary you have produced in part (a).

c) Calculate the minimum number of bits required to represent an inde
produced in part (a).

d) Imagine you are using this compression scheme to send this text to a
Explain why the size of the message would need to be significantly la
indices multiplied by the number of bits requir[illegible] represent each i

.....

.....

e) Is [illegible]ible for the size of the encoded message to be larger than t
Ex[illegible] your answer.

.....

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.....

5. TLS is a protocol that is widely used to create secure connections to servers o
asymmetric encryption initially to set up the connection before switching to a

a) Explain why it is not generally possible to securely set up a connectio
symmetric encryption without using asymmetric encryption initially.

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b) Describe in detail the steps required to securely send data to a serve
asymmetric encryption. Explain the role of the server's public and pri

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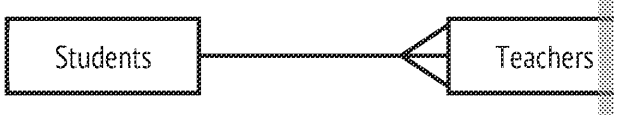
1.3.2 Databases 1

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 attends a single school. Extend the entity r
include *Schools* and update all the relationships.

2. Define each of the foll terms:

a) Pri ke

.....

b) Secondary key

.....

c) Foreign key

.....

3. ACID (atomicity, consistency, isolation and durability) is a set of principles transactions modify a database reliably.

a) Explain what an atomic database transaction is.

.....

.....

b) Imagine you are developing a database program that follows the ACI program will support multiple users reading from and writing to it co

i. The database needs to be fast and only need to be a couple of database be kept solely in main memory. Explain your answer.

.....

.....

.....

ii. If one user modifies a row in a table and another user adds a row transactions need to happen sequentially in order to be isolated be performed concurrently? Explain your answer.

.....

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iii. Describe a suitable process for deleting a row from a table in the

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Questions continue on the following page

4. SQL is a language commonly used to create, maintain and query databas

a) Consider this Data Definition Language (DDL) statement:

```
CREATE TABLE db.users
(
    UserName VARCHAR(20),
    FirstName VARCHAR(20),
    LastName VARCHAR(20),
    Password VARCHAR(20),
    PRIMARY KEY (UserName),
    UNIQUE INDEX (UserName)
);
```

i. What is the purpose of this s[illegible]m ...?

.....

.....

.....

ii. Why can't the primary key be *LastName*?

.....

.....

b) Explain what each of the following SQL statements would do when a

i. SELECT * FROM users

.....

ii. SELECT UserName, Password FROM users ORDER BY UserName

.....

.....

iii. SELECT FirstName, LastName FROM users WHERE UserName =

.....

5. Consider the following table of, players from ar[illegible]e fantasy role-playin

PID	GivenName	Surname	Character	Level	Race
001	Al[illegible]	Smith	Alzabeck	32	Orc
[illegible]	[illegible]ette	Jones	Thornzon	2	Dwarf
	Ibrahīm	Hassan	Teylar	12	Dwarf
004	Lili	Yu	Axethorn	6	Human
001	Alan	Smith	Tamto	24	Elf

a) Create an entity definition for the above table.

.....

b) Describe the purpose of database normalisation?

.....

.....

.....

c) Place the table into third normal form (3NF). You may assume that al
and that race and items only need to be stored as attributes, and do
Each PID is unique to a real person.

1.3.2 Databases 2

1. 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) Normalise the above database into 3NF by writing the entity descrip
   You may assume at this stage that you only need to order one item a

   .....

   .....

   .....

   b) i. nt[illegible] the primary keys

   .....

   ii. State the purpose of a primary key

   .....

   iii. Identify the foreign keys and their location

   .....

   iv. State the purpose of a foreign key

   .....

   c) Draw an entity relationship diagram for your database

d) Complete a Data Dictionary for your database using the layout below
all fields will have an entry for every column. You should aim to sugg
validation rule, input mask or default value in each table. Under the K
'Primary', 'Foreign' or leave it blank as appropriate.

Field	Data Type	Format	Validation Mask / De

e) Answer the following SQL questions based on the structure you have

i. Write an SQL statement to return all information on every item

.....

ii. Write an SQL statement to return the Title, First Name, Surname
customers in alphabetical order of surname.

.....

.....

iii. Write an SQL statement to return a list of order numbers, dates
item that has not been dispatched. The list should be in ascendi

.....

.....

f) i. Assuming a three-table structure has bee d to represent the
this question, what restriction doe ace on the database th
day-to-day running of

.....

.....

.....

ii. Describe a possible solution for this problem.

.....

.....

.....

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

1.3.3 Networks

1. a) Define the following types of communication link:

   i. Serial

   .....

   .....

   ii. Parallel

   .....

   .....

   b) A [illegible] to connect sites that are a considerable distance a[illegible] ne[illegible] (WAN). Which sort of cabling would you advise it to use, ser[illegible]

   .....

   .....

   .....

   c) The network link the company uses for its WAN has a latency of 10 n[illegible] (megabits per second). Calculate how long it will take to transfer 1 M[illegible]

2. A home user is trying to set up a local area network (LAN) that will be con[illegible] have drafted you in to help them set it up.

   a) They have bought a router that contains a built-in ADSL gateway and[illegible] router has an internal IP address of 192.168.1.1. Their Internet service[illegible] external IP address.

      i. Explain the purpose of the gateway built in to the router.

      .....

      .....

      ii. The ro[illegible] they have bought has a built-in wireless access point. [illegible]lic[illegible]ons of adding a wireless access point to the network and[illegible]uld be taken.

      .....

      .....

      .....

      .....

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

.....

c) The user is new to using the Internet and is worried that his compute
how the use of a firewall can help to prevent attacks.

.....

.....

d) The network has been set up and the router successfully obtained
ISP. Unfortunately the user isn't able to access any websites. You ask
of a well-known web server in their browser and the website loads
name and purpose of a service that is not working correctly?

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3. 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 advan
HTTP as a layer above TCP/IP rather than as a standalone protocol.

4. A new company entering the voice over IP (VOIP) telephony market is de
move voice data between customers. They have two options: a client-serv
model. Explain which model you would recommend the company use and
and disadvantages for both models.

1.3.4 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'.

.....

.....

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

.....

.....

.....

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

.....

.....

.....

.....

d) At the bottom of th e author wants to add a form to allow r form shou n two text boxes – one for the comment and one c ti g – 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

   .....

   .....

   .....

   .....

   .....

   .....

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 t[illegible] user enter should be at least eight characters
checkPas[illegible] will be called whenever a new character is added t
in[illegible]on of 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.

```
function checkPassword() {
```

4. a) Explain the concept of search-engine indexing.

.....

.....

.....

b) PageRank is an algorithm for ranking web pages in order of their imp
Larry Page and Sergey Brin while they were researchers at Stanford U

Explain how the PageRank algorithm works out how important a web

.....

.....

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1.4.1 Data Types 1

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

.....

.....

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:

.....

Questions continue on the following page

5. a) Shift the hexadecimal value 4F left by 2. Give your answer in hexadec

.....

b) Evaluate the following expressions:

i. 0111 AND 1010

.....

ii. 0111 OR 1010

.....

iii. 0111 XOR 1010

.....

c) So ng ... provide two different types of right shift: a signed right
A right shift of n is equivalent to division by 2^n when performed o

Explain how the signed right shift works.

Hint: -18 / 2 = -9. How are -18 and -9 represented in two's complem

.....

.....

.....

.....

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 are in the 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 number 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.

.....

.....

.....

.....

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.

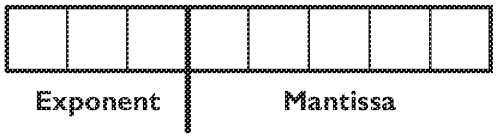
1	1	0	0	1	0	0	0

Exponent | **Mantissa**

.....

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

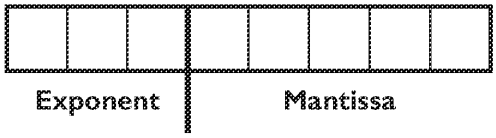
i. 0.75



ii. -7.5

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

i. In floating-point binary:

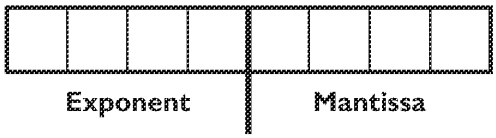


ii. In denary:

.....

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

i. In floating-point binary:

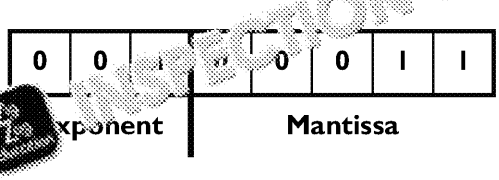


ii. In denary:

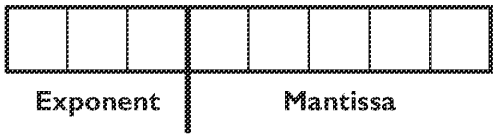
.....

e) Normalise the following floating point nu b

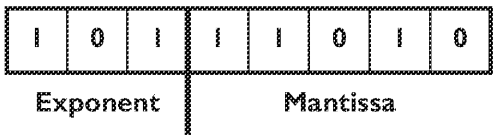
i.



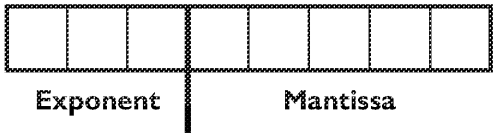
Answer:



ii.

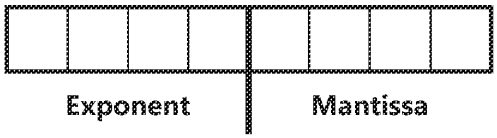


Answer:



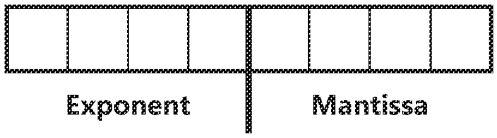
f) Add the following two numbers and normalise the result. Show your

Answer:



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

Answer:



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

.....

.....

.....

.....

.....

1.4.2 Data Structures 1 (arrays, linked lists, stac

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 's
   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.

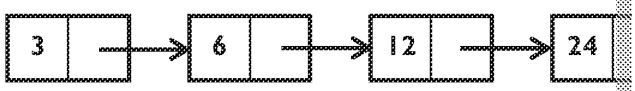
   .....

   .....

   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 to look up an item by index in a linked list or an a

   .....

   .....

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

   .....

   .....

   .....

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 t
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	TopOfStack
6		
5		
4		
3	Fish	←
2	Cat	
1	D	

a) Complete the table after the following commands:

Push 'Mouse', Pop, Pop

MemLoc	Data	TopOfStack
6		
5		
4		
3		
2		
1		

b) Complete the table after the following further commands:

Pop, Pop, Push 'Rabbit'

MemLoc	Data	TopOfStack
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.

.....

.....

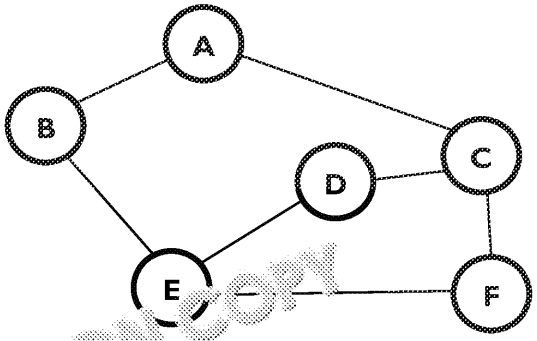
.....

.....

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	State 4
start state	A joins queue	Item served from queue	J join
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. Here is an example of an unlabelled graph:



a) Is this gra[illegible]? Explain your answer.

.....

b) This graph can be converted into a directional graph (digraph). Expla

.....

c) One way to represent a graph in a computer is to use an array. This a
different formats.

i. Draw an adjacency list to represent this graph.

ii. Draw an adjacency matrix to represent this graph.

2. You have been given the following numbers to insert into a data structure

12, 18, 42, 22, 56, 87, 99

a) Add the numbers in the order given to a binary search tree.

b) How many steps does it take to find the number 99 from this tree?

.....

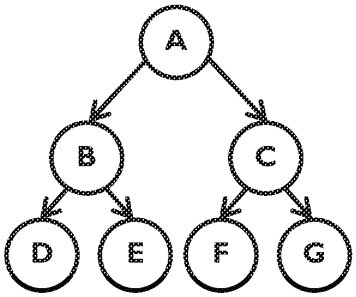
c) Is this tree efficient? Explain your answer.

.....

.....

.....

d) A binary search tree can be represented as an array as follows:



Label:	A	B	C	D	E
Index:	0	1	2	3	4

If the index of a node is n then the index of its left child will equal $2n$ and the index of its right child will equal $2n + 2$. Write a pseudo-code algorithm to find the smallest value in a binary search tree with an arbitrary length. Use the functions `leftChildExists(array, index)` and `rightChildExists(array, index)` to see if the node at `index` has a left or right child.

3. Consider the following class that represents a node in a graph:

```
class Node
    private name                 // string
    private destinationNodes     // list of nodes

    public procedure new(givenName)
        name = givenName
        destinationNodes = new List()
    endprocedure

    public procedure addDestination(node)
        destinationNodes.append(node)
    endprocedure

    public function getName()
        return name
    endfunction

    public function getDestinationNodes()
        return destinationNodes.copy()
    endfunction
endclass
```

a) Name the attribute in the Node class that represents the edges in the

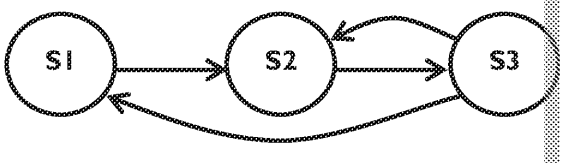
.....

b) A copy of the list of destination nodes is returned to the user instead list. Explain why the class designer would want to do this.

.....

.....

c) Write a pseudocode algorithm to build the following graph using the



d) Is it possible to remove a node from the graph given only the node t your answer.

.....

.....

4. The following diagram represents a hash table:

0	1	2	3	4	5
London		Bristol	Manchester		Yo
		Newcastle			

The index of a city name is the value of the lowest three bits of the hash c
code is generated using a hash function that takes a string as its argumen
The city names are stored in an array at each index.

a) Calculate the index to insert each of the following cities at:

City Name	Hash Code	Index
[illegible]	16	
Edinburgh	32	
Swansea	44	
Cardiff	15	

b) Bristol and Newcastle share the same index. Is it possible that their h
Explain your answer.

.....

.....

.....

c) A colleague wants to add 100 cities to this hash table. Will the speed
affected? Explain your answer.

.....

.....

.....

Questions continue on the following pag

d) The hash table is implemented using the following classes:

```
class CityHashTable
    private table

    public function getArrayAtIndex(i)
        return table[i]
    endfunction

    ...
endclass

class CityArray
    private array
    private length

    public function getLength()
        return length
    endfunction

    public function getCityNameAtIndex(i)
        return array[i]
    endfunction

    ...
endclass
```

Write a pseudocode function that takes a `CityHashTable` and a st
table and the name of a city respectively as arguments, and returns t
the given city name, and false otherwise. You may assume that the st
`hashCode` that returns the hash code and `equals` method that retu
a string given as an argument.

1.4.3 Boolean Algebra

1. Draw the logic symbol for each of the following gates:

   a) AND

   b) NOR

   c) XOR

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. a) Compute the result of the following logic expressions:

   i. $1 \vee 0$

   .....

   ii. $1 \wedge 0$

   .....

   iii. $(0 \vee 0 \vee 0) \vee (0 \vee (1 \wedge 1))$

   .....

b) Simplify the following logic expressions:

i. $(A \wedge B) \vee (A \wedge B)$

.....

ii. $\neg(\neg A \wedge B) \vee A$

.....

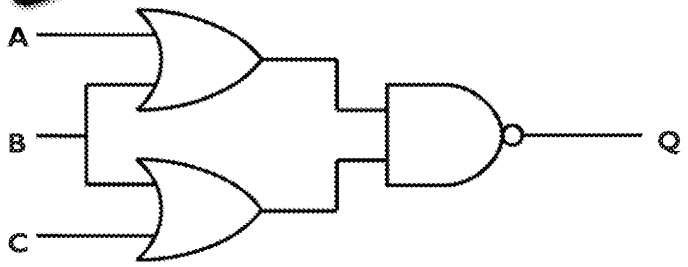
.....

iii. $(A \wedge \neg(A \vee B)) \vee C$

.....

.....

4. Consider the following logic diagram:



a) Write the logic equation for Q.

.....

b) Simplify the equation.

.....

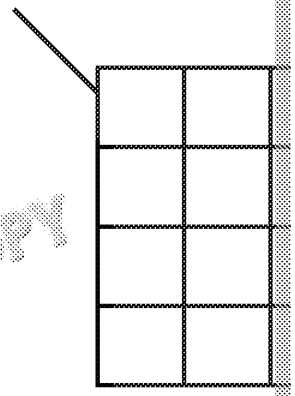
.....

.....

c) Draw the logic diagram of the simplified equation.

5. a) Fill in 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	1
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.

.....

6. a) Fill in the truth table for a half adder.

A	B	SUM	CARRY
0	0		
0	1		
1	0		
1	1		

b) Draw the logic diagram for a half adder.

c) Draw the logic diagram for a full adder.

d) Explain the purpose of a D-type flip-flop and how it works.

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.....

.....

.....

.....

.....

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 give an example of a way a crim
   gain access to a computer syst

   .....

   .....

   .....

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 principles.

   1.....

   2.....

   3.....

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

   .....

   d) A marketing company w ect data about potential custome
   information such erson's name, date of birth and contact det
   and rin 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 na
protected?

.....

c) Explain the concept of *fair dealing*.

.....

.....

.....

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

.....

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.....

.....

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

   .....

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   .....

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   .....

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, privacy
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 and 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 factors

      i. Explain how pipelining the Fetch-Decode-Execute cycle improve
      ii. Give two other examples of design techniques used to improve 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 is

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] and one disadvantage of rewriting a single-threa
   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 al

   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]sin[illegible] a virtual storage system rather tha
   storage to store r[illegible]r data.

5. Graph[illegible]cessor Units (GPUs) have been traditionally used to render in
   or telev[illegible] screen. Nowadays they are also used for a wide variety of co
   order to reduce their execution time.

   a) Explain **two** ways a GPU differs from a Central Processor Unit (CPU).

   b) Give **one** example of a non-graphical application that is a suitable ta
   GPU, and explain how running the application on a GPU will make it

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

   c) Briefly explain what a distributed oper. tin. system is.

2. When a process is start is a located some memory by the operating s addressed direc by the process; instead a technique called *virtual mem*

   a) E hat virtual memory is.

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

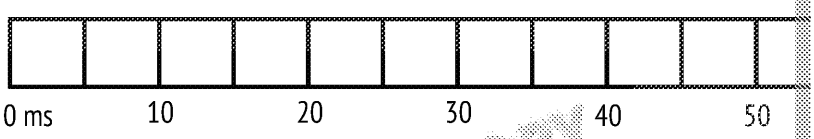
   c) Virtual memory enables paging to a secondary storage device such a State one advantage and one disadvantage of using paging.

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:

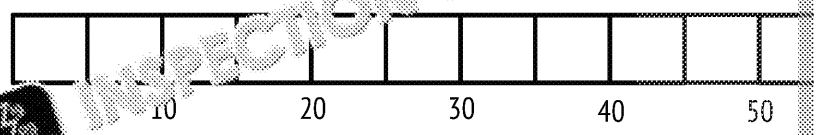
Process ID	Start time	Total execution time
A	10 ms	10 ms
B	0 ms	20 ms
C	5 ms	30 ms

   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 tin

      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 mu
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 translator program. Name the other two ty

   b) Explain the diff[illegible] between the three different types of translato

   c) A [illegible]ler typically consists of four stages. Copy the table below and in[illegible]tion:

Stage	Descrip
Lexical analysis	
	Uses the language grammar to transform into an intermediate form suitable for t
Optimisation	
	Reproduces the program in a new form execution on the target system.

3. Libraries can provide programs with access to functionality that would ot consuming for an application developer to write herself.

   a) Libraries present the application developer with an application progr Explain what an API is and the benefits that APIs give application dev

   b) Libraries can usually be provided in one of two forms: static or dynam

      i. Explain the difference between these forms and how they are linke
      ii. Explain one benefit of using a dynamic library instead of a static

4. Open-source programs are heavily used throu[illegible]th computer indust

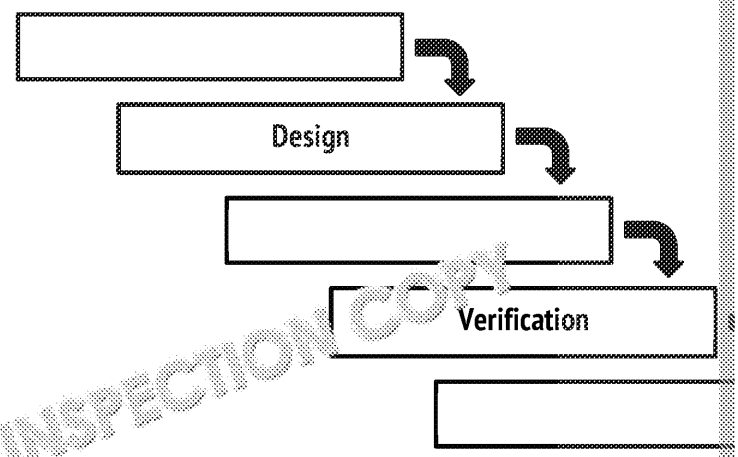
   a) Explain the difference betwee[illegible]ed source program and an ope

   b) Give one exampl[illegible]ed-source program and one example of a

   c) D[illegible]e d[illegible]vantage and one disadvantage to a company of dist in[illegible]source form.

1.2.3 Software Development

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



b) Ex[illegible]he 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

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
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

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

4. Continuous integration testing is utilis[illegible]ex[illegible]sively in projects following
programming methodologi[illegible]

a) Explain wh[illegible]t[illegible]t is and how it relates to continuous integratio

b) Ex[illegible]ow well-designed unit tests can help software developers w

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
the measures taken to reduce risk in the waterfall methodology, the extre
methodology and the spiral model of software development.

1.2.4 Types of Programming Language

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

   a) Describe the properties of a procedural programming language.

   b) Variables declared in a procedural program may be accessible in one 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.

   c) Describe two ways a *functional* programmi g age differs from a language.

2. The following object-oriented code defines a class called `FileReader` t from a file. Internally it calls two system functions: `open` which opens the handle and `read` which reads a byte from the file referred to b

```
class FileReader
    private handle
    public procedure new(name)
        handle = open(name)
    endprocedure
    public procedure readByte()
        return read(handle)
    endprocedure
endclass
```

   a) Identify one example of each of the following in the class `FileRead`

      i. An attribute
      ii. A method
      iii. A constructor

   b) Explain the effect of the keywords `public` and `private`.

   c) The `FileReader` class is part of a library that cannot be modified. A library that takes a `FileReader` as an argument and you need to co from a file during this procedure. To do this a colleague has suggest `CountingFileReader` class that inherits from `FileReader`.

      i. Explain the benefits of using inheritance to implement `Countin`
      ii. Write an implementation of the `Co n FileReader` class th `FileReader`.

3. a) Define each of th addressing modes:

      i. ne
      ii. ct
      iii. Relative

   b) Explain which of the addressing modes given in part (a) are most suit might not always have the same memory addresses allocated to it at

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) Describe 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`
may assume that A and B are positive integers. Provide the pseudocode

1.3.1 Compression, Encryption and Hashing

1. 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

2. Run-length encoding is a form of lossless compres[illegible]. A simple way of r
   data is as a series of pairs of bytes, with the [illegible] in each pair represe
   byte in each pair representing the [illegible] times the character is repea

   Example: The ASCII stri[illegible] "HHLLEELLLLOOOOOOOO" would be encoded

   [illegible]['H', 3, 'E', 4, 'L', 4, 'O', 7].

   a) En[illegible]he string "GGOOOOODDBYYYEEEEE" using the format descr

   b) Calculate the compression ratio achieved by your answer to question
   data stored to maintain the array data structure itself (e.g. length).

   c) Would using the described run-length encoding scheme on its own
   large amounts of English text? Explain your answer.

3. A web-hosting company keeps a hash table containing all of the domain
   customer types a domain name into their website to see if it is still availab
   value of the given domain name, checks for it in the hash table, and retur
   name is not found in the table and **UNAVAILABLE** if the domain name is

   For example:

Domain Name	Result
reallyobscureandlongdomainname.com	AVAILABLE
google.com	UNAVAILABLE

   a) Explain how a lookup in a hash table works.

   b) A hash algorithm is used to generate the hash values for the domain
   used by the company has a bug and only produces even hash values
   would affect the performance of the hash table.

   c) The company is launching a new download service for customers. Th
   service have made sure a checksum is supplied for every file. Explain
   why it is useful for customers who are downloading files from the Int

4. Dictionary coding compression schemes can use a variety of different tec
   One simple technique is to encode English ASCII words separated by space
   the di[illegible]y a word is encountered.

   Use this text to answer the following questions:

   I LOVE CHOCOLATE YOU LOVE CHOCOLATE WE ALL LOVE

   a) Build a dictionary from the text using the technique described above

Index	Word

   b) Encode the text using the dictionary you have produced in part (a).

c) Calculate the minimum number of bits required to represent an inde produced in part (a).

d) Imagine you are using this compression scheme to send this text to a Explain why the size of the message would need to be significantly la indices multiplied by the number of bits required to represent each i

e) Is it possible for the size of the encoded message to be larger than th Explain your answer.

5. TLS is a protocol that is widely used to create secure connections to servers o asymmetric encryption initially to set up the connection before switching to

a) Explain why it is not generally possible to securely set up a connectio symmetric encryption without using asymmetric encryption initially.

b) Describe in detail the steps required to securely send data to a serve asymmetric encryption. Explain the role of the server's public and pri

1.3.2 Databases 1

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 attends a single school. Extend the entity re
include *Schools* and upd[illegible] the relationships.

2. Define each of the following terms:

a) Primary key

b) Secondary key

c) Foreign key

3. ACID (atomicity, consistency, isolation and durability) is a set of principles
transactions modify a database reliably.

a) Explain what an atomic database transaction is.

b) Imagine you are developing a database program that follows the ACI
program will support multiple users reading from and writing to it co

i. The database needs to be fast and only needs to be a couple of
database be kept solely in main memory? Explain your answer.

ii. If one user modifies a row in a table and another user adds a row
transactions need to happen sequentially in order to be isolated
they be performed concurrently? Explain your answer.

iii. Describe a suitable process for deleting a row from a table in the

4. SQL is a language commonly used to create, maintain and query databas

a) Consider this Data Definition Language (DDL) statement:

```
CREATE TABLE db.users
(
    UserName VARCHAR(20),
    FirstName VARCHAR(20),
    LastName VARCHAR(20),
    Password VARCHAR(20),
    PRIMARY KEY (UserName),
    UNIQUE INDEX (UserName)
)
```

i. What is the purpose of this statement?

ii. Why can't the primary key be *LastName*?

b) Explain what each of the following SQL statements would do when a

i. SELECT * FROM users

ii. SELECT UserName, Password FROM users ORDER BY UserName

iii. SELECT FirstName, LastName FROM users WHERE UserName =

5. Consider the following table of, players from an online fantasy role-playin

PID	GivenName	Surname	Character	Level	Race	
001	Alan	Smith	Alzabeck	32	Orc	
002	Yvette	Jones	Thornzon	2	Dwarf	
003	Ibrahim	Hassan	Teylar	12	Dwarf	
004	Lili	Yu	Axethorn	6	Human	
001	Alan	Smith	Tamto	24	Elf	

a) Create an entity definition for the above table.

b) Describe the purpose of database norm[illegible]at[illegible]?

c) Place the table into third n[illegible]al [illegible]m (3NF). You may assume that a[illegible] and that race and [illegible] only need to be stored as attributes, and do Each PID i[illegible]to a real person.

1.3.2 Databases 2

1. 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) Normalise the above database into 3NF by writing the entity descrip
   You may assume at this stage that you only need to order one item a

   b) i. Identify the primary keys
   ii. State the purpose of a primary key
   iii. Identify the foreign keys and their locatio
   iv. State the purpose of a foreign ke

   c) Draw an entity relationship diagram for your database

   d) Complete a Data Dictionary for your database using the layout below
   a
   w have an entry for every column. You should aim to sugg
   va
   n rule, input mask or default value in each table. Under the K
   'Primary', 'Foreign' or leave it blank as appropriate.

Field	Data Type	Format	Validation Mask / De

   e) Answer the following SQL questions based on the structure you have

   i. Write an SQL statement to return all information on every item o
   ii. Write an SQL statement to return the Title, First Name, Surname
   customers in alphabetical order of surname.
   iii. Write an SQL statement to return a list of order numbers, dates a
   item that has not been dispatched. The list should be in ascendi

   f) 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?
   ii. Describe a possible solution for this problem.
   iii. Draw an Entity Relationship Diagram for your new structure.

1.3.3 Networks

1. a) Define the following types of communication link:

   i. Serial
   ii. Parallel

   b) A company wishes to connect sites that are a considerable distance a network (WAN). Which sort of cabling would you advise it to use, ser

   c) The network link the company uses for its WAN has a latency of 10 r Mbps (megabits per second). Calculate how long it will take to transf

2. A home user is trying to set up a local area network (LAN) that will be con have drafted you in to help th et up.

   a) They have bou a router that contains a built-in ADSL gateway and ro as an internal IP address of 192.168.1.1. Their Internet service ex P address.

      i. Explain the purpose of the gateway built in to the router.
      ii. The router they have bought has a built-in wireless access point implications of adding a wireless access point to the network an should be taken.

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

   c) The user is new to using the Internet and is worried that his compute how the use of a firewall can help to prevent attacks.

   d) 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 name and purpose of the service that is not working correctly?

3. 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.

   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.

   c) The Hypertext Transfer Proto P) is the protocol most commo HTTP is commonly im em ed on top of TCP/IP. Explain the advan HTTP as a lay ov CP/IP rather than as a standalone protocol.

4. A new ny entering the voice over IP (VOIP) telephony market is de move voice data between customers. They have two options: a client-ser model. Explain which model you would recommend the company use an and disadvantages for both models.

1.3.4 Web Technologies

1. A software developer is making a personal website that she wants to use s she has worked on and some of the things that interest her. The website c 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. Expla her to use this tag for the he ... her than using the <p> tag.

   c) The website auth ... cided to refactor her favourite things into wri... th... ng HTML:

```
<li 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 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 co... e achieved while kee Your answer should include the HTML ... S required to implemen

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>
       <scri
           document.getElementById("pswd").onkeydow
       script>
   </body>
   </html>
   ```

   The password that the users 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 modifies 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` string can be retrieved using its `length` property. The background co modified using its `style.backgroundColor` property.

   ```
   function checkPassword() {
   ```

4. a) Explain the concept of search-engine indexing.

   b) PageRank is an algorithm for ranking web pages in order of their imp by Larry Page and Sergey Brin while they were researchers at Stanfor

   Explain how the PageRank algorithm works out how important a web

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	Hexadecima
0		
↓		
16		

2. Evaluate the following binar[illegible] ons. Show your working:

   a) 0111 + 0010

   b) 1[illegible]10

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. 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. Dena[illegible]
      ii. [illegible]adecimal:

   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:

5. a) Shift the hexadecimal value 4F left by 2. Give your answer in hexadec

b) Evaluate the following expressions:

i. 0111 AND 1010
ii. 0111 OR 1010
iii. 0111 XOR 1010

c) Some languages provide two distinct types of right shift: a signed right
A signed right shift of n is equivalent to division by 2^n when performed o

Explain how a signed right shift works.

Hint: -18 / 2 = -9. How are -18 and -9 represented in two's complem

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 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 popular type of Unicode encoding that uses a variabl encoding. 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

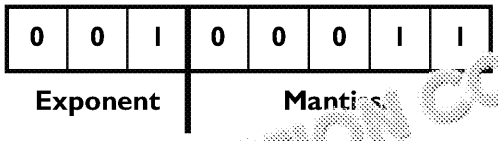
i. In floating-point binary
ii. In denary

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

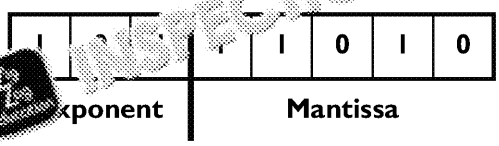
i. In floating-point binary
ii. In denary

e) Normalise the following floating point numbers:

i.

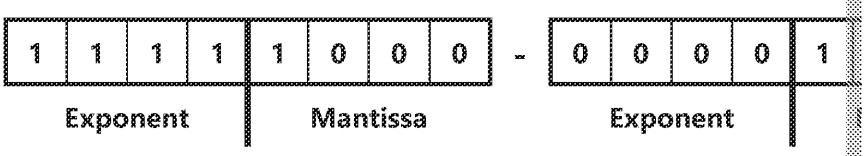


ii.



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, linked lists, stac

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

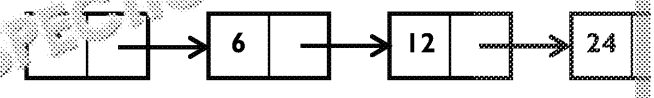
   a) Write the code that would create a one-dimensional array (named 's five sports that are played at a school: rugby, football, hockey, netba

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

   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 t is information.

2. Consider the following linked li



   a) W 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 to look up an item by index in a linked list or an a

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

   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 a . ou may assume that t encapsulated in a linked list node (i.e. `item` as the attributes `value` list elements may be assu to equal to `nil`. The procedure sho

3. Take the follow example of a stack that 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'

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

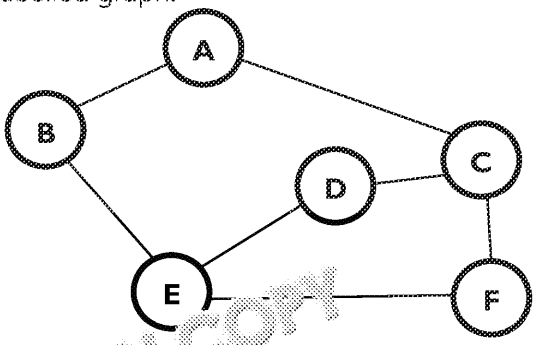
a) Explain the difference between a queue and a stack.

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 com[illegible] state of the queue a
NextFree values at each stage.

State 1	State 2	State 3	St
[illegible]	H joins queue	Item served from queue	J join
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	FrontPtr =	FrontPtr =	FrontP
NextFree = 4	NextFree =	NextFree =	NextFr

1. Here is an example of an unlabelled graph:



a) Is this graph a tree? Explain your answer.

b) This graph can be converted into a directional graph (digraph). Expla

c) C[illegible] to represent a graph in a computer is to use an array. This a
di[illegible] formats.

i. Draw an adjacency list to represent this graph.
ii. Draw an adjacency matrix to represent this graph.

2. You have been given the following numbers to insert into a data structure

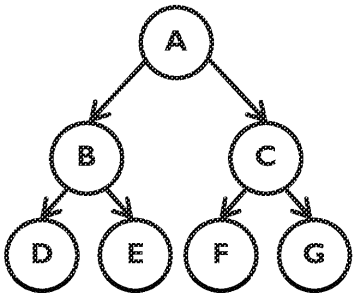
12, 18, 42, 22, 56, 87, 99

a) Add the numbers in the order given to a binary search tree.

b) How many steps does it take to find the number 99 from this tree?

c) Is this tree efficient? Explain your answer.

d) A binary search tree can be represented as an array as follows:



Label:	A	B	C	D	E
Index:	0	1	2	3	4

If the index of a node is n then the index of its left child will equal $2n$
child will equal $2n + 2$. Write a pseudocode algorithm to find the sm
binary search tree with an arbitrary length. Use the functions `leftCh`
and `rightChildExis[illegible](myArray, index)` to see if the node at `i`

Questions continue on the following page

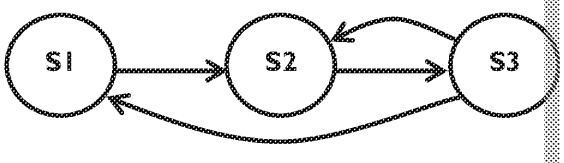
3. Consider the following class that represents a node in a graph:

```
class Node
    private name                 // string
    private destinationNodes     // list of nodes

    public procedure new(givenName)
        name = givenName
        destinationNodes = new List()
    endprocedure

    public procedure addDestination(node)
        destinationNodes.append(node)
    endprocedure

    public function getName()
        return name
    endfunction

    public function getDestinationNodes()
        return destinationNodes.copy()
    endfunction
endclass
```

a) Name the attribute in the Node class that represents the edges in the

b) A copy of the list of destination nodes is returned to the user instead list. Explain why the class designer would want to do this.

c) Write a pseudocode algorithm to build the following graph using the



d) Is it possible to remove a node from the graph given only the node t your answer.

4. The following diagram represents a hash table:

0	1	2	3	4	5
London		Bristol	Manchester		Yo
		Newcastle			

The index of a city name is the value of the lowest three bits of the hash c code is generated using a hash function that takes a string as its argumen The city names are stored in an array at each index.

a) Calculate the index to insert each of the following cities at:

City Name	Hash Code
Liverpool	16
Edinburgh	32
Swansea	44
Cardiff	15

b) Bristol and Newcastle share the same index. Is it possible that their h Explain your answer.

c) A colleague wants to add 100 cities to this hash table. Will the speed affected? Explain your answer.

d) The hash table is implemented using the following classes:

```
class CityHashTable
    private table

    public function getArrayAtIndex(i)
        return table[i]
    endfunction

    ...
endclass

class CityArray
    private array
    private length

    public function getLength()
        return length
    endfunction

    public function getCityNameAtIndex(i)
        return array[i]
    endfunction

    ...
endclass
```

Write a pseudocode function that takes a `CityHashTable` and a st
table and the name of a city respectively as arguments, and returns t
the given city name, and false otherwise. You may assume that the st
`hashCode` that returns the hash code and `equals` method that retu
to a string given as an argument.

1.4.3 Boolean Algebra

1. Draw the logic symbol for each of the following gates:
   a) AND
   b) NOR
   c) XOR

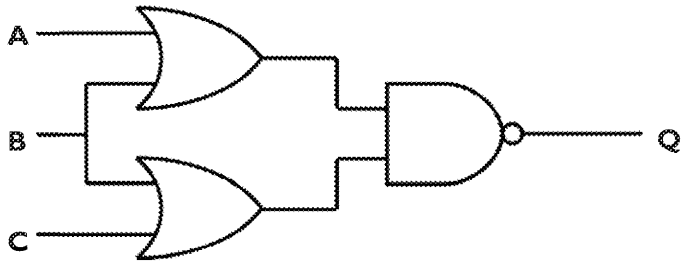
2. Copy and complete the following truth table:

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

3. a) Compute the results of the following logic expressions:
   i. $0 \vee 1 \vee 1 \vee 0$
   ii. $1 \wedge 0$
   iii. $(0 \vee 0 \vee 0) \vee (0 \vee (1 \wedge 1))$

   b) Simplify the following logic expressions:
   i. $(A \wedge B) \vee (A \wedge B)$
   ii. $\neg(\neg A \wedge B) \vee A$
   iii. $(A \wedge \neg(A \vee B)) \vee C$

4. Consider the following logic diagram:

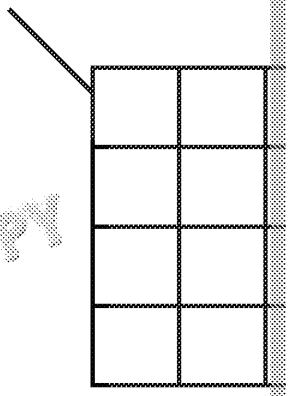


   a) Write the logic equation for Q.
   b) Simplify the equation.
   c) Draw the logic diagram [illegible] simplified equation.

Questions continue on the following page

5. 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	1
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.

6. a) Copy and complete the truth table for a half adder.

A	B	SUM	CARRY
0	0		
0	1		
1	0		
1	1		

b) Draw the logic diagram for a half adder.

c) Draw the logic diagram for a full adder.

d) Explain the purpose of a D-type flip-flop and how it works.

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 p eti c mpany wants to collect data about potential custome in on 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 o
      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 new 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 s surveillance and and postal communication.
   a) Encrypted communicat on a e seless when they are intercepted un Explain the pr s n the act contains to mitigate this problem.
   b) T ha 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
   n robots for work i

3. There has been a huge push in
   ears into the development of com
   software by companie
   oogle, Facebook and Apple.

   If a hu
   s
   wo pictures, they will be able to identify if the same
   an acc
   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[illegible] c[illegible] 1 mark if the description is less specific b*
   i. Program Co[illegible]n Cr: Stores the memory address of the next instr[illegible]er [illegible]uction and can be overwritten to branch.
   ii. [illegible]mulator (ACC): Stores the results of arithmetic and logic opera[illegible]perations.
   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. Th 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 pr 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 instruct alternative destination register (1 mark). If the operation is a HLT in are loaded (1 mark).

   b) i. *1 mark for each of the following up to a maximum of 2 marks:*
   - Pipelining separates the logic for th[illegible]ent processor step Instructions move from one p[illegible]pe[illegible]stage to another as they
   - Multiple instructi[illegible]c[illegible]processed in parallel, each pipeli different i[illegible]uctio[illegible]Therefore, the processor can theoretical th[illegible]or pipeline stages, subject to other constraints su

   ii. *ar[illegible]identifying a technique and 1 mark for a correct explanat*
   Clock speed: Increasing the clock speed reduces the time the each operation.
   - Cache size: Increasing size of the cache reduces the chance t need to travel all the way to the main memory, reducing the an operation.
   - Vector instructions (also known as SIMD): Operations take pl rather than needing to be executed one after another.
   - Multiple cores: Increasing the number of cores means tha completed simultaneously rather than needing to be exec

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 t
- Used in most general purpose computers.

Harvard: Instructions are stored in a separate memory address space to the da
- Used in DSPs and other 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, one for identification and o*

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

Disadvantages:
- Difficult: Writing and maintaining multi-threaded code is generally 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 u
- Custom chips: RISC processors are simpler and, therefore, cheaper 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 CISC and, therefore, more mobile-centric software is available.
- Simpler assembly: Code written in RISC assembly uses a smaller nu be easier to write and understand. This can be important if a mobi to heavily hand-optimise parts of the software to improve perform

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 program might be lost. By s to accidentally wipe the boot program.

b) *1 mark per advantage and disadvantage. Only one advantage and disadv*

- Flash memory (USB stick, SD card, etc.):
- Advantages: can save operating system state, maximum capacity
- Disadvantages: 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 sh[illegible]commands can be used
- Optical Mark Re[illegible]very quick and access to computer not nee
- Bar Cod[illegible]easy to use and could later be used (by pupils)
- [illegible]on [illegible]ed sheet by teacher
- [illegible]ctronic 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 part 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 performance 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

5. a) *1 mark for each difference and 1 mark for a good explanation of the differenc*

- Many-core: GPUs typically have more cores than an equivalently p
- Simpler cores: GPU cores are simpler and less heavily optimised th them fit on a chip
- Higher bandwidth memory: GPUs tend to use higher bandwidth, l GDDR5 instead of DDR3)
- Slave: GPUs need to be controlled by a CPU; CPUs do not need G

b) *2 marks for an application and 2 marks for e[illegible]ng why it is faster on a*

- Particle simulations: Particle in[illegible]ra[illegible]ti[illegible]can be calculated concur resulting in a faster [illegible]ti[illegible]
- Computatio[illegible]d dynamics: Cores can simulate different areas
- Vide[illegible]ng: Cores can scan different parts of each frame in p [illegible]re quickly

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 addr sp e t a physical addres that processes do not use physical m addresses directly.

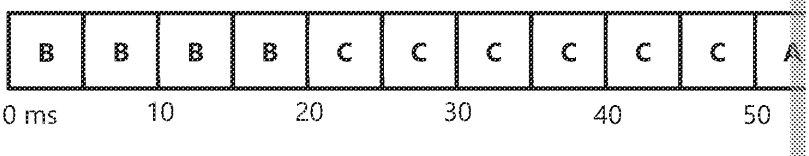
   b) Since each process can only e address space it has been allocated are not in its ad se. Therefore, it cannot overwrite or read memo sy or processes.

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

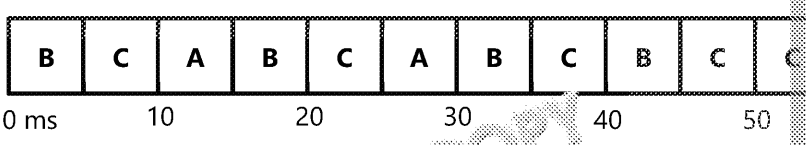
   1 mark for one of the following disadvantages:
   - System performance may be reduced if data contained in seconda
   - Memory may be moved to secondary storage unnecessarily.
   - Memory access times become more variable (important in system performance/responsiveness is required).

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 r 50 ms rather than 60 ms).
   ii. No (1 mark), if A r B longer-running processes and started have to w ti e long-running processes completed before ge nd n approach, C would get processor time earlier, and so c first come, first served system (2 marks).
   iii. Multi-level feedback queues could be used (1 mark). In this schedul be placed in a higher priority queue than A or B. The scheduler pref higher priority queues so C would be run in preference to A or B un

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

b) *1 mark each for up to two of the following:*
- Executing an instruction in software incurs overhead (the cost of m
place for example) that executing an instruction in hardware does
- Hardware may contain specialised circuits to perform certain oper
- The instruction set of the machine being emulated may not be a g
machine the emulator is run on, so the virtual machine may have t
map the instructions to the real underlying hardware.

c) *1 mark for each of:*
- Interpreting an intermediate instruction set generated by a compi
- Running one or more operating systems within another.

5. *1 mark for each of the following steps. Full marks shou[illegible]o be given if an alt*
is provided:
- Provide an interrupt service ro[illegible]SR, that will add the process back
scheduler.
- Register the IS[illegible] will be called when the given time period ha
- R[illegible]e p[illegible]ocess from the operating system's scheduler.
- [illegible]e process to stop executing.
- When the process resumes, check to see if the given time period has e
repeat the process subtracting the time elapsed from the delay require

1.2.2 Applications Generation

1. a) 1 mark each for correct descriptions of system software and application
Application software is used for a specific task. System software controls
maintains 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 as[illegible]bly language into a
machine code.
Interpreters execute code direct[illegible]v[illegible]ou[illegible]ecessarily first converting int

c) *1 mark for each corre[illegible]nsw[illegible]n bold.*

[illegible]ta[illegible]	Description
[illegible]analysis	Breaks up the source code in
Syntax analysis	Uses the language grammar to transform the outp intermediate form suitable for transform
Optimisation	Applies transformations to the intermediate form and/or size of the outp
Code generation	Reproduces the program in a new form (e.g. machi on the target systen

3. a) An API is a group of function/procedure definitions (1 mark). APIs provid
libraries (1 mark) and allow the use of different libraries that implement t
example, on a different operating system) (1 mark).

b) i. A static library is linked with an executable at build time (1 mark) wi
linked with an executable at runtime (1 mark).

ii. 1 mark for a benefit and 1 mark for a description.

- Upgradeable: Can fix security problems, etc. without upgradi
- Abstraction: Can provide the same API on different platforms

4. 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, max 2.*
Open-source: Linux, Open Office, GCC, Mozilla Firefox, Chromiu
Closed-source: Windows, Office, Internet Explorer, Safari, PowerDVD,

c) *Up to 2 marks for an advantage and a good description. Up to 2 marks fo
description.*

Advantages:

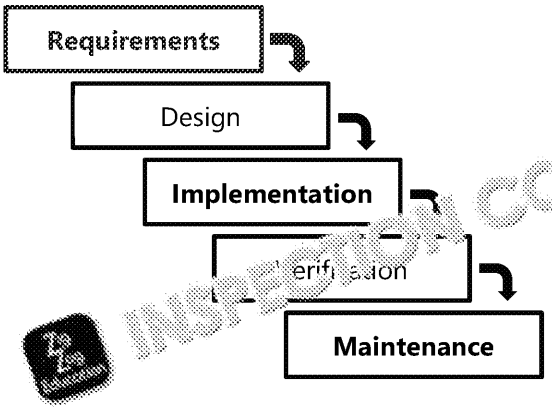
- Community involvement and support: members of the software d
develop and support the software.
- Maintaining community relations: open-sourcing software can hel
relations with the community and encourage similar ventures by o
- Increased adoption: the software might be adopted more widely a
commercial 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 Software Development

1. a) *1 mark for each correct stage.*



b) The purpose of the design phase is to use the requirements to identify t
components of the system (1 mark) and guide the implementation, verifi
stages (1 mark).

c) RAD uses prototypes (1 mark) and short iterative development cycles (1
that meets the requirements rather than detailed design (1 mark).

d) *1 mark per strength up to a maximum of two.*

- Simple and straightforward to implement.
- The requirements gathering and design phases should ensure tha customer's requirements, thereby reducing the risks involved in th
- The product has a clear lifecycle and can be staffed appropriately

1 mark per weakness up to a maximum of two.

- No clear process for handling changes in requirements.
- Problems that are identified in the later phases can be very expens project to be abandoned.
- The product is unlikely to be useful until after the implementation been completed.

2 a) *1 mark for each two correct answers circled*

- Communication
- Software
- Collaboration
- Respo[illegible]ss

b) A [illegible]entative of the customer is made available to the software deve qu[illegible]s (1 mark). Software is developed quickly and the customer repr presented with prototypes / partially working software to provide feedb

3 a) *1 mark for a correct definition and 1 mark for each advantage up to a ma*

Pair programming means that two software developers work together, u single piece of code (1 mark).

Advantages:

- Reduces the chances of bugs being introduced
- Spreads knowledge about the code around the team
- Allows developers to learn from one another

b) The planning game is an exercise where stories/tasks are created (1 mar to the stories/tasks (1 mark) and business people prioritise the stories/ta

4 a) A unit test is a test designed to validate the behaviour of a single piece Continuous integration testing involves rerunning all of the tests every t changes is made to a software project to check that it still works (1 mark

b) *1 mark for each of the following points up to a maximum of 2 marks.*

- Unit tests can be run to validate that a piece of code still works af
- Unit tests document the expected functionality of a piece of code refactoring the code knows exactly what it is supposed to do.

c) *1 mark for each of the following points up to a maximum of 3 marks.*

- Makes it easier to identify the change that b[illegible]e a piece of code s investigative effort.
- Refactoring to add functionality can be done quickly with confide existing behaviour.
- Validation is performed alongside implementation reducing, the r stage before the product is finally shipped.

5 *1 mark [illegible]h of the following descriptions/comparisons up to a maximum o*

The waterfall method uses detailed upfront requirement gathering and desig programming method uses short development iterations to reduce risk (1). T early design iterations to quantify or mitigate risks before a commitment is m efforts (1). The waterfall model works well when the task is well understood i mitigated through detailed design (1). The extreme programming method wo can be created in a short period of time and then improved later (1). The spir project has a lot of unknowns and is likely to take a long time and involve a s extreme programming and spiral methods are similar in that they use increm and can respond better to the risk of changing requirements than the waterfa

1.2.4 Types of Programming Language

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

   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 program can see.
   - Reduces the possibility of procedures having side effects that understand and work with the code.
   - Allows access to variables to be restr to the executing th accessed by any thread – pos in a unsafe manner).

   c) *1 mark for each of the follow ces up to a maximum of 2 marks.*
   - Functions in a fu tio a programming language cannot have sid
   - The val u ed by functions in a functional programming lan ou
   - ta is always immutable in functional programming languages.
   - Functional languages use recursion instead of loops.

2. a) i. handle
   ii. readByte
   iii. new

   b) Private attributes/methods can only be accessed by methods defined in attributes/methods can be called by any code using the class.

   c) i. Polymorphism means that the CountingFileReader class can be pas FileReader class as an argument (1 mark). It can, therefore, count th file in a subroutine without modifying the subroutine (1 mark). It al FileReader and automatically benefits from any improvements mad

   ii.
```
class CountingFileReader inherits FileReader
    private count

    public procedure new(name)
        super.new(name)
    endprocedure

    public procedure readByte()
        count = count + 1
        return super.readByte()
    endprocedure
endclass
```

   1 mark for each of the following and 1 additional mark for a complet
   - Attribute called count or equivale
   - Constructor calling super.new()
   - readByte metho t calls super.readByte and increments th

3. a) i. Immedia a encoded in the instruction.
   ii. ct the address of the data in memory is encoded in the instruc
   iii. ive: The instruction contains an offset to the data.

   b) Immediate and relative are both suitable (1 mark). Direct cannot be used data is not known in advance (1 mark).

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

   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 in

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

2 marks for a correct pseudocode algorithm (does not have to match ex
2 marks for an assembly program that has minor errors.
4 marks for an assembly program that is correct.

1.3.1 Compression, Encryption and Hashing

1. a) Lossless compression is reversible: the original data can be recreated exa
Lossy compression is not reversible: some data is lost (e.g. the quality m

b) Examples: Music, Video, Pictures

Reason: Humans can still understand/enjoy the result when certain in

c) Lossless compression techniques require all the information in the comp
order for 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

2. a) ['G', 2, 'O', 5, 'D', 2, 'B', 1, 'Y', 3, 'E', 5]

b) 3:2 (18 bytes in original, 12 bytes encoded)

c) No (1 mark). The frequency of repeated letters in English text is low (1 m
versions of files would be larger than the original (1 mark).

3. a) A hash function is applied to the key string to find its hash value (1 mark
calculate the index into the table (1 mark) and then the key (or keys) fou
against the key being looked up (1 mark).

b) Hash collisions would occur twice as frequently for a given table size (1 m
performance will be halved or the table will need to be twice as big (1 m

c) A checksum is a fixed-length string/number calculated using all the byte
algorithms are designed so that small changes in the input bytes result i
(1 mark). They are useful to customers because they can use the checksu
while the file was downloaded (1 mark).

4. a) *2 marks for a correct dictionary.*

Index	Word
0	I
1	LOVE
2	CHOCOLATE
3	YOU
4	WE
5	ALL

b) 0 1 2 3 1 2 4 5 1 2

c) $\log_2(6) = 2.6$, so at least three bits would be requi

d) The dictionary would also need to be tra sm tted.

e) Yes (1 mark). This can hap n th number of words repeated is low be then the amount of r quired to represent it increases as an index is as the orig nal w (1 mark).

5. a) Sy ic encryption requires a shared key (1 mark) and there is no wa party securely unless asymmetric encryption is used (1 mark).

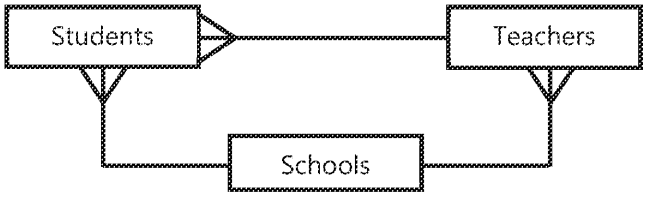
b) 1. Client requests the server's public key (1 mark).
2. Client uses the server's public key to encrypt the data (2 marks).
3. Client sends the encrypted data to the server (1 mark).
4. The server decrypts the data using its private key (2 marks).

1.3.2 Databases 1

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 fo nd in multiple tables. It must be th tables.

3. a) An atomic database transaction means that the transaction either compl cl the database at all (1 mark). Other database transactions cannot tra on until it has completed (1 mark).

b) i. No it cannot (1 mark). Database transactions need to be recorded t the durability requirement (1 mark).
ii. They can be performed concurrently (1 mark) because they do not so long as the data structures the database uses internally do not a
iii. The table/row should be locked to prevent other transactions from should then be deleted from the table (1 mark). If the operation do then any partially deleted data must be restored before returning (1 be unlocked once the change has been completed on disk (1 mark)

4. a) i. Creates a table called *users* in the database *db*
with the fields *UserName*, *FirstName*, *LastName* and *Password*.
It sets the primary key and unique index of the new table to be *User*
ii. Last names can be the same between different people. The primary

b) i. Selects the whole table *users*.
ii. Selects the *UserName* and *Password* fields from *users*
Displays them in descending order by *UserName*.
iii. Selects the *UserName* and *LastName*
of the person with the *UserName* Bilbo33 from *users*.

5. a) *1 mark for the table name outside the brackets, 1 mark for the correct*
Players(PID, GivenName, Surname, Character, Level, Race, Items)

b) Database normalisation aims to reduce repetition and ensures that all the att
another. This avoids, for example, the need to update multiple database
attributes, which reduces the chance of mistakes creeping in.

c) All entities must be present for full marks. 1 mark for each entity w
one table having the correct data, 1 mark for all three tables having the
given for alternative ways of representing the solution (e.g. entity definit
table layouts.

PID	GivenName	Surname
001	Alan	Smith
002	Yvette	Jones
003	Ibrahim	Hassan
004	Lili	Yu

PID	Character	Level	Race
001	Alzabeck	32	Orc
002	Thornzon	2	Dwarf
003	Teylar	12	Dwarf
004	Axethorn	6	Human
001	Tamto	24	Elf

Character	Items
Alzabeck	Potion
Alzabeck	Armour
Alzabeck	Axe
Thornzon	Armour
Thornzon	Sword
Teylar	Staff
Teylar	Potion
Axethorn	Axe
Axethorn	Horse
Tamto	Potion
Tamto	Horse

1.3.2 Databases 2

1. a) Table names can vary from the below suggestions but should be sensible

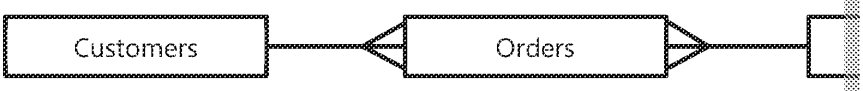
1 mark for each of the three tables with a further mark for correctly having the Order table for the relationships

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 t
Don't penalise twice for mistakes in part a.
OrderNum, CustNum, StockNum
ii. A primary key is an attribute which uniquely defines a tuple/row.
iii. Both foreign keys must be present to get the mark and must match
Don't penalise twice for mistakes in part a.
CustNum and StockNum in the Orders table
iv. A foreign key is an attribute which is found in multiple tables. It mu
of the tables.

c) *1 mark for all tables being present*

1 mark for the correct ordering and connections between them
1 mark for identifying 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 key

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

Customer Table *(4 marks)*

Field	Data Type	Format	Validation Rule/Input
CustNum	AutoNumber		"CUST
Title	Text	Length = 4	
FirstName	Text	Length = 15	
Surname	Text	Length = 15	
Address	Text	Length = 30	
PostCode	Text	Length = 8	>LL0

Stock Table *(4 marks)*

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

Order Table *(4 marks)*

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

e) i. SELECT * FROM Stock

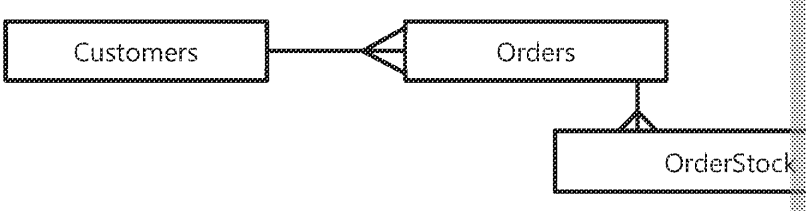
ii. *1 mark for the correct fields and table being used*
1 mark for the ordering by surname
SELECT Title, FirstName, Surname, PostCode FROM Customers ORD

iii. *1 mark for correct fields and table used*
1 mark for correct criteria of the search
1 mark for correct sorting
SELECT OrderNum, OrderDate, OrderTime FROM Orders WHERE Di
OrderDate ASC

f) i. *1 mark for the problem and 1 mark for the knock-on effect*
An order can only have one item of stock assigned to it.
So if a customer wants to buy more than one thing, several entries
to be created.

ii. *1 mark for identifying a fe[illegible] could be created*
1 mark for further explanation
Create a [illegible]
[illegible] store multiple entries of StockNum for the same OrderNum

iii. *[illegible]rk for link between Orders and Stock being broken*
1 mark for new table added with sensible name
1 mark for correct 1-many relationship between Orders and new tab
1 mark for correct 1-many relationship between Stock and new table



1.3.3 Networks

1. a) i. A 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) $transmission\ time = \frac{amount\ of\ data}{bandwidth} + delay$

$$transmission\ time = \frac{1}{100} + 0.01 = 0.02\ s = 20$$ [illegible]

2. a) i. A gateway is a device [illegible]rts between two different types o
In this example [illegible] required in order to convert between the ADSL
and the Ethernet system used in the local network (1 mark).

ii. [illegible]ers [illegible] does not need physical access to their building/network i
[illegible]ark) 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 header (1 mark). The header contains inf
the packet, the destination of the packet, the sequence number of the si
checksum of the packet, for example (2 marks for at least two).

b) Every time the server receives a packet it sends an acknowledgement to
received (1 mark). If the client does not receive the acknowledgement w
(1 mark) 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.*

Advan f peer-to-peer:
- C r – 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 implem
- Server can be upgraded to fix security problems – client is controlled b
as frequently
- Servers can provide more features

1.3.4 Web Technologies

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

```
<p>My favourite website is <a href="http://www.bbc.co
News</a></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 <li> tags, with an <ul> tag around the

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

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

```
<form>
    <label>Na  e:<br>
    <inp  t type="text">
    <br><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 t*

```
<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 different looks

b) *1 mark for identifying that a class is required. 1 mark for adding the class selector and 1 mark for the correct CSS syntax.*

The author should use a class. Example code:

HTML:
```
<p class="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 meets 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) Search-engine indexing is the process of collecting and storing data from search engine can quickly match the content against search terms (1 ma

b) PageRank measures the importance of a website by how many other websi algorithm iteratively calculates the importance of each website (1 mark) so t high importance are given a higher ranking than those linked from website

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)
```
  0111
+ 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.
   ii. .5625

4. a) i. 11001100
   ii. CC

   b) i. 199
   ii. C7

   c) i. 231
   ii. 11100111

   d) i. 10010011
   ii. 11101101

   e) i. 1000.0011
   ii. 1111.1101

5. a) 0b00101111 << 2 = 0b10111100 = BC

   b) i. 0010
   ii. 1111
   iii. 1101

   c) A signed right shift replicates the most significant bit when shifting, rath
   ensures that the result retains the correct sign.

1.4.1 Data Types 2

1. a) i. F: 70
   ii. M: 77
   iii. 8

   b) *1 m[illegible] 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 mentic
   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 encodi

c) $2^{16} = 65{,}536$

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

b) Increasing the n[illegible] exponent bits increases the range of the numb[illegible] pre[illegible]mber (1 mark)

4. a) i. [illegible] $* 2^2 = -44$

ii. $8 * 2^{-2} = 2$

b) i. 0.75

1	0	0	0	1	1	0	0
Exponent			Mantissa				

ii. –7.5

1	1	1	1	0	0	0	1
Exponent			Mantissa				

c) i.

0	1	1	0	1	1	1	1
Exponent			Mantissa				

ii. $15 * 2^3 = 120$

d) i.

0	1	1	1	1	0	0	0
Exponent			Mantissa				

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

e) i.

[illegible]	1	1	0	1	1	0	0
Exponent			Mantissa				

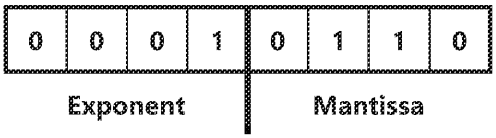
ii.

1	0	0	1	0	1	0	0
Exponent			Mantissa				

f) Equalise the exponents:
00000100 = 00010010

Add the mantissas:
0100 + 0010 = 0110

Answer:

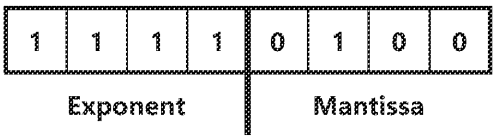


g) Equalise the exponents:
11111000 = 00001100

Subtract the mantissas:
1100 – 1010 = 0010

Normalise the result:
0[illegible]0 = 11110100

Answer:



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

1.4.2 Data Structures 1 (arrays, linked lists, stacks an

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

```
C: const char *sports[] = {"rugby", "football", "hock
"cricket"};
```

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

```
JavaScript: var sports = ["rugby", "football", "hocke
"cricket"];
```

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.writeli[illegible]s(0))
console.writeline(sports(4)) OR console.writeline(spo
```

J[illegible]:

```
co[illegible].log(sports[0]);
console.log(sports[4]); OR console.log(sports[sports.
```

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

2. a) Pointers (to the next item in the list).

b) Singly linked list (1 mark). Each item in the list only has one pointer (to t
doubly linked list would have two pointers, one to the next item and on

c) On average it takes longer in a linked list (1 mark). An item in an array ca
index in O(1) time, whereas to find the item in a linked list requires follo
previous items in the list and so takes O(n) time on average (1 mark).

d) *1 mark for each advantage up to a maximum of 2 marks.*

- Can add/delete items in a linked list without copying.
- Linked lists do not have a maximum length, unlike arrays.
- Linked lists do not require a 'length' and/or 'size' property, unlike
- Linked lists do not require a large contiguous block of memory be
- Items in the list can be of different sizes (items stored in array all n
allow indices to be calculated).

e) The loop condition should be: `i=0 to indexToRemove-1`. The code would
immediately following the index of the item to remove.

f) *1 mark for correctly appending an item to the end of the list, 1 mark for re
and 1 mark for adding the item to the head of the list if necessary.*

```
procedure append(head, item)
    if head = nil then
        head = item
        return head
    endif

    prev = head
    while prev.next != nil
        prev = prev.next
    endwhile

    prev.next = item
    return head
endprocedure
```

3. 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 the TopOfStack being in MemLoc 3 and 1 mark for th
Rabbit. (Don't penalise for a mistake in part a if their answers suit their r

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

4. 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 o

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 join
1 2 3 4 5 A B C	1 2 3 4 5 A B C H	1 2 3 4 5 A B C H	1 2 A B
FrontPtr = 1 NextFree = 4	FrontPtr = 1 NextFree = 5	FrontPtr = 2 NextFree = 5	Fro Nex

1.4.2 Data Structures 2 (graphs, binary search trees

1. a) No, it contains a cycle

b) Replace each line with an arrow. Accept an indication that there would be a line in the opposite direction (as it is a directional graph).

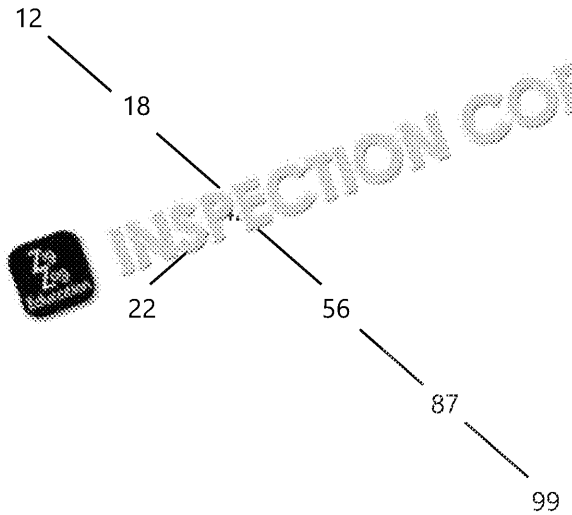
c) i. *1 mark for identifying and correctly labelling the adjacent vertices of*
1 mark for identifying and correctly labelling the adjacent vertices of

Vertex	Connected to
A	B, C
B	A, E
C	A, D, F
D	C, E
E	B, D, F
F	C, E

ii.

	A	B	C	D	E	F
A	X	1	1	0	0	0
B	1	X	0	0	1	0
C	1	0	X	1	0	1
D	0	0	1	X	1	0
E	0	1	0	1	X	1
F	0	0	1	0	1	X

2. a)



b) Six steps

c) No it is not, the tree is not balanced and so it can take close to O(n) time looked for.

d) The key in this question is to realise that the smallest number will always 1 mark for recognising this and 2 marks for correct pseudocode.

```
function findSmallest(array)
    index = 0
    while leftChildExists(array, index)
        index = 2 * index + 1
    endwhile
    return array[index]
endfunction
```

3. a) destinationNodes

b) The list is copied so that if the user modifies the list in their code then it

c) *2 marks for creating the nodes correctly and 2 marks for connecting them*

```
s1 = new Node("S1")
s2 = new Node("S2")
s3 = new Node("S3")
s1.addDestination(s2)
s2.addDestination(s3)
s3.addDestination(s1)
s3.addDestination(s2)
```

d) No it is not possible (1 mark). The node might still be in the destinationN unknown, node (1 mark).

4. a) *1 mark for each two correct indices.*

City Name	Hash Code	Index
Liverpool	16	0
Edinburgh	32	0
Swansea	44	4
Cardiff	15	7

b) Yes it is possible (1 mark). Multiple strings can have the same hash value strings than there are possible hash values (1 mark).

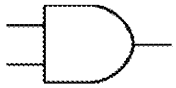
c) The table lookup time will increase (1 mark). This is because it takes O(n) index (where n is the number of items in the array). Once the hash table names there will be more than 12 city names at each index on average a increased significantly by the time taken to search the array (1 mark).

d) *6 marks for a function that is correct. Up to 4 [illegible] if the index is not calc*

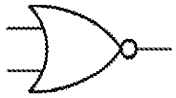
```
function contains(table, name)
    hash = name.hashCode()
    index = hash & 7                          // Mask th
    array = table.getArrayAtIndex(index)
    for i = 0 to array.getLength()
        if name.equals(array.getCityNameAtIndex(i))
            return true
        endif
    next i
    return false
endfunction
```

1.4.3 Boolean Algebra

1. a) AND



b) NOR



c) XOR

2. *1 mark for each correct column.*

	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) i. 1
   ii. 0
   iii. 1

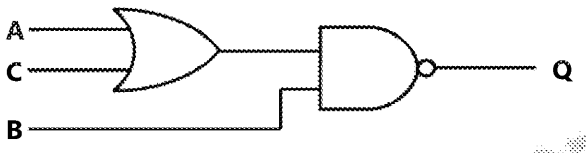
   b) i. $A \wedge B$
   ii. $\neg(\neg A \wedge B) \vee A = A \vee \neg B \vee A = A \vee \neg B$
   iii. $(A \wedge \neg(A \vee B)) \vee C = (A \wedge \neg A \wedge \neg B) \vee C = C$

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

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

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

   c)



5. a)

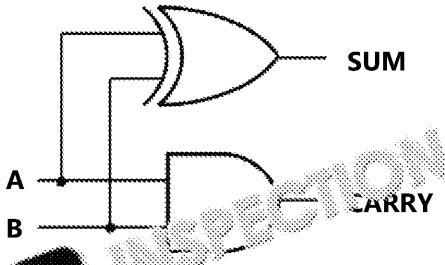
CD \ AB	00	01	11	10
00	0	1	0	0
01	0	1	1	1
11	0	1	1	1
10	0	1	0	0

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

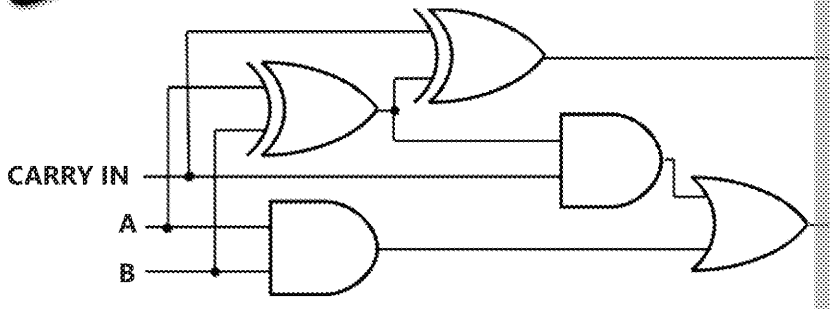
6. a) *1 mark for each correct column.*

A	B	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

b)



c) *2 marks for the correct sum, 2 marks for the correct carry out.*



d) A D-type flip-flop implements a delay (1 mark). The value is captured fro
clock-based trigger is seen (e.g. rising clock edge) (1 mark). The output v
new input is captured (1 mark).

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 those data (1 mark)
- from the data and other information the data controller has, or is
of the data controller (1 mark)

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

- Personal data shall be processed fairly and lawfully and, in particul
  - (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. Industrial appearance, configuration, decoration or shape
   iv. Names, logos and phrases

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

   c) Fair dealing is the legal reproduction of part of a copyrighted work (1 m
research/review or in news reporting (1 mark).

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

   They could use copyright or patents (1 mark). Copyright means that no
code / program (1 mark); however, it does not automatically stop someo
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 surveillance and clarifies the
institutions
- Allows police to intercept communications relating to terrorism an
- Allows secret services to intercept communications for national se

Example effects on civil liberties:
- Allows installation of equipment at ISPs enabling mass surveillanc
- Open to many different parts of government (including local coun
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 comp
- copied to differ co
- viewed a set number of times
- ay anything other than a particular proprietary program
- yed on portable devices
- played in an unsanctioned country

2. *1 mark for each but max of two advantages and two disadvantages:*

Advantages

- 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, s logically structured response. The response covers all four areas indicate 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. Submitted answer uses an excellent range of technical vocabulary and t more than a few spelling or grammar mistakes e answer.
3	A line of reasoning has been followed t pr e a coherent, relevant, sub logically structured response esponse may only cover three of the the guidance below ree substantiated points being made pe Submitted an good range of technical vocabulary but there f sp rammar mistakes in the answer.
2	ited attempt has been made to follow a line of reasoning by cover opic areas in the guidance below. Overall, at least four valid points made which can relate to any of the topic areas in the guidance. Submitted answer uses some technical vocabulary and there are severa grammar mistakes in the answer.
1	A few relevant points have been made but there is no evidence that a line o been followed. The points may only relate to one or two of the four areas f or may be made in a superficial way with little substantiation. Submitted answer contains very little if any technical vocabulary and th grammar are poor.

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 get to
Targeted advertising – Tesco announced plans for screens that identify your gend
checkout and target you with specific advertising.
The more companies such as Facebook and Google know about you, the better t
etc. Facial recognition allows them to create a kind of diary of your life from publi
Internet to create a personal history.
TVs are being made that can measure your engagement with a program/advert a
companies directly.
Benefits include targeted adverts that you may actually find relevant and significa

Privacy concerns
When is the data being collected?
Always-on technologies
Do the brands have th[illegible] know anything and everything about their custom
such info[illegible]
Who c[illegible]ata then be shared with? (SceneTap is a company in America who
allows u[illegible] identify real-time information on gender ratios and average age o
decide where to go on a night out. The company have since filed a patent for a p
people with their social networking profiles. This would then be used to determin
education and income' – is this information then going to be searchable by other
Most information that is currently data mined by companies is anonymous – facia
designed to be exactly the opposite.
Plans for use in public places means people don't get the choice to 'opt in' – is it even p

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 could w
you on the street without ever meeting you.
As soon as Google Glass was announced, an app called NameTag was created th
are able to start a conversation with a stranger; it would take a picture and search
find out who it is. Google Glass said they wouldn't use facial recognition with Gla
before someone else does – would Google then change their mind?
*Obviously the specific use of Google Glass is not required – even though the project is d
example to call upon and has only been discontinued so that Google can develop the n*

4.

Level	Description
4	A line of reasoning has been followed to pr[illegible] coherent, relevant, s logically structured response. The r[illegible]sp[illegible]nse [illegible]vers all four areas indicate guidance below and in at le[illegible] of these areas there is sufficient de the student has a [illegible] understanding of the technologies requ of understa[illegible] would be indicated by expanded points showing both [illegible] each section.
3	[illegible] of reasoning has been followed to produce a coherent, relevant, substa logically structured response but the response may only cover three of the ar guidance below, with two or three substantiated points being made per area
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 line o been followed. The points may only relate to one or two of the four areas fr 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 featu
able to complete the task without a 3rd party app.
When using these inbuilt apps, who has control over that data thought? Where is

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

What may the end goal be of gath[illegible]g [illegible] information?
The main argument for W[illegible]ving is to identify open networks for the convenien
where they can go to use Wi-Fi access if required (e.g. in a café).
WarDri[illegible] can be broken down into three groups:

- [illegible]nocently wish to gain free wireless access in their neighbourhoods
- 'They have commercial motivations and hope to sell security services.'
- 'They have dishonest motives and hope to surreptitiously access networks 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.